It's about time

Clerical-monastic engagements with calendar science

in Vatican, BAV, Pal. lat. 485

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Abbreviations

abb.	years of an abbacy.
Abtei	Bernhard Bischoff, *Die Abtei Lorsch im Spiegel ihrer Handschriften*, Geschichtsblätter für den Kreis Bergstrasse, vol. 10 (1989).
ac.	year of an arch-chancellorship.
AD	*Anno Domini*.
ae.	years of an arch-episcopate.
BAV	Biblioteca Apostolica Vaticana.
BC	Before Christ.
BNF	Bibliothèque Nationale de France.
BOT	Bede the Venerable, *Bedae opera de temporibus,* ed. Jones (1943).
ca.	circa.
ch./chs.	chapter/chapters.
Cap. comp.	'Das Aachener Verhör von 809', ed. Borst, *Schriften* 3, 1034-1053.
CCSL	*Corpus Christianorum Series Latina.*
CCCM	*Corpus Christianorum Continuatio Mediaevalis*.
CLA	*Codices Latina Antiquiores.*
DC	Hrabanus Maurus, *De computo,* ed. Stevens, CCCM XLIV (1978).
DTR	Bede the Venerable, *De temporum ratione*, ed. Jones, CCSL CXXIIIB (1977).
DT	Bede the Venerable, *De temporibus*, ed. Jones, CCSL CXXIIIC (1980).
fol./fols.	folio/folia.
Lect. comp.	'Die rheinische Anleitung von 760/792*',* ed. Borst, *Schriften* 2, 544-659.

Lib. ann.	'Das Veroneser Jahrbüchlein von 793', ed. Borst, *Schriften* 2, 660-772.
Lib. calc.	'Die Salzburger Enzyklopädie von 818', ed. Borst, *Schriften* 3, 1367-1451.
Lib. comp.	'Die Aachener Enzyklopädie von 809', ed. Borst, *Schriften* 3, 1054-1334.
ep.	year of an episcopate.
fasz.	faszikel.
fn./fns.	footnote/footnotes.
Kalenderreform	Arno Borst, *Die karolingische Kalenderreform*, MGH Schriften 46 (1998).
KFH	Bernhard Bischoff and Birgit Ebersperger, *Katalog der festländischen Handschriften des neunten Jahrhhunderts*, vols. 1-3 (1998-2014).
MGH	*Monumenta Germaniae historica.*
Epp.	*Epistolae* (in Quart).
Cap. ep.	*Capitula episcoporum*.
MS/1[1]	Vatican, BAV, Pal. lat. 485.
MS/2	Vatican, BAV, Pal. lat. 1447.
MS/3	Vatican, BAV, Pal. lat. 1448.
MS/4	Vatican, BAV, Pal. lat. 1449.
MS/7	Vatican, BAV, Pal. lat. 834.
MS/9	Vatican, BAV, Reg. lat. 123.
MS/37	Berlin, Staatsbibliothek, Phillipps 1869.
MS/67	El Escorial, Real Biblioteca del Monasterio de San Lorenzo, L III 8.

[1] The sigla used to identify computistical manuscripts in footnotes correspond to the catalogue of Computus.lat, e.g. www.computus.lat/ms/1. In the main text, manuscripts are identified in abbreviated form, i.e. Pal. lat. 485, Cologne 103, Wolfenbüttel 91, et cetera.

MS/88	Cologne, Erzbischöfliche Diözesan- und Dombibliothek, 83-II.
MS/89	Cologne, Erzbischöfliche Diözesan- und Dombibliothek, 103.
MS/92	Laon, Bibliothéque Municipale, 422.
MS/94	St. Gall, Stiftsbibliothek, 225.
MS/98	St. Gall, Stiftsbibliothek, Cod. Sang. 397.
MS/99	St. Gall, Stiftsbibliothek, Cod. Sang. 459.
MS/101	St. Gall, Cod. Sang. 878.
MS/107	Paris, BNF, Latin 4860.
MS/143	Madrid, Biblioteca Nacional de España, 3307.
MS/194	Oxford, Bodleian Library, MS Canonici Miscellaneous 353.
MS/225	Trier, Stadtbibliothek, 2500.
MS/247	Wolfenbüttel, Herzog August Bibliothek, Wissemburgensis 91.
MS/296	Paris, BNF, Latin 13373.
MS/307	Monza, Biblioteca Capitolare, e-14/127.
MS/308	St. Gall, Stiftsbibliothek, Codices Sangallense 124.
MS/503	Vatican, BAV, Pal. lat. 1341.
MS/523	Vatican, BAV, Pal. lat. 235.
MS/525	Vatican, BAV, Pal. lat. 495.
MS/526	Vatican, BAV, Pal. lat. 39.
MS/527	Vatican, BAV, Pal. lat. 973.
MS/528	Vatican, BAV, Pal. lat. 277.
MS/529	Vatican, BAV, Pal. lat. 833.
no.	catalogue number.
OT	Bede the Venerable, *On Times*, transl. Calvin B. Kendall and Faith Wallis, TTH 56, Liverpool, 2010.

p./pp.	page/pages.
PL	*Patrologiae Cursus Completus, Series Latina.*
Quaest. Austr.	'Die austrasische Abhandlung von 764*,* ed. Borst, *Schriften* 1, 462-508
Quaest. Langob.	'Die langobardische Abhandlung um 780*,* ed. Borst, *Schriften* 1, 509-526.
r	recto (after folio numbers);
r.	years of the reign of a king and/or emperor.
Reckoning	Faith Wallis, *Bede: The Reckoning of Time*. TTH 29 (1999).
Reichskalender	Arno Borst, *Der karolingische Reichskalender und seine Überlieferung bis ins 12. Jahrhundert*, vols. 1-3, MGH Libri memoriales 2 (2001).
Schriften	Arno Borst, *Schriften zur Komputistik im Frankenreich von 721 bis 818*, vols. 1-3, MGH Quellen zur Geistesgeschiechte des Mittelalters 21 (2006).
St./Sts.	Saint/Saints.
TTH	Translated Texts for Historians.
TROT	Bede the Venerable, *The Reckoning of Time*, transl. Faith Wallis. TTH 29 (1999).
v	verso (after folio numbers).

Acknowledgements

In the years working on this Master's thesis, I have had the pleasure and privilege to exchange ideas with a great number of scholars at Utrecht University, the Descartes Centre in Utrecht, Huygens ING in Amsterdam, the Institut für Mittelalterforschung in Vienna, during the 6th International of the Science of Computus in Galway, and using digital means of communication. I am particularly thankful to the learned discussions with four scholars. Firstly, I would like to thank Carine van Rhijn and Richard Corradini for our inspiring discussions during the early stages of my research project. Secondly, I owe a debt of gratitude to Immo Warntjes, who took a keen interest in my object-oriented approach to computus manuscripts. I have simply lost count of the number of occasions on which we discussed technical aspects of computus, my analysis of clerical-monastic engagements with calendar science, and especially the object-oriented methodology, using e-mail and Skype. Finally, I would like to thank Mariken Teeuwen for her expert advice, extensive feedback throughout my research project, and sharing her personal notes with me after an examination of Pal. lat. 485 at the Vatican Library in June 2017. I feel privileged to have worked under her supervision during my internship at Huygens ING and the writing process of the present study.

Introduction

In more than one respect, time is of the essence in this Master's thesis. Firstly, the primary source at the heart of my case study deals with the subject of time, but how and why exactly? Furthermore, I argue that a suitable time has arrived for a new approach to the varying contents of medieval manuscripts that deal with the reckoning of time, as well as a reappraisal of the place in the history of science, scholarship, and education of this body of knowledge known as computus. Last but not least, it is safe to say that at this point in time, it also became important to finish my thesis.

Reading it right

This study concerns a single text or compilation and the question of "reading it right". An answer to this question depends on who one believes to have the authority over a text.[2] Does its message stem from the authoritative reading of an author or compiler? Or is its meaning determined by the interpretations and attitudes of its readers? In my view, the historiographical interpretation of any source should incorporate both perspectives, resulting in an examination of the context in which a source was created and the context in which it was consulted.

My case study is a small anthology on the subject of calendar science within the second quire of the manuscript Vatican, BAV, Pal. lat. 485 (hereafter Pal. lat. 485).[3] In the following chapters, I consider the extent to which the presence, arrangement, and function of

[2] Richard Trachsler, "How to Do Things with Manuscripts: From Humanist Practice to Recent Textual Criticism", *Textual Cultures* vol. 1, no. 1 (2006), 5-28; The expression "reading it right" is borrowed from David Hult, "Reading It Right: The Ideology of Text Editing", in *The New Medievalism*, edited by Marina Scordilis Brownlee, Kevin Brownlee, et al. (Baltimore: John Hopkins University Press, 1991), 113-130.

[3] MS/1, fols. 4r-15r. In the present study, I revise, correct, and build forth on an outdated preliminary study of the computus in Pal. lat. 485, see Thom Snijders, "*Bonus liber*? (Dys)Functional computistical material in Vatican, BAV, Pal. lat. 485." Final paper for Tutorial AMR II, Utrecht University, 2015.

this corpus in a manuscript from the abbey of Lorsch, created between the years 850/860–875 and used between ca. 850–950, can be explained on the basis of its internal and external manuscript context, as well as its historical and intellectual context.[4] In other words, I examine the clerical-monastic engagement with computus in Lorsch, where the computistical collection in Pal. lat. 485 was allegedly created and used for the education of rural priests.[5]

Relevance

If scholarship from the fourth to the tenth century is not disregarded at all, or briefly characterized by stagnation and ignorance, historians of science describe early medieval science as an affair of a small group of extraordinary individuals. Thus, it may come as a surprise that a scientific anthology was included in a ninth-century monastic schoolbook for the education of priests. Because little is known about the schooling of local priests, let alone their initiation in calendar science, the educational level of secular members of the clergy is disputed by medievalists. Generally speaking, however, more recent representations of priests as local experts with sophisticated knowledge of all sorts of subjects refute more traditional depictions of secular members of the clergy as uninformed semi-literates.[6]

Thus far, the slowly increasing number of revisionist articles and books about the background, education, and life of medieval priests do not move beyond superficial descriptions of the engagements which priests had with calendar science. In short, computus is thought to have been required knowledge for secular members of the clergy, because they needed to be able to calculate correct dates for the moveable feasts like Easter and Pentecost.[7] Even the most specialist studies of the medieval reckoning of time do not perform a close

[4] Appendix 1 provides an annotated description of MS/1. For the place and date of origin of MS/1 and its use as a monastic schoolbook for the education of members of the clergy, see pp. 65-74.
[5] For the notion of a clerical-monastic engagement with science: Faith Wallis, "Albums of Science in Twelfth-Century England", *Peritia* vol. 28 (2017), 195-224, esp. 201.
[6] See pp. 44-47.
[7] See pp. 59-62.

reading of the computus collections were used to educate priests in the setting of monastic or episcopal schools. If such primary sources are taken into account, the computistical texts and tables in medieval schoolbooks are regarded as witnesses of earlier works, rather than interesting collections and objects in and of themselves.[8]

Simultaneously, the interpretation of the educational level of medieval priests during the period in which Pal. lat. 485 was created and used, is inextricably bound to debates about the nature of the Carolingian education reforms (ca. 750-900). On the one hand, the central manuscript of the present study could be interpreted as a witness of canonized and royally sponsored works, and thus a derivative outcome of uniform ambitions and a centralized reform programme. On the other hand, Pal. lat. 485 might be regarded as the product of a decentralized response to uniform reformative ambitions, characterized by local resources and the agency of a particular compiler.[9]

In short, a detailed examination of the presence, arrangement, and function of the computus in Pal. lat. 485 is due, for the analysis of this work of reference for computistical studies by rural priests has the potential to substantially change and problematize the outlook of the aforementioned debates and interpretations.

Structure

Because my case study is inseparable from numerous philological and historiographical considerations and disputes, I discuss the relevant debates at length in the first two chapters of this thesis. Chapter 1 is an examination of scholarly approaches to texts which are relevant to an analysis of Pal. lat. 485, and of its second quire. Based on a criticism of existing methodologies and terminologies, I introduce a new and object-oriented approach to cataloguing and analysing the contents of computus manuscripts. Having established that the

[8] See, especially, pp. 20-23 and 63-64.
[9] See pp. 36-47 and 53-59.

historical and intellectual context of a text are relevant to the interpretation of Pal. lat. 485, on the basis of the notions of "textual communities" and "social logic of texts", chapter 2 discusses historiographical interpretations and debates concerning medieval science, as well as educational reforms, calendar science, and clerical engagements with computus during the Carolingian period.

Together, chapters 1 and 2 provide several starting points for the detailed analysis of the presence, arrangement, and function of the computistical anthology in Pal. lat. 485 during the second half of this thesis. Chapter 3 is an introduction to this central manuscript as a whole and the abbey of Lorsch, including a reconstruction of the intellectual network of this monastery and the selection of a sample of regional manuscripts containing computus in preparation of the following chapter. Chapter 4 provides a close reading of the contexts of compilation and consultation of the computistical anthology in Pal. lat. 485. My examination incorporates the computistical material which was available in the inner circle of the intellectual network of Lorsch, the contents of the computus in Pal. lat. 485, and the boundary conditions for an educational use of this work of reference by future priests. Regarding the function of Pal. lat. 485's computistical anthology, special attention is requisite for its technical ambiguities and uncorrected mistakes. These remarkable traits of the computus in our central manuscript significantly increased the complexity of the material at hand, with significant implications for its educational use.

The fourth chapter is followed by the conclusions of my research. In short, clerical-monastic engagements with calendar science using Pal. lat. 485 required a vast amount of prior knowledge and/or the assistance of a local master of calendar science. Consequentially, the computus collection in Pal. lat. 485 is best understood as a work of reference for advanced studies of the reckoning of time by future rural priests.

The attached appendices provide additional information on Pal. lat. 485, some supplementary analyses of particular computistical details, and several overviews of the data on which my analysis is based. In turn, most of the appendices are based on a database and website, which I created during an internship at Huygens ING. The database and website, available on http://www.computus.lat/, are an essential part of my research project.

To facilitate the reading of the present study by an audience unfamiliar with the medieval reckoning of time, appendix 10 provides a list of definitions and explanations of the computistical terminology used in the present study. Rather than elaborating the used terms at every turn of my analysis, I have designed the glossary in such a way that it provides an alphabetical and thematical overview of all the information which is required for an understanding of my analysis.

Research strategies

My primary research strategy consists of the successive treatment of several cross-sections of my case study, which steadily narrow down the scope of this thesis. Moreover, I employ a contextual, comparative and object-oriented approach to textual analysis, examining Pal. lat. 485's computistical contents in relation to ninth-century intellectual developments, normative or legislative texts, and a range of computus collections and works within the selected regional manuscripts. In turn, each of these manuscripts consists of one or more codicological units, that is to say a number of quires which was produced at once and under the same circumstances.[10] Each of these codex units is thought to have been available in intellectual centres that were part of the inner circle of the intellectual network of Lorsch, prior to the creation of our central manuscript. By implication, their contents may be

[10] Johan Peter Gumbert, *Codicologische eenheden – een opzet voor een terminologie* (Amsterdam: KNAW, 2004), 1-38.

considered to be representative for the computistical material that was available during the creation and use of the computus in Pal. lat. 485.

Scope

For the sake of focus, the scope of this thesis is limited. Firstly, the analysis of my case study is restricted to the periods of Pal. lat. 485's creation (ca. 850/860–875) and its context of consultation (ca. 850/860–950), with an emphasis on the second half of the ninth century.[11] Secondly, I focus on Bede's paschal works and the Dionysian reckoning of time, which arguably provided the underlying computistical framework for most of the calendar science in our central manuscript.[12] Thirdly, some additional sources and perspectives have not been incorporated, although I am aware of their potential. For instance, the scope of this thesis necessitated the selection of a sample of extant regional codex units.[13]

Furthermore, it is important to note in advance that the computistical handbooks by Hrabanus Maurus (ca. 820) and Helperic of Auxerre (ca. 900) are absent in the sample of regional codex units. However, a now lost copy of Hrabanus' *De computo* (hereafter DC) must have been available in Lorsch ca. 860.[14] Because the exact contents and provenance of this codex are unknown, the value of DC as a source for my examination is questionable. Consequentially, my attention is limited to the parts of Hrabanus' handbook that would have been most relevant for the use of the computus in Pal. lat. 485, as a supplement to Bede's paschal works. A copy of Helperic's *De computo* from Lorsch is extant, but dates from the years 950-999.[15] As a result, the arrival of Helperic's computus in the abbey of St. Nazarius post-dates the period in which Pal. lat. 485's computus was used (ca. 850/860–950).

[11] These periodizations are supported by internal evidence, see pp. 65-74.
[12] See pp. 96-99.
[13] See pp. 88-91.
[14] See pp. 81-82.
[15] MS/503, fols. 95r-104v.

Therefore, I disregard the contents and educational use of Helperic's handbook in the present study.

Purpose

Finally, it is essential to remark that the purpose of the present study is not to create an edition of Pal. lat. 485 or its computus collection. Therefore, I do not pursue a complete source analysis for the contents of Pal. lat. 485 from the early history of medieval calendar science until ca. 850/860–875.[16] Instead, my case study is a proof-of-concept for a different and more restricted mode of analysis, namely a contextual and regional source analysis. In other words, the purpose of my analysis is to explain the presence, arrangement, and function of the computus in Pal. lat. 485 based on the educational and computistical traditions that were of influence in the inner circle of the intellectual network of Lorsch, as well as the computistical material that was regionally available.

[16] E.g. Immo Warntjes, *The Munich Computus: Text and Translation, Irish computistics between Isidore of Seville and the Venerable Bede and its reception in Carolingian times* (Stutgart: Franz Steiner Verlag, 2010).

1. Text approaches: old and new

Apart from a concern for analytical perspectives, the question of "reading it right" has an important methodological dimension. Therefore, this chapter builds forth on the preceding introductory remarks by examining what text approaches are relevant to an understanding of Pal. lat. 485's computistical dossier.

The social groups and sites of texts

According to Brian Stock, the existence of texts implies the historical presence of one or more social groups whose conducts and activities are centred around the aforementioned texts.[17] What all members of a "textual community" have in common is that they follow the same interpretation of and attitudes towards one or more texts through oral and written communication, either by having read the texts themselves, or knowledge of the texts by way of a literate mediator. As such, the minimal requirement for the formation of a textual community is a micro-society of a text, a literate interpreter, and an audience. Such micro-societies can include literates, but a wider group of semi-literates and even non-literates can also be part of them.

During the process of oral and/or textual initiation, education, and reflection, the central texts of textual communities produce new conducts and amend existing ones, thus shaping and reinforcing the identities of its members, both on a personal and a communal level. Hence, consciously and unconsciously, literacy has reforming effects and is often employed for reformative purposes.

[17] Brian Stock, *The Implications of Literacy: Written Language and Models of Interpretation in the Eleventh and Twelfth Centuries* (Pinceton, New Jersey: Princeton University Press, 1983), especially 88-92 and 522-531; Brian Stock, *Listening for the Text: On the Uses of the Past* (Philadelphia, Pennsylvania: University of Pennsylvania Press, 1996), 1-51, esp. 22-24.

The notion of a textual community is relevant to the case study of this thesis. Firstly, the pertinence of the notion of a textual community to religious and monastic environments is abundantly clear in studies by Stock and other historians.[18] Secondly, an important implication of Stock's mode of analysis is that a contextual study of texts, incorporating understandings, attitudes, and behaviours related to texts within textual communities, can help historians to interpret the historical meanings of a primary source.

Pal. lat. 485 was written and compiled ca. 850/860-875 and used to educate members of the secular clergy in the monastic community of Lorsch.[19] Thus, priests in Lorsch probably formed one or more textual communities around the contents of Pal. lat. 485's second quire. Several questions arise. For instance, what common interpretations of and attitudes towards this compilation did members of these textual communities follow? Was there a particular curriculum for the computistical education of priests? Were all the members of these textual community able to read and use the computus in Pal. lat. 485? Did a mediator, for instance a master or scholar of the calendar science, pass its meaning on to other members of the monastic community?

Another approach to the interpretation of texts is offered by Gabrielle Spiegel's "social logic of the texts". The concept of the social logic of texts stems from a belief that the meaning of any text derives in large part from its social and historical context and its position within the social and political networks in which it was elaborated and used – a text's so-called social site or space. Therefore, the recovery of the full meaning of a text begins with an understanding of its social logic, which is gained by moving from context to text and text to context. More specifically, Spiegel argues for an emphasis on the local or regional social environments of a text at a given moment, rather than at the level of society as a whole or a

[18] E.g. C. Annette Grisé, "The Textual Community of Syon Abbey", *Florilegium* vol. 19 (2002), 149-162.
[19] See pp. 65-74.

text's history during longer periods of time. Due to interrelations between text and context, Spiegel argues that the social reality of a text exists inside and outside the work itself.[20]

The social logic of texts can be used in a complementary fashion to the perspective offered by Stock's notion of a textual community. Firstly, the context or social space of Pal. lat. 485's second quire within the textual community of Lorsch derived from its contexts of creation and consultation, namely the abbey's scriptorium, library, and school. By extension, the computus in our central manuscript should be understood in the context of Carolingian ecclesiastical, political, and intellectual networks and the Carolingian reforms.

Secondly, it is plausible that the social logic of the computistical anthology in Pal. lat. 485 was bound to change. This, it seems, is something that Stock does not rule out, for it is imaginable that different textual communities formed around the same texts at different places and moments in time. For instance, the understanding of and attitudes towards the computus in Pal. lat. 485 from the perspective of its compiler and scribe versus its interpreters and audience were not necessarily the same. Moreover, its educational use during the final decades of the ninth century and the second quarter of the tenth century was not necessarily the same, as generations of students and, perhaps, school masters succeeded each other. It would, therefore, be best to presume the existence of changing sets of interpretations, attitudes, and emphases, belonging to multiple textual communities.

Identifying and describing texts and textual relations

The notions of a textual community and the social logic of texts point in the same direction: understanding the social and intellectual contexts of Pal. lat. 485's second quire is crucial for an interpretation of its meanings. The purpose of the following chapters is, therefore, to

[20] Gabrielle M. Spiegel, "History, Historicism, and Social Logic of Texts in the Middle Ages", *Speculum* vol. 65, no. 1 (1990), 59-86; Gabrielle M. Spiegel, *The Past as Text: The Theory and Practice of Medieval Historiography* (Baltimore: The Jonhns Hopkins University Press, 1997), especially 24-28 and 53-54.

discuss an array of different contexts, steadily moving from a general level to a more specific level and taking on board what is relevant to the analysis of our case study.

However, in order to examine the arrangement and function of the computus in Pal. lat. 485, further terminological and theoretical considerations need to be placed under scrutiny. The computistical anthology in Pal. lat. 485 is part of a bigger manuscript and emerged from the tradition of the Carolingian reforms, including the production of other regional codex units. To analyse the internal and external manuscript contexts of our case study, a terminology is required to classify, describe and analyse the texts and relationships between texts within one or more codicological units.

Incipits and explicits

The existing method for the identification of text units in manuscripts is based on the beginnings (*incipits*) and/or endings (*explicits*) of texts. Such identifications, based on the first and last words of a texts, are employed in the indices of several studies and editions, but also within traditional manuscript descriptions. To give two examples that match the topic of this thesis, *incipits* and *explicits* are extensively applied by Alfred Cordoliani and Arno Borst.[21]

Working with this mode of identification is, however, not watertight: the contents of texts sometimes varies, although their beginnings and endings are the same, and texts can be closely related, although their beginnings and endings are different. Furthermore, *incipits* and *explicits* are not very helpful for the representation of the contents of calendars, tables and diagrams, which are abundant in computistical manuscripts.

[21] *Schriften* 3, 1507-1537; Alfred Cordoliani, "Contribution à la littérature du comput ecclésiastique au haut moyen âge", *Studi medievali* vol. 1 (1960); Alfred Cordoliani, "Contribution à la littérature du comput ecclésiastique au haut moyen âge", *Studi medievali* vol. 1 (1961), esp. 176-208.

From copies to *scripta*

Our ways of thinking about texts, the identification of texts, and their history of dissemination is, moreover, shaped in a major way by the traditional critical method of editing texts by Karl Lachmann. In the words of Peter F. Dembowksi, the Lachmannian method stands for 'a rigorous study of variant readings culled from all manuscripts, leading ultimately to a reconstruction of a hypothetical original (…) based on the crucial idea of common error.'[22] The resulting edition is usually presented as a genealogical tree – the so-called *stemma codicum* – which describes the extant manuscript evidence of a textual work as a family, accompanied by a reconstruction of the original, or a representation of the copy that is presumably the closest to this archetype. Thus, the "common error method" ranks the value of surviving sources according to their closeness to "the original".[23]

According to Tjamke Snijders, the terms deriving from the Lachmannian method – *copy*, *witness*, *recension*, *variant*, *version,* and *standard reading* – are subject to three very profound conceptual problems. Firstly, the entire terminology serves to characterize a manuscript's contents in terms of their relation to something external to that codex, namely some earlier work: an ideal *Urtext* or archetype 'that [is] considered to be the text as the author had meant it to be, without the noise introduced by scribes.'[24] Yet, apart from considering the possibility that a manuscript text may be a deliberate variant or version of some ideal work, it is important to also consider and describe codices as stable and self-contained objects, with specific textual and material characteristics, and a particular historical significance which does not only derive from the notion of some original. Hence, the

[22] Peter F. Dembowski, "The "French" Tradition of Textual Philology and Its Relevance to the Editing of Medieval Texts", *Modern Philology* vol. 90, no. 4 (1993), 514.
[23] Complementary descriptions and overviews of main criticisms of the Lachmannian can be found in ibid., 512-32; Trachsler, "Things", 14-22; Tjamke Snijders, "Work, Version, Text and Scriptum: High Medieval Manuscript Terminology in the Aftermath of the New Philology", *Digital Philologhy: A journal of Medieval Cultures* vol. 2, no. 2 (2013), 266-8 and 274-80.
[24] Snijders, "Scriptum", 267.

contextual factors of their moments of compilation should be taken into account, e.g. by perceiving scribes as authors, rather than copyists. Unfortunately, the traditional terminology of philology always brings the notion of a presupposed original into play, impeding the interpretation of a text units as interesting objects in and of themselves.[25]

Secondly, rather than being representative of the overwhelming amount of variance within the manuscript evidence, the Lachmannian methodology forces researchers to rigidly classify manuscript texts in a recension of several independent branches of the transmission of the *Urtext*.[26] However, the textual and material relationships between different codices usually are too complex and ambiguous for such classifications to succeed. It is often impossible to tell whether "common errors" are changes that were intentionally made for the better, or unintentionally made in the form of truly degenerative errors. They might, moreover, be the result of straightforward copying (implying a direct relation between copies) or coincidence (implying no relation whatsoever). The extant manuscripts do not necessarily belong to a single branch of transmission. Moreover, it is impossible to tell whether extant manuscripts are directly related or independently based upon a now lost exemplar.[27]

Here, it should be added to Tjamke Snijders' criticism that the manuscript context of works, including computistical works, usually differs. In fact, the notion of a work as a clearly defined unit is in jeopardy, because abridged and extended versions were regularly distributed. For instance, Bede's *De temporibus* (hereafter: DT) and *De temporum ratione* (hereafter: DTR) were often copied without the chronicles at their ends. Meanwhile, a calendar, Easter table, and other algorithms and tables were attached to these handbooks. Some of this material is thought to have been affixed by Bede himself, whereas other complementing material may have been added by scholars, scribes, and compilers distributing

[25] Ibid., 276-88.
[26] For the notion of variance, see Trachsler, "Things", 19-20.
[27] Snijders, "Scriptum", 278-9.

these paschal works. For a valid understanding of the material within the extant manuscripts, it is essential to take all of these marks of variance and agency into account, rather than filtering them out.

Finally, the existing terminology exclusively pertains to textual evidence, disregarding material considerations. Tjamke Snijders considers this to be an especially pressing matter, for Material Philologists, like herself, are particularly interested in the parchment used, the binding structure, and the layout of the contents of medieval codices.[28] All these elements contain vital information about where, when, and why a text was produced.[29]

For these reasons, so-called New Philologists argue that attempts to create Lachmannian editions need to be abandoned, and that a return to analyses of manuscripts as unique objects with equal merit is in place. Tjamke Snijders rejects this radical proposal, for it dissolves the possibility of classifying relations between the contents of multiple manuscripts. Instead, she explores the middle ground, arguing that the ability to classify a manuscript's variance and materiality can be maintained by returning to a terminology that is based on a late medieval ontological debate concerning the problem of universals (like ideas or concepts of a work) and particulars (like the materiality of a specific manuscript).[30]

Building forth on a proposal by John Dagenais, Tjamke Snijders uses the notion of a *scriptum* in reference to a manuscript or some part of a manuscript, which is defined by its physical boundaries, instead of its contents. Hence, this notion signifies the material unity – and if present the textual cohesion – of an object, with materiality preceding over textuality, and without automatically presupposing relationships to other *scripta*, or the transmission of an *Urtext*. There is, however, no objection to the adoption of this notion in the context of the Lachmannian method. It remains possible to regard *scripta* as witnesses or versions of a work.

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[28] Ibid., 266 and 279.
[29] See the special issue of *Speculum* titled *The New Philology*, especially Stephen G. Nichols, "Introduction: Philology in a Manuscript Culture", *Speculum* vol. 65, no. 1 (1990), 1-10.
[30] Snijders, "Scriptum", 267-8 and 283-6.

However, discussing such relationships is no longer the basis of the entire terminology. The roles of the work and the *scriptum* are, essentially, reversed.[31]

Unfortunately, the use of the term *scriptum* has at least two downsides. For one thing, the term has not gained any traction in manuscript studies. More importantly, although talking about *scripta* can be especially useful for describing self-contained parts of a manuscript, a network analysis of the textual and material relations between multiple codices would still involve a recourse to the Lachmannian terminology and method of edition-making. Yet, doing so exposes the researcher to the second weakness of the Lachmannian approach, which remains unresolved: the rigid method of classification is inapplicable due to the sheer variance in the extant manuscripts.

Consequentially, rather than starting to use the notion of a *sciptum*, accompanied by the traditional terminology of philology, I prefer to introduce a new terminological framework that covers the grounds of the term *scriptum,* and is, at the same time, functional for a different mode of classifying textual and material relations within and between codices.

An object-oriented approach

A suitable terminological framework that also involves the notion of an "object" can be borrowed from computing, a modern field of work that, like the medieval science of computus, is named after the Latin word for calculating or computation.[32]

The terminological and structural similarities between philology and programming are striking, to say the least. Terms related to the notion of a script are use in both fields. For instance, manuscripts and scripted applications are both interpreted as having been compiled at some point in time. The resemblances stretch beyond the terms in use. At a structural level,

[31] Ibid., 280-286.
[32] See p. 50-51.

the coding habits of modern day software developers are reminiscent to medieval scribal practices. Programmers and scribes alike use libraries: collections of pre-written texts or pre-programmed scripts that are used or excerpted when new manuscripts or applications are being compiled. In both cases, the habit of excerpting often implies some notion of open-source prefabricated texts or scripts that are reused, for acknowledgements of sources are regularly absent in medieval manuscripts and programmed scripts. Likewise, although standing at great historical distance to one another, the process of compilation, in both contexts, results in a vast amount of fluid compilations that were and are continuously updated to ever-changing and local practical requirements. Consequentially, the works of programmers and scribes hardly ever attain a canonized status. Updated versions, new offshoots and alternative compilations were and are continuously created and distributed. Yet, outdated compilations continued or continue to be used, or are preserved as unused shelf-ware. As a figure of speech, programmers may be described as the present-day scribes. In turn, it is probable that there is something to be learned from a take to philology from a programmer's perspective.

Objects, classes and occurrences

In fact, a suitable terminological framework for the classification and description of the contents of computistical manuscripts based on internal textual and material characteristics, as well as the external relationships between textual and material properties of manuscript texts, can be based on Object-Oriented Programming.[33]

[33] The following paragraphs are a translation and improved version of the description of the object-oriented methodology, which first occurred in a report about my internship at Huygens ING, see Thom Snijders "*Een digitale en object-georiënteerde benadering van computus manuscripten*." Stageverslag, Utrecht University, 2017. An experimental object-oriented catalogue, created using the dataset of this thesis, is available on www.computus.lat. I first suggested an early version of the object-oriented approach to computistical manuscripts to Immo Warntjes in April 2017. Thereafter, we discussed and improved the methodology using e-mail and Skype. This thesis and the experimental object-oriented catalogue on http://www.computus.lat/objects provide its first application to a case study.

In the object-oriented approach to manuscript evidence, the notion of an *object* resembles Tjamke Snijders' *scriptum*. The object is some part of a manuscript that is defined by its material and/or textual boundaries and/or cohesiveness: it is a unified object in and of itself, without automatically presupposing relationships to other objects. Like the objects from computing, computistical objects have certain *characteristics* (also: *attributes* or *variables*). Moreover, computistical objects usually contain or describe one or more *procedures* and/or *formulas* (also: *methods* or *functions*). The notion of an object could be compared to the medieval concept of particulars.

In contrast to *scripta*, the proposed object-oriented approach to philology does, in fact, offer the possibility to invoke some sort of an ideal type, but this time around this *class* is explicitly artificial. The class is a theoretical description of what distinguishes all of its instances – the objects – from the instances belonging to other classes. Thus, the notion of a class is used like a template or blueprint, which describes the shared characteristics of all the objects belonging to it. A comparison could be made to the medieval notion of universals.

Similar objects can be found in multiple codices and could be described as multiple objects belonging to the same class. Meanwhile, identical computistical objects can be encountered in more than one manuscript, resulting in a description of multiple *occurrences* of the same object. However, a non-relational approach is not ruled out, for the notion of an object can be used independently from the concepts of classes and occurrences.

Rules of engagement

A class can be defined based on the textual and material characteristics of a single object. However, it is more easily identified and described using similar objects. The process of identification generally relies on the layout and/or the contents of an object, which stands out in comparison to its neighbouring objects or forms a cohesive unit. Moreover, objects and

classes can be deduced using existing editions.[34] The following rules of engagement can be applied for the identification of classes, objects and occurrences:

Different classes are discerned when 1) the subject and/or scope of texts is entirely or for the most part different; 2) the subject and/or scope of texts is the same, but most numbers and/or units are different; 3) the type of the texts is different, e.g. a formula and a table; and/or 4) the text consists of differing combinations of smaller elements. Possibly, some of these smaller objects do belong to the same class.

Different objects of the same class are discerned in case of 1) structural differences; 2) consistent differences that cannot have been caused by scribal mistakes and/or partially or significantly differing numbers, e.g. characteristics occurring in multiple manuscripts; 3) differences in the phrasings and wordings of texts, with the exception of synonyms; and/or 4) differences in the length or word count of texts; and/or 5) differences between the given examples.

Finally, different occurrences of the same object are discerned in case of: 1) identical objects; 2) non-consistent differences, presumably scribal mistakes; 3) differences in the order of the words within a sentence; 4) synonyms or different writing styles of the same word, numbers or data; 5) the doubling of words within a sentence, usually resulting from changes in the order of words within a sentence; and/or 6) the doubling of words and parts of sentences that can be explained as homeoteleuta and/or dittography.[35]

[34] E.g. the chapters of the computistical works edited in *Schriften*.

[35] Paul Edward Dutton, "Eriugena's workshop: The making of the *Periphyseon* in Rheims 875", in *History and Eschatology in John Scottus Eriugena and his Time*, edited by James McEnvoy and Michael Dunne, *Ancient and Medieval Philosphy, De Wulf-Mansion Centre Series* (Leuven: Leuven University Press, 2002), 141-167, esp. 150.

Variance and clusters

Based on the available manuscript evidence, medieval scribes working on computistical texts were not limited to making faithful copies of existing objects. On the contrary, identical occurrences of the same object are the exception to the rule of adjustments in the form of excerpting, recompiling, and rephrasing. Although medieval scribes would not have thought of their practises in terms of objects and classes, the conscious and unconscious dynamics of scribal habits can be described as a process of instantiation of computistical objects that impacted their textuality (i.e. phrasing and meaning) and materiality (i.e. layout, quality of the parchment, writing style). With each new object, some textual and material attributes or variables were preserved (*inheritance*), while other characteristics were altered (*mutations)*. Consequentially, computistical manuscripts usually contain miscellaneous and unique anthologies, typically consisting of aberrant objects, rather than collections or *copies* of canonized computistical objects or works.

If anything, flexibility and scalability is what is needed to represent and describe the variance encountered in the extant manuscript. Hence, it is desirable to define computistical objects at multiple levels, following the opposite directions of compiling and de-compiling. In principle, any object can be a building block for a new group of objects – known as *clusters* – when it is combined with other objects (*extension)* or included in another object (*inclusion)*. The processes of extension and inclusion result in a new and bigger object. The boundaries of these clustered objects can scale upwards from the size of some part of a folio to the size of a complete manuscript, forming a compilation or work. Usually, however, clusters have a size ranging from some part of a folio to a codicological unit. In the opposite direction, parts of an object can at some point in time be excerpted, forming new and smaller objects. In turn, this self-contained object can be used separately and/or be included and extended to form a new clustered object. As a result, newly identified objects and classes may immediately be

recognized as a cluster, consisting of smaller objects, but can also be identified as such at a later point in time, when an object is compared to the contents of other manuscripts.

The object-oriented approach can be applied in analyses of textual and material relations *within* manuscripts, as well as external textual and material relations *between* manuscripts. Comparable objects and clusters in multiple manuscripts can be described as instances or objects of the same class and/or occurrences of the same object. Additionally, the object-oriented terminology can be applied in a more traditional philological context, for different objects belonging to the same class can be, but do not necessarily have to be, discussed as copies or variants of an original work.

Finally, it is essential to note that the process of identifying objects and classes is an arbitrary process. Ideally, the digital format of an object-oriented catalogue is, therefore, scalable and adaptable on the basis of new insights.

Shortcomings, benefits and purpose

The subjectivity, inconclusiveness and anachronistic nature of the object-oriented approach may be interpreted as shortcomings of this methodology, yet the same criticism is applicable to the Lachmannian approach. Inconclusiveness is, moreover, a generic characteristic of most, if not all, historiographical debates. More importantly, the inconclusiveness of the object-oriented method points in the direction of what may be the biggest strength of this approach, namely its scalability and flexibility.

An occurrence of an object can at the same time be interpreted as an independent unit *and* as a cluster, depending on the argument that is being made. The list of characteristics of objects and classes within an object-oriented description can, moreover, be supplemented at any point in time, especially in the case of a digital catalogue of manuscript contents. For instance, the initial properties of classes could be their type (e.g. calendar, verse, or formula),

some computistical parameters, and a formula. In the description of an object, the combination of an incipit and explicit could be specified, as well as a mentioned example or dating clause. In turn, the description of occurrences mentions their locations within specific codex units and a word length. Meanwhile, characteristics are inherited from the level of the class to the object, and the level of the object to the occurrences. At a later point in time, additional computistical, codicological, and palaeographical attributes could be added to these entries, such as writing style, quality of parchment, et cetera.

Furthermore, it is crucial to note that the first catalogued occurrence of an object or object of a class is not necessarily the oldest or original. The first instance in the catalogue is arbitrary and depends on which manuscript was consulted first. At the onset, all objects belonging to the same class have an equal merit, contrary to the witnesses in the Lachmannian terminology. Nonetheless, a network analysis of the historical transmission of computistical objects may in some cases be possible, perhaps even in the form of a Lachmannian recension. However, such interpretations are up to the users of the catalogue.

Note, from this perspective, that occurrences of the same clustered object do not necessarily imply that these groups are copies. The same cluster may coincidentally have come about in the hands of more than one scribe, for example by way of associative attraction.[36] Furthermore, although multiple instances of objects and related objects can be found within the extant manuscripts, it is important to keep in mind that a medieval user of a small number of manuscripts may not have known more than a small number of instances. Obviously, a scholar active in the process of compiling a manuscript and comparing objects of the same class, was aware of multiple instances. For a priest, however, the occurrence of an

[36] For the principle of associative attraction see Faith Wallis, "Medicine in Medieval Calendar Manuscripts: A Book of Essays", in *Manuscript Sources of Medieval Medicine*, edited by Margaret R. Schleissner (New York and London: Garland, 1995), 105-143.

object in a monastic schoolbook or a personal instruction-reader potentially was the *realized object*.[37]

Ultimately, the object-oriented approach is intended as a new approach to all kinds of miscellaneous manuscript evidence, offering new approaches to identifying, cataloguing, and describing objects and providing opportunities for network analyses of textual relations. Although the use of this method may result in a vast object-oriented catalogue of the computus within medieval manuscripts, such a work of reference should not be interpreted as a compilation of definitive identifications and interpretations. Principally, it is a question-generator, providing new ways to analyse and compare manuscript texts, leaving the task of interpretation to the historians that use it for their research.[38]

[37] For the notion of realized variants, see Trachsler, "Things", 22.
[38] In the experimental object-oriented catalogue on http://computus.lat/objects, classes are identified using abbreviations (i.e. CC for a table of concurrents). Every object belonging to a class has a reference number (i.e. CC/1, CC/2, et cetera).

2. Computus as Carolingian Science

Based on the ideas of textual communities and the social logic of texts, historical and intellectual contexts are essential to an interpretation of the meanings of the computus in Pal. lat. 485.[39] Hence, this chapter investigates the developments in learning during the period in which our central manuscript was compiled, namely the era of the Carolingian reforms (ca. 750–900). Moreover, this chapter defines and explains what computus was about and questions whether the medieval reckoning of time could be interpreted as a form of medieval science. Finally, Carolingian computus and notions of clerical-monastic engagements with calendar science in royal and episcopal instructions are placed under scrutiny. An analysis of these subjects is inseparable from an introduction to several interpretative problems, disputed in prolonged and ongoing historiographical debates. Because "medieval science" is itself a debatable term, that is where this chapter sets off.

The long shadow of the Dark Ages

Judged by the general consensus in the historiography of science, the early middle ages and science are an improbable combination.[40] Usually, the attention devoted to early medieval scholarship and education in textbooks on the history of science is limited at best. The

[39] See pp. 16-18.

[40] My examination of medieval science in the historiography of science is based on the interpretations and discourse in studies and textbooks by Anthony M. Alioto, William B. Ashworth, H. F. Cohen, Harold Dorn, Edward Grant, Frederick Gregory, Pearl Kibre, David C. Lindberg, James E. McClellan III, and Ronald L. Numbers. For earlier, annotated analyses, see Thom Snijders, "Een Missende Schakel: Nieuw Licht op de Vormen van Natuurkennis van de Donkere Eeuwen" (Bachelor thesis, Utrecht University, 2014, http://dspace.library.uu.nl/handle/1874/290106); Thom Snijders, "The Roman and Early Medieval Glass: A Reappraisal of the Historiographical Interpretation of Roman and Early Medieval Nature-Knowledge, 1980-2014" (Final paper for History, Role and Impact of the Natural Sciences, Utrecht University, 2014.

medieval West is depicted as an intellectual wasteland where "science" was non-existent, in decline, and/or exclusively an affair of exceptional individuals.

Although the exact applicability of these designations often remains vague, the preeminent interpretation reads as follows. The degeneration of intellectual traditions in the medieval West, during and after the fall of the Roman empire, was first and foremost caused by barbarian invasions. In addition, a process of transplantation, assimilation, and adaptation of knowledge by an increasingly Christian civilization took place, interpreted as a sign of disinterest and the demeaning of "science". The problem with these approaches to medieval learning and the notion of "the Dark Ages" is that the shadow thus cast is more likely to obscure than illuminate.[41]

The image of decline and disinterest is problematical. Chronologically, a period of intellectual decline is thought to have occurred at the beginning of the Roman era, followed by ages of limited Roman interest in "the sciences". By implication, the high tide of ancient learning was bygone before the beginning of the Middle Ages. However, "science" is nonetheless said to have declined during the early medieval period. Meanwhile, it is usually reckoned that the focal point of ancient intellectual developments was located in South-Eastern Europe, with Athens and Alexandria as the main intellectual centres, rather than North-Western Europe. Taking these antimonies into account, it becomes obvious why one should be careful with arguments of decline and stagnation, considering a region and period that is located at a vast distance from the point of reference in the dual sense of space and time.

[41] In this final sentence, I borrow a metaphor from Matthew Innes, derived from an entirely different context, but nonetheless applicable. Matthew Innes, "Charlemagne's Government", in *Charlemagne: Empire and Society*, edited by Joanna Story (Manchester: Manchester University Press, 2005), 86. Likewise, the expression in the title of this paragraph is based on Paul Fouracre, "The Long Shadow of the Merovingians", in *Charlemagne: Empire and Society*, edited by Joanna Story (Manchester: Manchester University Press, 2005), 5-21.

Historically, North-Western Europe was only partially and peripherally integrated into the Roman Empire. Likewise, vast amounts of this geographical area were incorporated into the Frankish kingdoms and Christianised as late as the first half of the ninth century. Thus, in terms of the state of learning, it seems unjustifiable to presume that North-Western Europe had at any earlier time and in general terms been on par with the remote centres of ancient learning. In other words, it seems unlikely that the (pre-)medieval state of learning in the North-Eastern part of the Carolingian empire had ever before provided sufficient preconditions for the occurrence of a sharp decline of scholarship.

The explanatory bond of a process of transplantation of knowledge by Roman and medieval scholars, and negative connotations of stagnation and popularization of ancient learning, is equally susceptible to crumbling under scrutiny. A more positive appreciation of the modest influx of ancient scholarship during the Roman and early medieval eras seems appropriate, namely in the sense of a first encounter with foreign intellectual traditions in what would become the Visigothic, Irish, Anglo-Saxon and Frankish regions.

In practice, knowledge and practices were assimilated or neglected, depending on their compatibility with local circumstances and interests. Apart from differences in language and the local inapplicability of, for instance, astronomical observational data, the early medieval period was characterized by an exclusive interest in learning that was deemed relevant from a theological or practical perspective. Rather than a negative process of intellectual stagnation, an introduction and adaptation of knowledge occurred in an entirely different time and place, where scholarship and learning played by a different set of rules.

A further sign of the inconsistency of the preeminent representations of the early and late medieval periods in the history of science concerns the sharp contrast between the dark intellectual vacuum of the former period and the brighter phase of intellectual history during the latter. Early medieval and late medieval “scientific” practices are, nevertheless, often

conjointly designated as “medieval”, implying some sort of coherence and continuity in what is otherwise described as a period of great discontinuities.

One reason for these shortcomings is the fact that historians of science perceive early medieval learning and bodies of knowledge through a lens that is adjusted to rigid and modern definitions of “science”. Besides, historians of science assume that a specific inclination of science is applicable to the medieval period, namely that of disciplines of the liberal arts (grammar, logic, and rhetoric, arithmetic, geometry, music, and astronomy). By and large, however, such definitions and associations are incompatible to early medieval scholarship and education. Consequentially, the clearest evidence of what was characteristically early medieval learning is disregarded, for it remains in the blurred fringes of the historiography of science: broad bodies of knowledge like *computus*, and the principles of associative attraction and learning for God, in the inseparable senses of medieval scholarship and education.[42]

As the liberal arts were only loosely assimilated into the new Christian, medieval educational programme between ca. 400 and 700, their influence was modest and ambivalent at best. In practice, the precepts of patristic texts, monastic rules, and royal or episcopal instructions were more influential. Thus, although the liberal arts occupied a place in Christian learning, a single taxonomy of distinguishable disciplines never materialized. As a result, Carolingian pupils studied less than half of the seven liberal arts, for literacy, numeracy and an understanding of symbolism were prioritized. Meanwhile, higher-educated scholars often appealed to the liberal arts, but their aspirations remained symbolical and haphazard at best. Early medieval learning was all the more idiosyncratic, because it depended on local circumstances, resources and interests. At all times, however, it was subordinate to the pursuit

[42] For the principle of learning for god, see John J. Contreni, "Learning for God: Education in the Carolingian Age", *The Journal of Medieval Latin* vol. 24 (2014), 89-129. For the *artes liberales* versus computus as medieval science, see Immo Warntjes, "Irische Komputisik zwischen Isidor von Sevilla und Beda Venerabilis: Ursprung, karolingische Rezeption und Forschungsperspektiven", *Viator* vol. 42, 1-4.

of divine wisdom of the Scriptures and God's creation, in which all forms of early medieval education and scholarship culminated.[43]

The shadow cast by the combined notions of "science" and "the Dark Ages" is long indeed, for it also affects the historiography of subsequent periods. Historians of science often speak of a "revival" or "recovery" of intellectual traditions from the eleventh century and onwards, culminating in the Renaissance, Scientific Revolution and the Enlightenment. Instead, the term "discovery" may be more applicable, for most of the newly arriving ancient texts during and after the eleventh century were probably unknown to any person in North-Western Europe up to this point in time.

In the light of the dominant and consenting view that scholarship and education between 400 BC and 1050 AD are justly disregarded, the general lack of a widely supported revisionist tradition in the history of science is easily explained. This is, however, not to say that there have been no incentives for a reappraisal, as several related fields of research have been thoroughly overhauled. For instance, the old paradigm of the Fall of the Roman Empire has been rejected, due to a growing recognition for the continuity between the third and seventh centuries after Christ. Accordingly, the notion of the Dark Ages has also waned, at least in medieval studies.[44] Furthermore, other modernist periodizations such as the

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[43] See John J. Contreni, "Education and Learning in the Early Middle Ages: New Perspectives and Old Problems", *The International Journal of Social Education* vol. 5 (1989), 725-747; John J. Contreni, "The Carolingian Renaissance: education and literary culture", in *The New Cambridge Medieval History: c.700–c.900*, edited by Rosamond McKitterick, vol. 2 (Cambridge: Cambridge University Press, 1995), 709-757; John J. Contreni, "Counting, Calendars and Cosmology: Numeracy in the Early Middle Ages", in *Word, Image, Number: Communication in the Middle Ages*, edited by John J. Contreni and Santa Casciani (Florence: SISMEL, Edizioni del Galluzo, 2002), 43-90; Contreni, "Learning for God", 89-129. Moreover, Brigitte Englisch describes the continuity of the quadrivium between antiquity and the Early Middle Ages as an incoherent body of loosely defined mathematical arts, and computus as an innovative tradition that complemented the quadrivium: Brigitte Englisch, *Die Artes liberales im frühen Mittelalter (5.-9.Jh.): Das Quadrivium und der Komputus als Indikatoren für Kontinuität und Erneuerung der Exakten Wissenschaften Zwischen Antike und Mittelalter*, vol. 33, Sudhoffs Archiv Zeitschrift für Wissenschaftsgeschichte (Stuttgart: Franz Steiner Verlag, 1994).

[44] For an introductory article, see Glen W. Bowersock, "The Vanishing Paradigm of the Fall of Rome", *Bulletin of the American Academy of Arts and Sciences* vol. 49, no. 8 (1996), 29-43; Also, see the recent textbooks on medieval history, e.g. Matthew Innes, *Introduction to Early Medieval Western Europe, 300–900: The Sword, the Plough and the Book* (London: Routledge, 2007), particularly 1-9 and 20-207; Julia M.H. Smith, *Europe after Rome: A New Cultural History 500-1000* (New York: Oxford University Press, 2005), particularly 1-9;

Renaissance and the Scientific Revolution have come under fire.[45] Nevertheless, these and other overhauls never induced a reappraisal of the "mainstream" history of science between the Ancient Greeks and the late medieval period – at least, not by historians of science.[46]

Unity and diversity: the Carolingian reforms

To wit, historians of the Middle Ages, whom hardly ever concern themselves to be historians of science, have often studied medieval intellectual developments in more detail and from a less biased point of view. Usually, however, they did so under the banner of the history of identity formation, learning, linguistics, or Christianity.[47] Moreover, historians of intellectual history, the history of ideas, and in particular the history of knowledge employ notions of scholarship and knowledge that are similar to the perspective of this thesis.[48]

An early medieval period that has been of special interest from these perspectives is the era in which the central manuscript of the present study was produced, namely the "Carolingian Renaissance" (ca. 750-900). Traditionally, this period is known for its conjoined revival of learning, cultural renewal and reforms of government, Church and education. All of

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Chris Wickham, *The Inheritance of Rome: A History of Europe from 400 to 1000*, 7 vols., vol. 2, The Penguins History of Europe (Londen: Penguin Books, 2010), particularly 3-18 and 23-251.

[45] See, for example, Ken Alder, "The History of Science, Or, an Oxymoronic Theory of Relativistic Objectivity", in *A Companion to Western Historical Thought*, edited by Lloyd Kramer and Sarah Maza (Malden and Oxford: Blackwell Publishing, 2006), 297-318; William B. Ashworth Jr., "Natural History and the Emblematic World View", in *The Scientific Revolution. The Essential Readings*, edited by Marcus Helleyer (Malden and Oxford: Blackwell Publishing, 2003), 132-156.

[46] Of course, exceptions to the rule exist, such as Victor J. Katz, ed. *Sourcebook in the Mathematics of Medieval Europe and North Africa* (Princeton: Princeton University Press, 2016); Daryn Lehoux, *What Did the Romans Know? An Inquiry Into Science and Worldmaking* (Chicago: University of Chicago Press, 2012); Stephen C. McCluskey, *Astronomies and Cultures in Early Medieval Europe* (Cambridge: Cambridge University Press, 1998).

[47] Which is, of course, not to say that medievalists with an interest for the history of early medieval science have never published about "science" as such. For instance, see the numerous articles concerning astronomy, computistics, mathematics and applied sciences in *Science in Western and Eastern Civilization in Carolingian Times*, ed. Paul Leo Butzer and Dietrich Lohrmann (Basel: Birkhäuser Verlag). See also James T. Palmer's recent blog posts "Early medieval science is changing" (3 March 2018) and his new project about early medieval science (5 April 2018): https://merovingianworld.wordpress.com.

[48] I.e. Peter Burke, *What is the history of knowledge?* (Cambridge: Polity Press, 2016); Richard Whatmore, *What is Intellectual History?* (Cambridge: Polity Press, 2015).

these efforts are associated with the advancement of uniformity, orthodoxy and literacy, and the ultimate goal of salvation for the Christian people under Carolingian rule.[49]

Like the abovementioned periodizations and notions, the interpretations of the "Carolingian Renaissance" are subject to shifting and ambivalent perspectives, some of which are more radical or reserved than others. Consequentially, the field of Carolingian studies is aptly characterized as a variety of voices and inflections, in which individual interpretations and emphases have, during the last decades, collectively produced a new perception of the period.[50] This is not to say that the debate about the "Carolingian Renaissance" is nowadays resolved, for stronger and more subdued interpretations continue to exist.

The precise historiographical positions and nuances are too complex a story to explain in detail here. However, it seems possible and relevant to deduce some complementary and/or widely supported perspectives from the ongoing debates, which bear directly or indirectly upon the case study of this thesis. In short, most studies of the Carolingian period concern the nature, predecessors and external influences, circumstantiality, and/or the scale and depth of the educational reforms between the years 750–900. Moreover, a range of inextricably bound revisionist tendencies has generally resulted in a growing awareness for the complexity of this

[49] This paragraph is based on numerous studies: Giles Brown, "Introduction: the Carolingian Renaissance", in *Carolingian Culture: Emulation and Innovation*, edited by Rosamond McKitterick (Cambridge: Cambridge University Press, 1994), 1-51; John J. Contreni, *Carolingian Learning, Masters and Manuscripts*, vol. 363, Variorum Collected Studies Series (Hampshire: Variorum Reprints, 1992), original 1-21; 9-25; 59-74, 184-91, 213-216; 81-96; Contreni, "Literary culture"; Contreni, "Counting"; Contreni, "Learning for God"; Rosamond McKitterick, *Charlemagne: The Formation of a European Identity* (Cambridge: Cambridge University Press, 2008); Stuart Airlie, David A. Bullough et al., *Charlemagne: Empire and Society* (Manchester: Manchester University Press, 2005), 1-4, 71-89 and 103-151. The theme of unity and diversity or concord and discord within the Carolingian reforms is invoked in several studies, e.g. Rosamond McKitterick, "Unity and Diversity in the Carolingian Church", *Studies in Church History* vol. 32 (1996), 59-83; James T. Palmer, "Calculating Time and the End of Time in the Carolingian World, c. 740-820", *English Historical Review* vol. 125, no. 523 (2011), 1308, fn. 6.

[50] Here, I paraphrase Joanna Story, although she writes about studies of the age of Charlemagne in particular, see Joanna Story, "Introduction: Charlemagne's reputation", in *Charlemagne: Empire and Society*, edited by Joanna Story (Manchester: Manchester University Press, 2005), 4.

150-years period and contributed to a substitution of "Carolingian Renaissance" and *renovatio* with "Carolingian reforms", *correctio,* and *emendation*.[51]

As will become apparent in the course of the present study, many of the revisionist perspective discussed in the following paragraphs recur in subsequent discussions of Carolingian computus and the case study of Pal. lat. 485. While reading the following description, it is, therefore, essential to keep in mind that all of the discussed subjects and perspectives set a broad scene for the examination of the computus in the central manuscript of this thesis.

The nature of reform

One of the subjects questioned in Medieval Studies is the principal achievement of the Carolingian heightening of learning and scholarship. The traditional notion of a "Carolingian Renaissance" emphasized cultural revival and the correction of scholarship; efforts that were interpreted as a crucial development in the material, institutional, and intellectual history of Western European civilization.[52] Sometimes, the period was even described as more pioneering than the Renaissance of the fourteenth and fifteenth centuries.[53] More recently, however, the years between 750 and 900 are more carefully described as "the Carolingian reforms", primarily associated with the formation of a distinct and harmonious Frankish-Christian cultural identity[54] and/or chiefly explained as an educational, ecclesiastical and/or

[51] What follows is deeply influenced by the important reflections on Carolingian Learning in John J. Contreni, "Inharmonous Harmony: Education in the Carolingian World", *The Annals of Scholarship: Metastudies of the Humanities and Social Sciences* vol. 1 (1980), 81-96. The elaborated revisionist perspectives are discussed in a thematical, rather than a chronological order.

[52] See, for example, Paul Lehmann, "Das Problem der Karolingischen Renaissance", in *I problemi della civiltà carolingia*, edited by Guiseppe Ermini, *Settimane di studio del Centro italiano di studi sull'alto medioevo* (Spoleto: Presso la Sede del Centro, 1954).

[53] G.W. Trompf, "The Concept of the Carolingian Renaissance", *Journal of the History of Ideas* vol. 34, no. 1 (1973), 3-26.

[54] McKitterick, *Charlemagne*.

governmental reform programme, resulting in the collection, organization, and systematization of written resources and a network of communication.[55]

New light was also shed on the question of impetus. For instance, Carolingian ambitions of moral and spiritual renewal are nowadays emphasized, instead of a nascent pseudo-humanistic revival of knowledge. Moreover, it is reckoned that the reforms were driven by the reality of empire that resulted from the military success of the Carolingian dynasty. From this perspective, the *emandatio* and *correctio* of learning was essential to the integration of the realms under Carolingian control and the provision of legitimacy and authority to the ruling dynasty.[56]

Predecessors and external influences

Moreover, attention is raised for the predecessors of and external influences on the Carolingian reform efforts. In different degrees, a focus on continuities between Late Antiquity the Early Middle Ages is used to downplay the novelty of the Carolingian reforms.[57] Most importantly, the long tradition of patronage of learning and the so-called Christian reform idea is stressed, for it was already visible in Roman, Byzantine, Visigothic, Anglo-Saxon, and Lombard antecedents, and also in the Frankish kingdom under Merovingian rule.

The Christian reform tradition was based on the view that the unity of a people depended on its religion. In turn, the cultivation of learning was deemed a means of salvation.

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[55] Contreni, "Learning for God", 128.

[56] Such considerations are abundant in several studies, especially in the sense of royal control and legitimizing efforts exerted through the written word, i.e. Brown, "Introduction"; Fouracre, "Shadow"; Rosamond McKitterick, "The Illusion of Royal Power in the Carolingian Annals", *The English Historical Review* vol. 115, no. 460 (2000), 1-20; McKitterick, *Charlemagne*, 292-380.

[57] For introductions to Carolingian preconditions and precursors see Brown, "Introduction", 1-11; Rosamond McKitterick, "Eight-Century Foundations", in *The new Cambridge medieval history. Vol. 2 : c.700-c.900*, edited by Rosamond McKitterick, *Cambridge histories online* (Cambridge: Cambridge Univeristy Press, 1995), 681-694; Yitzhak Hen, *Roman Barbarians: The Royal Court and Culture in the Early Medieval West* (New York: Palgrave MacMillan, 2007).

Consequentially, Christian rulers committed themselves to furnishing the correction of the lives of the Christian population at large. Like their predecessors and influencers, Carolingian kings and emperors took up this obligation by way of patronage of scholarship and education.

However, not all forms of scholarship were thought to be equally important. In the tradition of the Christian intellectuals known as the Church Fathers, stemming from the fourth and fifth centuries, all forms of scholarship were subordinate to theology. Subscribing to the teachings of patristic authorities, early medieval scholars were characterized by an exclusive interest in learning that was deemed relevant and useful from a theological or practical perspective.[58]

This was by no means a negative or remarkable development in the sense of decline or stagnation of ancient intellectual traditions, for the interests of intellectuals throughout history more often than not reflect the interests and reinforce the values of the society in which they live. Put differently, preservation by way of assimilation was – from an early medieval perspective – the logical path to tread. Moreover, this path had two-way lanes, for Christianization reshaped ancient traditions of learning, and the latter influenced early medieval learning.[59]

Apart from the Christian reform tradition, historiographical attention was raised to other influences on the Carolingian reforms, for instance by Irishmen during the seventh-century expansion of Frankish monasticism and Anglo-Saxon missionary activity on the edges of the Frankish kingdoms. These insular incursions of the continent were accompanied by a transmission of texts, knowledge and scribal habits. Moreover, papal influences should

[58] Malcolm de Mowbray, "Philosophy as Handmaid of Theology: Biblical Exegesis in the Service of Scholarship", *Traditio* vol. 59 (2004), 1-37; Frederick van Fleteren, "De Doctrina Christiana", in *The Oxford Guide to the Historical Reception of Augustine*, edited by Karla Pollmann and Willemien Otten, 3 vols., vol. 2 (Oxford: Oxford University Press, 2013), 285-291.

[59] See, for example, the balanced description of the appropriation, revision and supplementation of earlier astronomical and calendrical practices by the Christian church, based on the Julian solar calendar and a tradition of scriptural commentaries in McCluskey, *Astronomies and Cultures*, esp. 11-48.

not be ruled out either.[60] Finally, it is often reckoned that the majority of "Carolingian" scholars was foreign, including those associated with the Carolingian court.[61]

According to Giles Brown, it is important not to overemphasize these influences and continuities, for he seriously questions the state of learning in the period preceding the eighth century. Hence, he asserts that the Carolingian reform programme was pursued with more purpose, more success and greater resources than the efforts of their predecessors.[62] Likewise, Rosamond McKitterick especially emphasizes the gradual increase of learning and intellectual activity in the abovementioned regions during the eighth century, to account for the extraordinary efflorescence of scholarship starting in the 780s.[63]

Circumstantiality

Furthermore, it is argued that most aspects of Carolingian rule and culture, including its learning, were highly circumstantial**.** Thus, several historians now reject the use of a single, global, and misleadingly consistent interpretation of longer periods in time, based on the import of temporal and regional differentiation.[64] For instance, different phases, shifting patterns, and overall a gradual development are observed in the reformative efforts of different Carolingian leaders, as well as in the course of the reign of a single ruler like Charlemagne (r. 768-814).[65] Attention is, moreover, raised to regional differences within the

[60] For Irish, Anglo-Saxon and papal influences, see Brown, "Introduction", 9-11; McKitterick, *Charlemagne*, 306; Rosamond McKitterick, "The Migration of Ideas in the Early Middle Ages: Ways and Means", in *Foundations of learning: The Transfer of Encyclopaedic Knowledge in the Early Middle Ages*, edited by Rolf H. Bremmer and Kees Dekker, *Mediaevalia Groningana New Series* (Leuven: Peeters Publishers, 2007), 9; Contreni, "Literary culture", 709-757.

[61] I.e. John J. Contreni, "The Carolingian Renaissance", in *Renaissance before the Renaissance: Cultural Revivals of Late Antiquity and the Middle Ages*, edited by Warren Treadgold (Stanford: Stanford University Press, 1984); Philippe Depreux, "Ambitions et limites des réformes culturelles à l'époque carolingienne", *Revue Historique* vol. 304 (2002), 722-723.

[62] Brown, "Introduction", 6.

[63] McKitterick, "Foundations", 681-694, esp. 690.

[64] E.g. Richard E. Sullivan, "The Context of Cultural Activity in the Carolingian Age", in *"The Gentle Voices of Teachers": Ascpects of Learning in the Carolingian Age*, edited by Richard E. Sullivan (Columbus, OH: Ohio State University Press, 1995), 81-84.

[65] Brown, "Introduction", 11-16; McKitterick, *Charlemagne*, 292-380.

Carolingian empire, especially after its partition, but also between individual monastic, episcopal, and ducal centres. Hence, a great variety in space and time is now emphasized within a more general framework of broad and uniform reformative ambitions.

As a counterweight to the traditional depiction of centralized reforms – with a central role of the royal court, and abbots, bishops and the counts as agents carrying out the royal reform programme – a new portrayal of reform surfaced, in which kings and clerical and lay power brokers all had a stake. Moreover, the notion of the school, library and scriptorium at the court was seriously questioned, for it turned out to be impossible to pinpoint where the (itinerant) court was located before 794. As the "court scholars" of the 770s and 780s had dispersed over the realms by 794, the notion of intellectual influence of a central court school and library throughout the Carolingian kingdoms is problematic.[66]

Rather than focussed on a solitary cultural centre, it is argued that the Carolingian reforms were characterized by a vast cultural network of personal and institutional relationships. Often, it is assumed that the effectiveness of the reform programme depended on this intellectual, ecclesiastical and governmental network of communication. Comparably, the status of the royal and episcopal instructions in the form of admonitions and capitularies was questioned, raising the issue of the nature and impact of the reforms in the localities of the Carolingian realms.[67]

McKitterick emphasizes the role of Charlemagne and his inner circle of scholars as the main protagonists of reform, who defined a canon of knowledge and practices that resulted in the formation of a distinct Frankish cultural identity. Moreover, she describes the gradual creation of a sacred topography of dioceses, parishes and monasteries throughout the Frankish realms. Using this structure, a network of communication between the different magnates and

[66] E.g. Contreni, "Education and Learning", 713; Brown, "Introduction", 28-33; Mayke de Jong, "Charlemagne's Church", in *Charlemagne: Empire and Society*, edited by Joanna Story (Manchester: Manchester University Press, 2005), 107; McKitterick, *Charlemagne*, ?-? and 345-369.
[67] Innes, "Government", 71-89.

centres came into being; secular, sacred or scholarly, and often all at once. Within this vast network of communication, books, texts and ideas were accumulated, preserved, corrected and disseminated. Simultaneously, a set of orthodox conducts and correct practices was established and spread, concerning subjects like clerical discipline, canon law, liturgical innovations, and correct Latin.[68] As the foundation of the Carolingian network of communication was laid in the eighth century, when important links between Frankish, Anglo-Saxon, Spanish and Italian cultural centres already existed, a continuity with earlier times is once again recognized.[69]

John J. Contreni is far less certain about the existence of a vast network of communication. Although he notes that intellectuals maintained epistolary and personal relations, Contreni asserts that the network of relations between intellectual centres was rather loose. Consequentially, bishoprics and the Carolingian court only exerted some measure of control at the lower level of society. Seen from this perspective, the repetition of reformative recommendations in multiple admonitions and statutes, indicates their limited impact.[70]

Like McKitterick, Contreni considers the written word and masters to be at the heart of Carolingian learning. By implication, he advocates that the vitality of the activities and influence of intellectual centres like cathedrals and monasteries depended on their resources. Without the possession of books, the presence of gifted masters, and institutional stability, the aims of reform could not be attained. Moreover, rather than following central directions as mere ‘puppets’, Contreni describes Carolingian scholars, masters and students in monastic and episcopal school as responding to a call for reform based on their own agency and interests. Thus, the implementation of the reforms was effectively based on local initiatives and conditions, resulting in a far less schematic and less centralised depiction of the

[68] McKitterick, *Charlemagne*, 292-380; McKitterick, "Migration", 1-17. See also Innes, "Government".
[69] McKitterick, "Foundations", esp. 687-688.
[70] Contreni, "Literary culture", 709-757.

Carolingian reforms. Logically, then, the results of the Carolingian reforms were pluralistic, rather than uniform.[71]

Scale and depth

Another implication of the necessity of books and gifted scholars, as elaborated by Contreni, is that the hammering out of the Carolingian reforms can be interpreted as the project of a relatively small educated elite, in the form of several generations of masters and their disciples in the presence of the proper resources. [72] From this perspective, it seems to be confirmative that the most important abbots and bishops of the Carolingian era were selected from a small group of learned and experienced scholars.

Recent studies have, however, shown that Carolingian *correctio* was more than an affair of a small group of intellectuals, for literate and well-educated priests carried out the reform programme at the lowest level of society. Of special relevance, from the perspective of Pal. lat. 485, is the fact that there is sufficient evidence for the presence of educated rural priests, fulfilling the crucial role of intermediaries between their community and the local episcopate or monastery.[73]

Until recently, the image of local priests was dim at best, dominated by the old models of *Eigenkirchen* and *eglises privée*. However, this image of semi-literate priests obeying their lords is shifting. Firstly, the existence and importance of different kinds of priests, external to

[71] Ibid., esp. 724-5, 'puppets' at 712.
[72] Ibid., 721 and 726. Similarly, see Depreux, "Ambitions", 721-753, at 750-1.
[73] Pioneering studies are Susan A. Keefe, "Carolingian Baptismal Expositions: A Handlist of Tracts and Manuscripts", in *Carolingian Essays: Andrew W. Mellon Lectures in Early Christian Studies*, edited by Uta-Renate Blumenthal (Washington, D.C.: The Cahtolic University of America Press, 1983); Susan A. Keefe, *Water and the Word: Baptism and the Education of the Clergy in Carolingian Europe*, vol. 1 (Paris: Notre Dame Press, 2002); Carine van Rhijn, "Priests and the Carolingian reforms: the bottlenecks of local *correctio*", in *Texts and identities in the early middle ages*, edited by Richard Corradini and Rob Meens (Vienna: Austrian Academy of Sciences, 2006), 219-237; Carine van Rhijn, *Shepherds of the Lord. Priests and episcopal statutes in the Carolingian period* (Turnhout: Brepols, 2007). For more recent perspectives see the different contributions to Steffen Patzold and Carine van Rhijn, eds., *Men in the Middle: Local Priests in Early Medieval Europe*, Ergänzungsbände zum Reallexikon der Germanischen Alterumskunde (Berlin: De Gruyter, 2016).

the private sphere, was brought to the foreground.[74] Secondly, a growing group of medievalists argues for the presence of educated Carolingian priests with agency and in the possession of books, which sometimes appear to have been written and compiled by priests themselves. Like Contreni's masters and students, bishops had agency, for they were free to decide how reformative ambitions were carried out at a local level, for instance in the form of the education of the clergy. In turn, the way in which pastoral care was administered depended on the texts which were available to a priest, his education, and his personal assessment.[75] Thus, although the reforms occasionally turn out to be more than an elite project, impacting even the lower levels of Carolingian society, the rural reality of reform was as pluralistic as Contreni's interpretation of the Carolingian reforms.

Not so long ago most medievalists only fragmentarily studied 'clerical manuscripts' with an exclusive interest in individual texts that needed editing. Due to the influence of Material Philology, the entire manuscript context of these 'instruction-readers' and monastic or episcopal 'schoolbooks' is nowadays increasingly analysed, resulting in new angles at the compilers and the users of medieval codices. For instance, clerical manuscripts have come to be known as carefully compiled collections that provide deep insights into 'what priests knew, did and thought important.'[76] Often, it is shown that the contents of a priests' books, as well as the books that were used to educate members of the clergy, depended on the material that was regionally available or deemed relevant by the commissioner or compiler of a clerical codex. Once more it can, therefore, be asserted that the local renditions of the Carolingian reforms were a heterogeneous phenomenon, consisting of multiple local reforms that were

[74] E.g. Steffen Patzold, "*Correctio* an der Basis: Landpfarrer und ihr Wissen im 9. Jahrhundert", in *Karolingische Klöster: Wissenstransfer und kulturelle Innovation*, edited by Julia Becker, Tino Licht, et al., *Materiale Textkultur* (Berlin/München/Boston: De Gruyter, 2015).

[75] E.g. Carine van Rhijn, "The Local Church, Priests' Handbooks and Pastoral Care in the Carolingian Period", *Settimane di studio del Centro italiano di studi sull'alto medioevo* vol. 61 (2013), 689-710.

[76] Steffen Patzold and Carine van Rhijn, "Introduction", in *Men in the Middle: Local Priests in Early Medieval Europe*, *Ergänzungsbände zum Reallexikon der Germanischen Alterumskunde* (Berlin: De Gruyter, 2016), 6.

characterized by a wide range of approaches to the shared reformative themes and ambitions.[77]

As a result, a staggering variety of selections, rearrangements, partial omissions, substitutions, rephrasings, and supplementations of even the most common texts is apparent within the manuscripts that were directed at the education and work of the clergy.[78] Each clerical compendium or dossier represents the main themes of the Carolingian educational reforms, that are roughly the same everywhere, although the included texts hardly ever are. Another general pattern concerns the notion of authority, for the texts within pastoral compendia are hardly ever attributed to an author, even though most of them are excerpts from works by great early medieval authorities, such as Isidore of Seville or Bede the Venerable, which were readily available in monastic and episcopal libraries.

Is this variety in the contents of clerical books a sign of reformative failure or success? What may be a sign of a lack of organisation and standardisation, and thus a failure of reform, can also be interpreted as a significant trace of the successful penetration of reformative ambitions at the level of rural and lay communities, be it in the form creative, pragmatic and therefore varying local attempts at *correctio* and *emendatio*.[79]

Such perspectives feed into an oft-recurring concern for the differences between the ambitions and rhetoric versus the outcomes of the Carolingian reforms. As McKitterick often articulates, corrective ambitions were easier to achieve than uniformity. Charlemagne and Louis the Pious, for instance, failed in their aims to introduce a single, reformed liturgy. Likewise, royal sponsorship for regulations of the Bible, computus, and the psalms, could not

[77] Carine van Rhijn, "Manuscripts for local priests and the Carolingian reforms", in *Men in the Middle: Local Priests in Early Medieval Europe*, *Ergänzungsbände zum Reallexikon der Germanischen Alterumskunde* (Berlin: De Gruyter, 2016), 689-710.
[78] See, for example, Keefe, "Handlist", 173.
[79] Rhijn, "Handbooks", 689-710; Rhijn, "Manuscripts", 182-187. Although Van Rhijn is chiefly occupied with instruction-readers, rather than episcopal or monastic schoolbooks, the analyses derived from these articles are equally applicable to the latter.

prevent that the corrected texts co-existed with the older texts they were meant to replace.[80] Partly due to the frequently repeated episcopal and royal rhetoric in the available admonitions, synodal proceedings, and capitularies, it often remains uncertain to what extent the ambitions of reform ever materialized in the localities of Carolingian society. Likewise, it remains controversial whether the reform programme was an affair of a small scholarly elite or amounted to a wide network of relationships between kings, bishops, abbots, monks, and even priests and their local flocks.[81]

In short, what appears to be certain is that the main characteristic of the Carolingian reforms, as well as the historiographical debate on this subject, is a complex mix of concord and discord. Interestingly, the same can be said about the medieval science of computus during the Carolingian era. However, before turning to the more specific subjects of Carolingian calendar science, it is essential to discuss and define computus more generally.

Computus as medieval science

Few early medieval intellectual activities were as technical and scientific as the measuring and reckoning of time. Simultaneously, no medieval form of scholarship dealing with the order and allegorical meaning of the natural world flourished to such an exceptional degree and with such continuity as the body of knowledge known as computus. The medieval reckoning of time dealt with practical as well as theoretical time-related questions and problems in a structured, empirical, and rational way. Although the resulting cycles and arguments were not literally discerned as universal principles or theories, they were usually applied as such. Hence, *computistae* sought to establish universal principles for the

[80] Brown, "Introduction", 22-23; Contreni, "Literary culture", esp. 740-44.
[81] See Rhijn, "Manuscripts", 177-179.

calculation of Easter using a deliberately artificial system of lunar and solar cycles based on mathematical principles and approximations.[82] As such, computus was the science-most early medieval body of knowledge. Representing an early phase in the emergence of science, computus can rightly be described as medieval calendar science.[83]

Because computus rose and declined during the medieval period, it does not have a direct ancestor, nor a modern descendent.[84] Nonetheless, the reckoning of time is a crucial and missing link in the history of the science. Firstly, calendar science served as an encyclopaedic vehicle. It was responsible for the introduction and distribution of scattered fragments of ancient supplementary materials in the medieval West on subjects like astronomy, mathematics, medicine, music, grammar, prognostics, and chronology, which were attached to computus texts and tables. Thus, computus is representative of the way in which ancient scholarship was fragmentarily adopted by an increasingly Christian civilization. Secondly, the search for more sophisticated astronomical and arithmetical texts during the eleventh and the twelfth centuries, often recognized as a watershed moment in the history of science, may have been a direct response to computistical debates about astronomical discrepancies and chronological anomalies.[85] Thirdly, the viability of calendar

[82] See Warntjes, *Munich Computus*, pp. XXXII, fn. 63. That medieval scholars were aware of the artificiality of their luni-solar cycles is apparent from their use of several normalizing and corrective devices, like the *dies bissextus* and *saltus lunaris*. Moreover, computists often discussed the occurrence of divergences between their calculations and the observable phenomena, i.e. DTR ch. 43.

[83] Discussions of computus as an art, technique, discipline, science, and/or body of knowledge are plentiful. In my view, the balanced considerations by Wallis are particularly enlightening. Wallis ambiguously settles for the terms 'body of knowledge' and 'science', which she uses in numerous publications, with and without inverted commas. See *Reckoning*, XVI-XVII; Faith Wallis, "The Church, the World and the Time: Prolegomena to a History of the Medieval Computus", in *Normes et pouvoir à la fin du Moyen Âge*, edited by Marie-Claude Déprez-Masson (Montreal: Éditions CERES, 1984), 15-29; Wallis, "Medicine", 105-43; Faith Wallis and Calvin B. Kendall, *Bede On the Nature of Things and On Times*, Translated Texts for Historians (Liverpool: Liverpool University Press, 2010), 1-33; Faith Wallis, "Bede and science", in *Cambridge Companion to Bede*, edited by Scott DeGregorio (Cambridge: Cambridge University Press, 2010), 126. Warntjes, meanwhile, confidently deems computus a medieval science, assigning an auxiliary role to manifestations of the ancient sciences. See Warntjes, *Munich Computus*, XXX-LI, esp. XXXII-XXXIV.

[84] Note that a case could be made for ancient calendar traditions as predecessors to *computus* and the technical chronology of scholars like Joseph Scaliger as its ancestor.

[85] See esp. Wallis, "Prolegomena"; See also C. Philipp E. Nothaft, *Scandalous Error: Calendar Reform and Calendrical Astronomy in Medieval Europe* (Oxford: Oxford University Press, 2018).

science throughout the Middle Ages is an important indicator of intellectual continuity and networks of communication stretching all over Europe. Finally, 'the particular problem-centred approach of *computus* had a long-term importance in the history of Western culture, as part of a fundamental reorientation of what used to be speculative sciences between antiquity and the rise of the universities.'[86]

Establishing a date for Easter

The principal issue that occupied computists was the question of the correct date for the feast commemorating the Passion and Resurrection of Christ. In short, the controversy revolved around two key questions. Firstly, what are the theological criteria for determining a valid date for Easter? Secondly, can such a date be calculated for many years in advance based on mathematical and astronomical data?[87] Solving these problems involved delicate interpretations of conflicting biblical texts and patristic works.[88] It also demanded a detailed coordination of the cycles of the Moon, the Sun, and the weekdays, for although opinions about specific technicalities were divided, the general consensus was that Easter was to be celebrated on the first Sunday after the first full Moon after the vernal equinox. In practice, computus encompassed a broad range of practices, including reading, writing, analysing, observing, calculating, theorizing, visualizing, and perhaps even experimenting.[89]

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[86] *Reckoning*, XXVI-XXVIII. Here, Wallis summarizes a hypothesis by Brigitte English, see Englisch, *Artes*; Brigitte Englisch, "Realitätsorientierte Wissenschaft oder praxisferne Traditionswissen? Inhalte und Probleme mittelalterlicher Wissenschaftsvorstellungen am Beispiel von *De temporum ratione* des Beda Venerabilis", in *Dilettanen und Wissenschaft. Zur Geschichte und Aktualität eines wechselvollen Verhältnisses*, edited by Elisabeth Strauss, *Philosophie und Repräsentation* (Amsterdam: Rodopi, 1996), 11-34.

[87] *Reckoning*, XXXIV.

[88] *Reckoning*, XVIII-XXI and XXXIV, quotation: XVIII. See also Georges Declercq, *Anno Domini: The Origins of the Christian Era* (Turnhout: Brepols, 2000), 49-53.

[89] *Reckoning*, XVIII. For observing, see especially C. Philipp E. Nothaft, "Bede's horologium: Observational Astronomy and the Problem of the Equinoxes in Early Medieval Europe (c. 700–1100)", *English Historical Review* vol. 130, no. 546 (2015), 1079-1101.

Unfortunately, the parameters for a valid date of Easter had far-reaching implications. Firstly, as the solar year neither contains a whole number of lunar months, nor a whole number of weeks, the date for Easter was moveable. In turn, the dates of other liturgical feasts like Quadragesima and Pentecost also differed each year, because they depended on the Paschal date. Secondly, disputes about certain computistical technicalities and different attempts to facilitate the computation of the dates for the moveable feasts, resulted in deviating reckonings of time. To great concern, these competing frameworks calculated different Easter dates for the same year, posing a risk for the unity of Christianity. Thirdly, the search for a precise and repetitive cycle of dates for Easter was simply interminable, for the lunar cycle is unstable, and the lengths of the lunar and solar cycles are incommensurable. Thus, the attempts to reconcile the course of the Sun and the Moon using cycles of 8, 19, 28, 84, 95, 112, and even 532-years all did some degree of violence to the astronomical reality. Although computists knowingly deviated from the observable phenomena using arithmetical and corrective devices like the bissextile day, the deviations of their approximations from the observable phenomena increased every passing year. Combined, the existence of competing computistical traditions and imperfect reckonings of time resulted in so-called Easter controversies throughout the medieval period.

Defining computus

From the perspective of actor categories, the classical Latin term *computatio*, and the related verb *computare*, can be defined as counting. However, the term also had a more metaphorical connotation of working out a problem. At different points in time, computus was associated with a broader meaning of calculating and a narrower connotation of time-reckoning. Finally, the term was also used in reference of the contents of manuscripts on these subject, describing

anthologies comprising of a calendar, tables, chronologies, formulas, and other texts as a computus.[90]

A suitable working definition for computus could then be a synthesis of all forms of learning that dealt with time-related subjects, calculation and numeracy.[91] However, due to the scope of this thesis, a more specific definition seems appropriate. To be precise, a statement about the meaning of computus in the context of this thesis should be representative of the ninth-century embrace of the computistical works written by the Anglo-Saxon scholar Bede, which started to emerge as the dominant computistical tradition during the final decades of the eighth century and arguably entailed a unification of computus as a discipline. Hence, I define computus as the medieval body of knowledge or science of Christian time reckoning, dealing with the creation of calendars, the calculation of the dates of liturgical feasts, and the unfolding of salvation-history.

In practice, computus encompassed and/or overlapped with subjects that may otherwise be described as separate disciplines or sciences, namely hemerology (the study of the divisions of time), chronology (the study of salvation-history), cosmology (the study of the universe), astronomy (the study of the celestial phenomena), and arithmetic (the study of numbers).[92] Furthermore, computistical material was often supplemented with texts on the subjects of medicine (the study and practice of diagnosis, treatment and prevention of diseases), prognostics (the interpretative and predictive study of, respectively, terrestrial phenomena and future events), and meteorology (the study of terrestrial phenomena).[93] As a derivative, I deem any medieval manuscript consisting of one or more codicological units containing computus texts a computistical manuscript.

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[90] *Reckoning*, 425-426. For other discussions of the term computus, see Warntjes, *Munich Computus*, XXXII, fn. 63-64.
[91] E.g. Contreni, "Counting", 73-90.
[92] This definition is loosely based on Wallis and Kendall, *ONT&OT*, 1-33, esp. 20-21 and 31.
[93] Wallis, "Medicine", 105-143. See also, *Kalenderreform*, 500-522.

Carolingian computus

Having established a definition for computus as science, special attention is due for Frankish calendar science and computistical developments during the Carolingian period. Following the reading by Immo Warntjes, the history of computus between 650-900 can be summarized as follows.[94] Most importantly, a new computistical genre of computistical textbooks emerged in Ireland and Anglo-Saxon England, roughly in the years of 650-750. By the 740s, the production of new computistical textbooks had waned.[95] From the 750s and onwards, Frankish computists focussed on the collection of computistical formulas and tracts concerning chronologic disputes. During the eight century, the computistical tradition of Dionysius Exiguus increasingly competed with the traditional paschal works by Victorius of Aquitaine in the Frankish kingdoms.[96] By the first decades of the ninth century, the Frankish collection efforts culminated in the creation of the new genre of computistical encyclopaedia. Meanwhile, the Bedan-Dionysian traditions of computus slowly surfaced as the dominant reckoning of time in the Carolingian empire. In 820, Hrabanus Maurus composed a new computistical textbook, which was deeply influenced by Bede's DTR and, to a lesser degree, Irish computistical concepts. Ultimately, the Bedan-Dionysian reckoning was unanimously accepted at the continent by the 850s. However, much like the other subjects of this chapter, the interpretation of Frankish and Carolingian computistics is complicated by the different narratives of several historians.[97]

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[94] See the introduction to Warntjes, *Munich Computus*, esp. XLI, LII-LVI, and CXI.

[95] Datable examples are *De temporibus* (AD 703), *Computus Einsidlensis* (ca. AD 689-719), Munich Computus (AD 719), and *De ratione conputandi* (ca. AD 719-727) and *De temporum ratione* (AD 725).

[96] A detailed account of the differences between these traditions is provided in Immo Warntjes, "Victorius vs Dionysius: The Irish Easter Controversy of AD 689", in *Early medieval Ireland and Europe: chronology, contacts, scholarship*, edited by Padraic Moran and Immo Warntjes, *Studia Traditionis Theologiae* (Turnhout: Brepols, 2015), 33-97, esp. 71-89.

[97] My discussion of Frankish and Carolingian computus is chiefly based on assessments by James Palmer and Immo Warntjes. See Palmer, "Calculating", 1307-1331; James T. Palmer, "Computus after the Paschal Controversy of AD 740", in *The Easter Controversy of Late Antiquity and the Early Middle Ages*, edited by Immo Warntjes and Dáibhí Ó Cróinín, *Studia Traditionis Theologiae* (Turnhout: Brepols, 2011), 213-241; Warntjes, *Munich Computus*, esp. XXX-LI. As it is impossible to study and discuss the ample bibliography on computus in the context of this thesis, I have restricted myself mostly to publications dating to the last

The nature of reform

Without doubt, Arno Borst published the most voluminous, influential, and disputed studies about the Frankish reckoning of time. His *Schriften*, *Kalenderreform*, and *Reichskalender* provide editions of dozens of computistical works based on thousands of smaller computistical texts, tables, and calendars in over 200 medieval manuscripts, accompanied by daring and tentative narratives of centralized and royal reform.

Frankish computus between 721 and 818, according to Borst, was for the most part characterized by confusion and dispute about the reckonings of Victorius of Aquitaine and Dionysius Exiguus. Ultimately, Borst alleges, the disagreements about the technicalities of these traditions and their competing dates for Easter culminated in an intervention by Charlemagne and his court. The resulting centralized reform of computus encompassed, firstly, a standardization of the Christian calendar in 789. Secondly, the royal reforms promoted the study of computus and, ultimately, the creation of three encyclopaedia on the reckoning of time in 793, 809/812 and 817. In Borst's sweeping theory, the attempts to reform calendar science were directed at a unification of astronomical, episodic, and memorial time within the Carolingian empire. Of these efforts, Borst concludes, the calendar reform was the most successful. Although the collection of Frankish computistical texts and the construction of royal encyclopaedias was pursued with considerable scholarly zeal, a Frankish computistical canon never materialized.[98]

decades. Note that an excellent bibliographical essay was recently published, see Immo Warntjes, "Introduction: State of Research on Late Antique and Early Medieval Computus", in *Late Antique Calendrical Thought and its Reception in the Early Middle Ages. Proceedings from the Third International Conference on the Science of Computus in Ireland and Europe, Galway, 16–18 July, 2010*, edited by Immo Warntjes and Dáibhí Ó Cróinín, *Studia Traditionis Theologiae* (Turnhout: Brepols, 2017), 1-42.

[98] See *Schriften, Kalenderreform*, *Reichskalender*, and Arno Borst, *Computus. Zeit und Zahl in der Geschichte Europas* (Berlin: Wagenbach, 1990). See also Thom Snijders, "Book review Arno Borst *Schriften zur Komputistik im Frankenreich von 721 bis 818*." Book review for Research Seminar, Utrecht University, 2018, 1-5.

On the one hand, Borst's studies were critically acclaimed, mostly because they made a broad range of previously unedited works accessible.[99] Moreover, he created an awareness for numerous Frankish, anonymous works on computus, and thus effected a historiographical shift from attention for works bearing the name of a medieval authority to works by anonymous authors and compilers.[100] On the other hand, Borst's interpretations were thoroughly criticized.[101] For example, Bruce Eastwood and Wesley M. Stevens pointed out that direct evidence for a centralized and royal promotion of uniform computistical encyclopaedias and calendars is absent, scattered, and/or suggestive at best. Moreover, Paul Meyvaert, Donald A. Bullough, and Brigitte English asserted that Borst misrepresented the extant calendar evidence, proposing diverging alternative explanations.[102] Finally, Warntjes emphasized that Borst wrongly used numerous manuscripts which contain only very few of the passages from the alleged normative encyclopaedias, creating the misleading impression that these passages were derived from the works he reconstructs, even though these lessons and arguments circulated widely in other contexts. In the absence of attention for the immediate manuscript contexts of these individual texts, Borst disregarded the fact that they belong to separate, cohesive texts and independent compilations, like the *Computus Rhenanus* of 775.[103] Although Borst remained largely unmoved in his conclusions until his death in

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[99] Dietrich Lohrmann, "Review of Arno Borst: *Schriften zur Komputistik im Frankenreich von 721 bis 818*", *Historische Zeitschrift* vol. 285 (2007), 441-447.

[100] Warntjes, "State", 12-14.

[101] My summary of the criticisms of Borst is indebted to Palmer, "Calculating", 216-217.

[102] See Bruce Eastwood, "Review of Arno Borst: *The Ordering of Time: From the Computus to the Modern Computer*", *Speculum* vol. 71 (1996), 692-693; Wesley M. Stevens, "Review Arno Borst: *Die Karolingische Kalenderreform*", *Speculum* vol. 78 (2003), 144-147; Brigitte Englisch, *Zeiterfassung und Kalenderproblematik in der frühen Karolingerzeit. Das Kalendarium der Hs. Köln DB 83-2 und die Synode von Soissons 744*, Instrumenta (Stuttgart: Jan Thorbecke Verlag, 2002); Paul Meyvaert, "Discovering the Calendar (annalis libellus) Attached to Bede's Own Copy of De Temporum Ratione", *Analecta Bollandiana: Revue Critique d'Hagiographie* vol. 120, no. 1 (2002), 5-64; David Bullough, "York, Bede's calendar and a pre-Bedan English martyrology", *Analecta Bollandiana* vol. 121, no. 2 (2003), 329-354. Borst responded to these criticisms in Arno Borst, *Der Streit um den karolingischen Kalender* (Hannover: Hahnsche Buchhandlung, 2004).

[103] For the *Computus rhenanus* of AD 775, see Warntjes, "State", 23; Immo Warntjes, "The argumenta of Dionysius Exiguus and their early recensions", in *Computus and its cultural context in the Latin West, AD 300–1200. Proceedings of the 1st International Conference on the Science of Computus in Ireland and Europe*, edited by Immo Warntjes and Dáibhí Ó Cróinín (Turnhout: Brepols, 2010), 40-111, esp. 75-76;

2007, the merits of his thesis of centralized Carolingian reforms of computus are controversial to say the least.

Without doubt, the reckoning of time was a crucial subject within the Carolingian programme of renewal, for '[i]t was essential to any sense of liturgical unity'.[104] What is in question, is whether the reform was chiefly a centralized, royal effort, aimed to establish a uniform and canonized computistical tradition, or whether it purported an encouragement of the study and education of computus in general, resulting in varying local responses. Although the former is disputed, the latter was certainly achieved in various ways.

By the turn of the eighth century, DTR enjoyed a wide popularity.[105] Proof of this development can be found in a sharp increase of manuscripts containing full copies of Bede's computistical works, as well as countless anonymous excerpts from his DT and DTR. Moreover, an examination or inquisition of the state of the reckoning of time in 809, written during a meeting of computists, provides several answers that correspond to the Bedan-Dionysian computistical tradition. Because the scholars present during this meeting show a certain degree of ignorance, Borst reads this examination as a preparation or inducement for the compilation of the Seven-Book computus or *Libri computi* of 809-812.[106]

In spite of the circulation of Bede's works and perhaps the Carolingian encyclopaedia, other texts and anthologies remained in circulation and continued to be created on a large scale. Contrary to Borst's suggestions, this was not evidence of conservative resistance

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Immo Warntjes, "The *Computus Cottonianus* of AD 689: A Computistical Formulary Written for Willibrord's Frisian Mission", in *The Easter Controversy of Late Antiquity and the Early Middle Ages*, edited by Immo Warntjes and Dáibhí Ó Dróinín, *Studia Traditionis Theologiae* (Turnhout: Brepols, 2011), 173-212, esp. 189-190, 198-203 and 207-211; Immo Warntjes, "Köln als naturwissenschaftliches Zentrum in der Karolingerzeit: Die frühmittelalterliche Kölner Schule und der Beginn der fränkischen Komputistik", in *Mittelalterliche Handschriften der Kölner Dombibliothek. Viertes Symposion der Diözesan- und Dombibliothek Köln zu den Dom-Manuskripten (26. bis 27. November 2010)*, edited by Heinz Finger and Harald Horst (Köln: Erzbischöfliche Diözesan-und Dombibliothek, 2012), 41-85, esp. 55 and 61-64.

[104] Palmer, "Calculating", 1319.

[105] For a list of manuscripts containing DTR and DT, see CCSL CXXIIIB, 241-256 and CXXXIIC, 580-583.

[106] *Schriften*, 1034-1053*;* Charles W. Jones, "An Early Medieval Licensing Examination", *History of Education Quarterly* vol. 3 (1963), 19-29; Kerstin Springsfeld, *Alkuins Einfluß auf die Komputistik zur Zeit Karls des Großen* (Düsseldorf: Franz Steiner Verlag, 2002), 105-119.

against royal or centralized attempts to control time or a confusion among computists.[107] As James T. Palmer convincingly points out, the extant manuscripts simply show how a great diversity of computistical materials was exchanged between different intellectual centres and discussed within scholarly networks, during a time 'when authority was generated by good education in schools, rather than by the introduction of new texts.'[108] Thus, '[o]utdated material continued to be copied alongside orthodox material in all centres and at the same time there is no hint that any community on the continent followed anything other than a Dionysiac Easter by the ninth century.'[109] In other words, what we encounter within the extant manuscripts is evidence for a pattern of 'diversity within unity' as an essential feature of Carolingian computus.

Predecessors and external influences

Apart from questions concerning the nature of Carolingian computistical reforms, several other perspectives in the debate about Carolingian or Frankish computus are familiar when we compare them to the debates about the Carolingian reforms. For instance, the role of external influences on Frankish computus has always been apparent in assessments of the reception of foreign computistical traditions, such as the works by the Alexandrian scholar Dionysius Exiguus[110] and the Anglo-Saxon scholar Bede the Venerable.[111] Likewise, the influence of missionaries like Willibrord and Boniface, and the role of Alcuin at Charlemagne's court, result in an emphasis on Anglo-Saxon influences on Frankish computus.[112] To balance this

[107] Palmer, "Calculating", 1323-1324, at 1323.
[108] Ibid., 1323.
[109] Ibid.
[110] See Warntjes, "Argumenta".
[111] DTR, DT, and DNR.
[112] A plausible case for the influence of Willibrord is made in Warntjes, "Willibrord", 173-212. For the role of Boniface, see Brigitte Englisch, "Karolingische Reformkalender und die Fixierung der Christlichen Zeitrechnung", in *Computus and its Cultural Context in the Latin West, AD 300-1200*, vol. 5, *Studia Traditionis Theologiae* (Turnhout: Turnhout Brepols Publishers, 2010), 253, fn. 62; Palmer, "Calculating", 213-241. For a comprehensive study of Alcuin's influence on Carolingian computus, see Springsfeld, *Einfluß*.

account, recent studies assert that the contributions of Irish learning and scholars like Dúngal and Dicuil in the Frankish empire are usually underestimated.[113]

Furthermore, it is now recognized that the introduction of the reckoning of Dionysius Exiguus in the Frankish kingdom was not induced by the arrival of Bede's computistical works on the continent by the late eighth century.[114] Although DTR may have sparked the final and decisive phase in the waning of Victorius' reckoning and Easter table, which had been the established tradition in the Frankish kingdom since the Council of Orléans in 541, strong evidence for such a dominant role of Bede's computistical works is non-existent. In contrast, the Dionysian reckoning undoubtedly circulated on the continent as early as the 690s, implying that the paschal works by Bede arrived in a late phase of this clash of traditions.[115] What remains is a strong sense of Insular influence, for the reckoning of Dionysius is thought to have been organically distributed from new Irish and Anglo-Saxon foundations in the north to older in centres in the south of the Frankish kingdoms.[116] Much like in the debates about the Carolingian reforms, it thus becomes evident that the developments in the history of computus are more complex than they were formerly thought to have been.

Circumstantiality

Whether Borst's theories are sound or not, it is a fact that Carolingian computists produced a number of *summa* and encyclopaedic works on the subjects of computus, signalling an important effort at the court or, more likely, within specific monastic and episcopal centres in

[113] See, especially, Warntjes, *Munich Computus*.
[114] Rosamond McKitterick, *History and Memory in the Carolingian World* (Cambrigde: Cambridge University Press, 2004), 92-97; Joshua A. Westgard, "Bede and the continent in the Carolingian age and beyond", in *The Cambridge companion to Bede* (Cambridge: Cambridge University Press, 2010), 201-215.
[115] Palmer, "Calculating", 213-241.
[116] James T. Palmer, "The Adoption of the Dionysian Easter in the Frankish Kingdoms (c. 670–c. 800)", *Peritia* vol. 28 (2017).

places like Cologne, St. Gall, and Salzburg. However, based on the extant Carolingian manuscripts, none of these collections appear to have been distributed widely throughout the empire, at least when one searches the extant manuscripts for complete copies. Clearly, the circulation of Bede's computistical works was second to none in comparison to any late eighth-century and early ninth-century computistical work.[117] This picture does not change when the distribution of works like Hrabanus' DC of 820,[118] Dicuil's *Liber de astronomia* of 814-816[119] are included. Based on the availalbe manuscripts, only Helperic's *De computo* of 900/903 became extremely popular during the tenth and the eleventh centuries.[120]

Yet, the distribution of Bede's works was paralleled and even exceeded by what turns out to have been the most distinctive characteristic of Carolingian computistical manuscripts, namely idiosyncratic, miscellaneous, and unique anthologies consisting of excerpts, formulas, tables, Easter tables, and calendars.[121] Thus, Carolingian computus was most of all characterized by elusive and anonymous selections and arrangements of computistical materials. Here, again, do we encounter the importance of differences in time and space, and the decisive influence of varying local circumstances. Consequentially, what Carolingian calendar science was or was not at an institutional level, depended on the horizon or *Wissenschaftslandschaft* of the scriptorium in which a computistical text or compilation was written.[122] Further down at a personal level, the specific anthologies or compilations used by a

[117] 245 extant copies: CCSL CXXIIIC, 242-256.
[118] 16 extant copies: CCCM XLIV, 190-194.
[119] 3 extant copies: CCCM XLIV, 175, fn. 45.
[120] Over 80 extant copies: Warntjes, "State", 26-27, esp. fn. 106.
[121] In his study of the Carolingian calendar reform, Borst describes these computistical passages and tables as *Rahmentexte* surrounding the calendars within medieval manuscripts, see *Kalenderreform*, 482-500.
[122] The theme of the horizon of a scriptorium is invoked in Palmer, "Calculating", 220. A similar concern for the local variety of computistical material can be found in Ivana Dobcheva, "The Umbrella of Carolingian Computus", in *The Compilation of Knowledge in the Middle Ages*, edited by María José Muños, Patricia Cañizares, et al. (Porto: Fédération Internationale des Instituts d'Études Médiévales, 2013), 211-229, esp. 215-216.

scholar or student working on the reckoning of time determined his realized variant of "Carolingian computus".[123]

Scale and depth: clerical computus

In regard of the case study of this thesis, the scale and depth of the Carolingian computistical reforms deserve a closer inspection. However, rather than focussing on the distribution of an imperial calendar or royally sponsored computus encyclopaedias like Borst, the present study demands special attention for the role of computus in the educational reform programme, aimed at secular members of the clergy. Generally speaking, little is known about the education of priests, apart from the fact that secular clerics received some of their education in episcopal and monastic schools.[124] Therefore, it is understandable that a subject which has attracted little to no attention, is the question of clerical instructions in the reckoning of time.[125] Nonetheless, a detailed examination of this subject is due, for the renewal and patronage of computistical education may have been among the most important efforts of all Carolingian reforms of the reckoning of time.

[123] For these and other insights, see Palmer, "Calculating", 219-221.

[124] The education of priests is discussed throughout Patzold and Rhijn, *Men*. More elaborate is Contreni, "Learning for God", 89-129; Julia Barrow, *The Clergy in the Medieval World: Secular Clerics, Their Families and Careers in North Western Europe, c. 800-c. 1200* (Cambridge: Cambridge University Press, 2015), esp. 170-235. However, the scope of the latter results in a broad and superficial description of Carolingian clerical education, with an emphasis on clerics affiliated to episcopal churches and schools, rather than monasteries. Computus is hardly mentioned in Barrow's chapters on the education of the clergy, apart from a brief reference on pp. 220-221 and 224, where she describes 'working out the date for Easter' as a task that clerics were allowed to do using 'basic computational skills'. For monastic and episcopal schools, see ibid., 180-200; Thomas Kohl, "*Presbyter in parochia sua*: Local priests and their churches in early medieval Bavaria", in *Men in the Middle: Local Priests in Early Medieval Europe*, *Ergänzungsbände zum Reallexikon der Germanischen Alterumskunde* (Berlin: De Gruyter, 2016), 61; Rhijn, "Handbooks"; Carine van Rhijn, "'Et hoc considerat episcopus, ut ipsi presbyteri non sint idothae': Carolingian local correctio and an unknown priests' exam from the early ninth century", in *Religious Franks. Religion and Power in the Frankish Kingdoms: Studies in Honour of Mayke de Jong*, edited by Rob Meens, Dorine van Espelo, et al. (Manchester: Manchester University Press, 2016); Bernhard Zeller, "Local priests in early medieval Alamannia: The Charter Evidence", in *Men in the Middle: Local Priests in Early Medieval Europe*, *Ergänzungsbände zum Reallexikon der Germanischen Alterumskunde* (Berlin: De Gruyter, 2016).

[125] For a recent and general discussion of early medieval numerical and computistical education, see Contreni, "Counting", 43-90.

In the royal mandate that defined the Carolingian reform of education and its reading program – the *Admonitio generalis*, issued by Charlemagne in 789 – computus is mentioned as a subject of great importance. In a translation by Contreni, its 70th chapter includes the following prescription:

> Let schools be established in every monastery and bishopric for boys to read psalms, notes, chant, computus, grammar, and well corrected catholic books, for often when someone desires to beseech God effectively, they ask poorly because of uncorrected books.[126]

Often, this brief reference to calendar science is attributed with great implications, as it is read in the sense that every priest in the Carolingian empire should be educated in the basics of the reckoning of time. Some interpretations are even stretched to such an extent that priests are assumed to have been able to calculate a valid date for Easter.[127]

That computus was a significant episcopal concern throughout the ninth century is apparent in fourteen surviving capitularies.[128] In these surviving normative or legislative texts, bishops insisted on the careful instruction of priests in the reckoning of time and/or their ownership of a computus. Like in the *Admonitio generalis*, the term "*compotum*" usually occurs in the context of an array of subjects or books that were of special interest to priests, like a sacramentary, lectionary, homiliary, penitential, martyrology, a collection of liturgical readings, and a computus.[129] Interestingly, a capitulary with a comparable reference to computus by Waltcaud of Liège is included in Pal. lat. 485.[130]

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[126] Contreni, "Learning for God", 102. An edition of the original Latin text and a German translation is available, see *Admonitio generalis*, 222-225.

[127] E.g. Englisch, "Reformkalender", 244-245. Remarks about the instruction of priests in the calculation of the date for Easter without reference to the *Admonitio generalis* are abundant. For instance, see Barrow, *The Clergy in the Medieval World: Secular Clerics, Their Families and Careers in North Western Europe, c. 800-c. 1200*, 221-222; Carine van Rhijn, "Carolingian Rural Priests as Local (Religious) Experts", in *Gott handhaben: Religiöses Wissen im Konflikt um Mythisierung und Rationalismus*, edited by Steffen Patzold and Florian Bock (Berlin: De Gruyer, 2016), 141. Moreover, see Warntjes, *Munich Computus*, XXXIII.

[128] See appendix 2 for a detailed overview.

[129] Note that the contents of manuscript directed at the education and pastoral work of priests usually reflect the pre-occupations of the reformers, see Rhijn, "Manuscripts", 182.

[130] MS/1, fols. 95v-96v.

None of the aforementioned royal and episcopal instructions are specific when it comes to the details of which particular books on any subject, including computus, should be studied or owned.[131] Although this could be interpreted as a sign of disinterest, Carine van Rhijn asserts that bishops, abbots, teachers and students may well have known what was meant by the authors of capitularies. Moreover, the intended audience of these instructions may have enjoyed some degree of freedom when it came to their particular execution of the ideals of reform. [132]

Interestingly, two episcopal instructions discuss clerical computus more comprehensively. The first capitulary of Willebert of Châlons, dating from ca. 869-870, requires a priest's ability to perform calculations related to the first day of each month and the age of the Moon. Furthermore, Willebert insists on knowledge of the use of the terms for the moveable feasts.[133] Even more extensive is chapter 96 of the appendix to the *Admonitio Synodalis*. [134] Here, a distinction is made between a basic and a more advanced level of computus. The minimal requirement of clerical computus skills – so-called *computum minorem* – is described as the use of the epacts, concurrents, regulars (presumably lunar, solar, and Paschal), and the terms for the moveable liturgical feasts. Although formulated in the technical discourse of computus, the meaning of this instruction is very similar to Willebert's capitulary.

Together, the extant royal and episcopal instructions suggest that priests were, at least in theory, supposed to be educated in a basic level of computistical knowledge. In short, this baseline of clerical computus appears to have been the calculation of the weekday and lunar

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[131] For the relationship between the varying contents of manuscripts for priests and reform capitularies, see Keefe, *Water*, 13-21.
[132] Rhijn, "Handbooks", 703.
[133] "*Ut de compoto kalendas et lunam et terminos adinvenire possit*." in MGH Cap. ep. II, 93,11, ch. 7.
[134] "*Computum minorem, id est epactas, concurrentes, regulares, terminum paschalem et reliquos, si est possibile, sapiat.*" in *Admonitio Synodalis*. Robert Amiet ed., *Une Admonitio Synodalis de l'époque carolingienne: Étude critique et Édition*, 68, ch. 96. See also *Sermo synodalis*. Friedrich Lotter ed., *Ein kanonistisches Handbuch über die Amtspflichten des Pfarrklerus als gemeinsame Vorlage für den Sermo synodalis "Fratres presbyteri" und Reginos Werk "De synodalibus causis"*, 51, ch. 96.

age on the Kalends of each Julian calendar month and the use of terms of the moveable feasts for the computations of their dates. By implication, the Carolingian computistical reforms were not only an affair of a small elite of exceptional intellectuals, for engagements with calendar science by secular members of the clergy at the lower levels of society were prescribed throughout the Carolingian empire. As a matter of fact, the consistent royal and episcopal concern for clerical computus throughout the ninth-century can be read as an important clue for the explanation of the presence of calendar science in Pal. lat. 485.

From *computum minorem* to Pal. lat. 485

Unfortunately, the date and place of origin of the *Admonitio Synodalis* is disputed in a highly specialised and fairly speculative debate of textual criticism. Nonetheless, it appears to be certain that this admonition originated from a region that is renowned for its proximity to and relations with the monastery of Lorsch, namely Lorraine or the Rhineland-Palatinate, and in particular the area of Metz, Trier, Prüm, and Mainz.[135] Moreover, this document is associated with the circles of archbishop Haito of Mainz (ae. 891-913, abb. Lorsch 898-913), Regino of Prüm (abb. 892-899) and archbishop Friedrick of Mainz (ep. 937-954). What remains disputed is whether the *Admonitio Synodalis* was created during the first two decades of the ninth century or between the years 888/906–964/966.

Notwithstanding this debates, it seems plausible that a definition of clerical computus or its lower limits, as elaborated by Willebert and in the *Admonitio Synodalis*, was known in Lorsch during the period in which Pal. lat. 485 was used to educate priests within its monastic school (ca. 850/860–950). Moreover, it does not seem farfetched to assume that a comparable concept of clerical computus was applied during the creation of Pal. lat. 485's computistical anthology (ca. 850/860-875). One could, therefore, wonder whether the computistical

[135] See chapter 3.

anthology within this pastoral schoolbook from Lorsch was used to instruct priests in *compotum minorem*.

Final considerations

Before turning to the case of Pal. lat. 485, it is important to briefly mention some further developments in the history of Carolingian computus. Firstly, the subjects of chronology and eschatology were a primary concern of scholars in close association with computus.[136] Secondly, a turn to planetary astronomy of Pliny the Elder, Macrobius, Martianus Capella, and Calcidius materialized around the middle of the ninth century.[137] However, as there is no material pertaining to planetary astronomy, chronology, or eschatology within Pal. lat. 485, a detailed analysis of these subject would be out of place in this study. Possibly, the lack of such material within Pal. lat. 485 can be explained by the limited scope of the clerical curriculum in Lorsch, and diverse levels of comprehension of computus by novices and more expert computists.[138]

Finally, it is crucial to address the elephant in the room, namely the fact that Frankish computus after 821 and especially 850 are massively understudied, due to an emphasis on the era of Charlemagne, and the centuries preceding his reign. For instance, the study of computus during the later ninth century is impeded by a lack of editions and translations of cohesive computistical works.[139] Moreover, the diverse collections of calendar science within the extant manuscripts composed during most of the ninth century are only regarded as witnesses of works of calendar science before 821, rather than as independent objects of interest, created for specific purposes and within particular intellectual centres. In fact, the

[136] E.g. Palmer, "Calculating".
[137] See Bruce Eastwood, *Ordering the Heavens: Roman astronomy and cosmology in the Carolingian Renaissance* (Leiden: Brill, 2007).
[138] For a similar explanation of the contents of another schoolbook, see Dobcheva, "Umbrella", esp. 219.
[139] Warntjes, "State", 26. For example, studies of the summa in MS/9 and MS/92 (Loire valley, ca. AD 850) and comparable collections remain desiderata.

number of existing studies of particular computus manuscripts as a whole, from any period in the history of medieval calendar science, as well as computus in particular intellectual centres, is almost negligible in comparison to the available studies of computistical works.[140] Hopefully, the two anticipated monographs by Wesley M. Stevens and Richard Corradini concerning Walahfrid's *vademecum* in Cod. Sang. 878, due to appear this year, will induce a change of this state of affairs for the period up to 850.[141]

[140] Ibid. Four recent examples are Jacopo Bisagni, "The Newly-Discovered Irish and Breton Computistica in Città del Vaticano, BAV, MS Reg. Lat. 123", *Peritia* vol. 28 (2017), 13-34; Dobcheva, "Umbrella", 211-229; Wallis, "Albums", 195-224; Warntjes, "Köln", 41-85.

[141] MS/101 (Reichenau, ca. 825-849).

3. An introduction to Pal. lat. 485 and the abbey of St. Nazarius in Lorsch

The second half of this thesis is written from the vantage point of the Carolingian educational reforms in a very specific space and time, namely the monastery of St. Nazarius in Lorsch, with an emphasis on the second half of the ninth century. Exploring the plausibility of different modes of computistical scholarship and education in the particular circumstances of a single abbey and its intellectual network, the present and next chapter examine the presence, arrangements, and function of Pal. lat. 485's computus by building forth on the broad historical and historiographical context provided in the preceding chapter.

More specifically, the paragraphs of this chapter serve as a threefold introduction to the case study of this thesis, laying the foundation for the closer reading of the computus in Pal. lat. 485 in the following chapter. Firstly, this central manuscript is examined in full detail, with special attention for its place and date of origin. Moreover, the presumed purpose of Pal. lat. 485 is placed under scrutiny in a discussion of this codex as a whole. Secondly, a sketch of Carolingian monasteries as hubs in intellectual, religious, and political networks, and a brief history of the monastery of St. Nazarius in Lorsch culminate in a tentative reconstruction of the intellectual network of the place of origin of our central manuscript. Thirdly, a sample of computus manuscripts produced in this network is selected, due to their potential relevance to the contexts of composition and consultation of the computus in Pal. lat. 485.

A clerical compendium

Once regarded as a composite and miscellaneous collection volume, Pal. lat. 485 is nowadays considered to be a carefully arranged late-ninth century product of the scriptorium of Lorsch,

which was compiled for the education of the clergy. Exemplifying a continued commitment to the Carolingian educational reforms, the editorial freedom and purpose within this codex is striking. Most of its quires show signs of systematic corrections and self-consciously rearranged materials, rather than simple copying from exemplars.[142]

Our central manuscript consists of 16 quires and a total of 113 folios: $(I + 1)^3 + VI^{15} + \ldots + 5\ IV^{55} + III^{61} + I^{63} + 3\ IV^{87} + 3\ III^{105} + IV^{113}$. The size of Pal. lat. 485 is approximately 25,5 x 185 cm. Based on the lack of a quire with the mark 'iii' and the looseness of the binding threads between fols. 15v and 16r, the third quire appears to have gone missing before the insertion of continuous page numbers during the seventeenth-century.[143]

Fredrick S. Paxton suggests that the lost quire may have comprised 'a *codicem (libellum) annalem* that included the whole decemnovenal cycle and thus would have been different from and supplementary to the ecclesiastical calendar on fols. 6-11'. [144] However, this interpretation appears to be unfounded, as evidence for the existence and contents of the missing quire is unavailable. The references to a *codicem annalem* and *libellum annalem* on fol. 4v, on which Paxton's interpretation relies, point to the first column of Pal. lat. 485's calendar on fols. 6r-11v, rather than a lost supplement. Finally, the mention of the *cyclus decemnovenalis* simply points out that the explained procedure can be applied for all years of this 19-year cycle.[145]

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[142] Frederick S. Paxton, "Bonus liber: A Late Carolingian Clerical Manual from Lorsch", in *The Two Laws: Studies in Medieval Legal History dedicated to Stephan Kuttner*, edited by Laurent Mayali and Stephanie A.J. Tibbets *Studies in Medieval And Early Modern Canon Law* (Washington, D.C.: The Catholic University of America Press, 1990), 1-30.

[143] *Abtei,* 55 and Michael Kautz, "Wissenschaftliche Beschreibung BAV Pal. lat. 485," http://digi.ub.uni-heidelberg.de/sammlung51/werk/pdf/bav_pal_lat_485.pdf.

[144] Paxton, "Bonus", 4 and 8, for the citation see fn. 30.

[145] See DTR ch. 19, 343-346; TROT, 63-64 for comparable references to a calendar available to Bede. Presumably, the excerpt in MS/1 was originally based on this chapter on the course of the Moon through the Zodiac. For a similar reference, see DTR ch. 23, 353-355; TROT, 71-73. For the corresponding class, see LPZ-EXPL. Note that the same text occurs in an earlier manuscript from Lorsch, see MS/4, fol. 2r, where *libellus annalis* is the title of the calendar on fols. 3r-8v, which is attributed to Bede on fol. 2v. Other references to an *annalis libellus* can be found in MS/2, fol. 19r (following a calendar); MS/3 II, fol. 70r and 71r (following a calendar) and in MS/89, fol. 3r (in rubric above of the calendar). See also, Meyvaert, "Discovering", 5-64. For other explanations and uses of this term, see Wesley M. Stevens, "Ars computi quomodo inventa est", in *Zwischen Niederschrift und Wiederschrift: Hagiographie und Historiographie im*

The contents of Pal. lat. 485 cover a broad range of theme's, such as votive masses, liturgical readings, the sacrament of baptism, rituals for the sick and dying, computus, prognostics, medicine, canon law, penance, and episcopal instructions.[146] To be more specific, our central manuscript consists of five parts: different kinds of texts on the subject of penance, sins and confession (fols. 1-3); a computus anthology, with attached material on the subject of prognostics and the communication of secret messages (fols. 4-15); discursive and explanatory writings on the terminology of the Old Testament, the church, its ministers, their tasks and responsibilities (fols. 16-48); liturgical directions, prayers, and benedictions (fols. 48-63); and canon law, penitential books and episcopal capitularies, amounting to a fully developed program for the order of clerical life and work, as well as Christian life for the laity (fols. 64-113).[147]

Apart from the fact that part of this material is specifically addressed to members of the secular clergy, all of these genres are especially relevant to the preparation of priests for a career of pastoral care.[148] Moreover, the corpus accords to the guidelines of the curriculum for clerical education, included in several reform capitularies, such as the one by Waltcaud of Liège which is included on fols. 95v-96v. Undoubtedly, this compendium was created for the education of future priests.

Date and place of origin

Pal. lat. 485 is a composite work based on contributions by numerous scribes, writing chiefly in Latin, but also in Old High German. The primary writing style within the codex is

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Spannungsfeld von Kompendienüberlieferung und Editionstechnik edited by Richard Corradini and Max Diesenberger, *Forschungen zur Geschichte des Mittelalters* (Vienna: Verlag der Osterreichischen Akadenie der Wissenschaften, 2010), 29-65, esp. 45, fn. 59; Richard Corradini, "The rhetoric of crisis. Computus and *Liber annalis* in early ninth-century Fulda", in *The construction of communities in the early Middle Ages : texts, resources and artifacts*, edited by Richard Corradini, Max Diesenberger, et al. (Leiden: Brill, 2003), 269-321, esp. 301-302.

[146] See appendix 1 for a detailed description of the contents of MS/1.

[147] This mapping of the contents of MS/1 is based on Paxton, "Bonus".

[148] See Keefe, *Water*, 13-21.

Carolingian minuscule. More specifically, most texts are written in what Bernhard Bischoff characterized as the '*jüngeren Lorscher Stil*' (after 820) and specifically its '*Spätphase'* (after 860), which leads to an initial hypothesis that Pal. lat. 485 was produced in the monastery of St. Nazarius of Lorsch after 860.[149] However, based on the digitally reconstructed Bibliotheca Laureshamensis, Tino Licht has suggested that an altered periodization is in place, antedating the *Spätstil* to ca. 850s and onwards.[150] Hence, it seems appropriate to argue for the creation of Pal. lat. 485 after 850/860.

Another sign of Pal. lat. 485 being produced in the scriptorium of Lorsch are the typical hl/hd *Verweisungsbuchstaben*, with a horizontal line through their shafts, used to mark lacunae and the inclusions of supplements, on fols. 17r, 22r, 68r, and 70r.[151] Furthermore, numerous glosses in Pal. lat. 485's calendar provide evidence for its place and date of origin. Firstly, several references place the manuscript within the monastery of Lorsch, namely the death of its first abbot, Chrodegang of Metz (5 March 776); the death of its patron, St. Nazarius (12 May); the translation of the relics of St. Nazarius to Lorsch (11 July 765); the dedication of the abbey church (1 September 774); and the death of abbot Ebergis of Minden (18 October 948/950). Secondly, three historical notes by later hands provide a *terminus ante quem* for the date of origin of Pal. lat. 485, namely the Battle of Andernach between Louis the Younger and Charles the Bald (8 October 876); the death of Louis the Younger († 20 January 882, buried in the *ecclesia varia* of Lorsch);[152] and the destruction of Louis' the Child's army

[149] For the writing style of Lorsch and its phases, see *Abtei*, 28-100; Bernhard Bischoff, "Panorama der Handschriftenüberliegerung aus der Zeit Karls des Großen", in *Mittelalterliche Studien: Ausgewählte Aufsätze zur Schriftkunde und Literaturgeschichte*, vol. 3 (Stuttgart: Anto Hiersemann, 1981), 5-38; Bernhard Bischoff, "Manuscripts in the Age of Charlemagne", in *Manuscripts and Libraries in the Age of Charlemagne*, translated by Michael Gorman (Cambridge: Cambridge University Press, 2007), 20-55. For writing styles and provinces, see also McKitterick, *Charlemagne*, esp. 359-63.

[150] Tino Licht, "Beobachtungen zum Lorscher Skriptorium in karolingischer Zeit", in *Karolingische Klöster: Wissenstransfer und kulturelle Innovation (Materiale Textkulturen)* edited by Julia Becker, Tino Licht, et al., *Materiale Textkultur* (Berlin/München/Boston: De Gruyter, 2015), 145-152 and 157-160.

[151] See *Abtei*, 30. The abbreviation 'hl' means *hic lege*, while 'hd' refers to *hic deest*. As noted by Bischoff, the use of these signs indicates corrections made in Lorsch in some manuscripts, rather than a creation in the Abbey of St. Nazarius. However, the same signs are sometimes also used in manuscripts from St. Gall and Weißenburg after ca. 841, and occasionally in codices from France and Italy.

[152] See also p. 83.

by the Hungarians (5 July 907). Together, these calendar notes confirm that the main portions of Pal. lat. 485 originated from Lorsch before 876. Demonstrably, moreover, the calendar was used in the abbey of St. Nazarius until at least ca. 950.

In conclusion, the main portion of the manuscript was written in Lorsch between 850/860-875.[153] However, parts of the codex appear to have been written during the final quarter of the ninth century, suggesting that the manuscript was bound together or rearranged at the end of the ninth century.[154] In other words, Pal. lat. 485 consists of more than one codicological units, although it is usually described and catalogued as a whole.

Potential commissioners

Paxton suggests that Pal. lat. 485 may have been commissioned for the education of future rural priests of planned settlements during the colonization of the Odenwald ca. 900. Based on the inclusion of a confession by Othmar of St. Gall on fols. 2r-2v, Paxton associates its final composition with abbot Adalbero of Augsburg (ep. 887-909, abb. 895-898).[155] Adalbero is known to have maintained close ties to St. Gall. Also, he provided a gift of relics of St. Afra and St. Magnus to Lorsch. Adalbero's dedication to St. Afra is underlined by his eventual burial in the church of St. Afra in Augsburg.[156]

To support his suggestion, Paxton mistakenly refers to a non-existing note concerning St. Magnus' feast day in Pal. lat. 485 calendar 'in a late-ninth-century hand'. On the other hand, a late-ninth-century addition referring to St. Afra can be found.[157] Thus, it is certainly

[153] Note that Bischoff consistently dates MS/1 in the second half of the ninth century before 875 (thus: 850-875), but ambiguously discusses this manuscript in a paragraph about the scriptorium of Lorsch after 860, presumably due to the appearance of the writing style known as the Later Phase of the Younger Style of Lorsch between its covers (therefore: 860-875). See *Abtei,* 52-56; KFH 3, 414, no. 6531.
[154] I.e. MS/1, fols. 2r-3v and 15r-15v,
[155] See Paxton, "Bonus", 9 (fn. 32) and 28-29; Patzold, "Basis", 227-254.
[156] Josef Semmler, *Die Geschichte der Abtei Lorsch von der Gründung bis zum Ende der Salierzeit, 764-1125* (Darmstadt: Hessische Historische Kommission, 1973), 90-91; Friedrich Knöpp, "Adalbero, Bischof von Augsburg 887-909", in *Die Reichsabtei Lorsch: Festschrift zum Gedenken an ihre Stiftung 764*, edited by Friedrich Knöpp, vol. 1 (Darmstadt: Hessische Historische Kommission, 1973), 257-260.
[157] MS/1, fol. 9v: '*et sanctae Afra virginis*' (7 Idus August).

possible that Adalbero brought together the separate pieces of Pal. lat. 485 and presided over its binding process between 895 and 898. No evidence seems to be available for the other possibility raised by Paxton, namely abbot Haito of Mainz (ae. 891-913, abb. 898-913).[158]

Although it may be tempting to choose one of these solutions to the puzzle of Pal. lat. 485's commissioner, the evidence is thin and suggestive. Most importantly, the arrivals of Adalbero and Haito in Lorsch postdate the presumed dates of origin of the main portions of the manuscript by more than two decades. Neither of them can, therefore, have functioned as a commissioner for the bulk of the manuscript, including the computistical corpus within its second quire. The more general interpretation that the different parts of Pal. lat. 485 were created for the education of priests in settlements belonging to the patrimony of Lorsch will therefore have to suffice. Eventually, the process of composition of our central manuscript culminated in a carefully constructed codex that may have been finalized during the years before the turn of the ninth century.

That Pal. lat. 485 computus was already used to educate members of the clergy before the arrival of Adalbero and Haito can be deduced from two of the aforementioned historical glosses in the calendar concerning events in 876 and 882. Moreover, a gloss by a ninth-century hand that seems to be more contemporary to the primary writing layer, than to other late-ninth-century or tenth-century additions, may provide further evidence. Interestingly, this gloss mentions a priest named Gerbraht.[159] The same name occurs in two other ninth-century manuscripts: one made in Lorsch between 825-850 and one containing a name list of members of the community of Lorsch. In the latter, the name Gerbreht occurs in the list corresponding to the time of abbot Samuel (abb. 837-856).[160] Considering the fact that

[158] Paxton, "Bonus", 29.
[159] MS/1, fol. 6r: '*Gerbraht presbyter*".
[160] See Darmstadt, Hs. 1957, fol. 187r (Lorsch, 825-850): '*Gerbraht*'; Zürich, Zentralbibliothek, Ms. Rh. hist. 27, fol. 40v (Reichenau, ca. 804-856): '*Gerbreht*'. The same name also occurs in a Gregorian sacramentary, which contains notes by a scribe trained in Lorsch, namely Vatican, BAV, Pal. lat. 494, fol. 76r (Germany,

specific roles, such as abbot, bishop, deacon, or presbyter were sometimes added to names, we might assume that Gerbreht did not have one, and that he was one of the ordinary members of the monastic community at the time. Was this, then, one and the same person? And could he have been among the first users of Pal. lat. 485's calendar? If so, a careful argument could be made for early use of Pal. lat. 485's second quire during the 850s and 860s. Perhaps, it should not even be ruled out that its main portions were composed during the final years of Samuel's abbacy.

Independent booklets

Finally, Paxton suggests that the first two quires (fols. 1r-3v and 4r-15v) had earlier lives as independent booklets.[161] Yet, some remarkable features described by Paxton are only applicable to the first quire: its writing is different than the rest of the manuscript and it has an odd number of leaves. Nonetheless, it is indeed notable that the number of leaves in both quires diverges from other parts of the manuscript. The first quire consists of a bifolium + one added leaf and the second is a sexternion, compared to a vast majority of quaternions. Moreover, the original contents of both quires did not fill them entirely, leaving empty spaces where later additions were made. Furthermore, the beginning and end of the first two quires coincide with the beginning and end of a specific group of texts. However, clear evidence for a difference in the shape of leaves or the quality of the parchments is absent. Finally, multiple folia within the first two quires are badly effaced and worn. However, most of the signs of wear and tear are located at the beginning of the first quire and in the middle of the second quire, rather than at their beginnings and endings. As such, the clearest evidence for

950-1000), but not in the name list of Lorsch from the time of abbot Gerbod: Vatican, BAV, Pal. lat. 169, fol. 151r (Northern-Italy, ca. 951-972).

[161] Paxton, "Bonus", 5-6.

prolonged prior lives as separate booklets is unavailable, unless it is assumed that the second quire was folded inside out during its life as an independent booklet.[162]

There is no lack of plausible alternative explanations. For instance, that some of the quires within Pal. lat. 485 are self-contained units, could also be explained as signs of careful planning. Moreover, the wear of the computistical corpus may have been due to its extensive use; something that is also suggested by the glosses of approximately 20-25 hands within the calendar, as well as other glosses and longer additions. Meanwhile, the damage, effacing and discolouring of fol. 1r is comparable to that of fol. 113r. Thus, although the possibility of prior lives as independent booklets should not be ruled out, it seems more likely that the depravations to the first and final folio of this compendium originate from an initial lack of the protection of a cover.

Further signs of use and provenance

As mentioned above, blank spaces in several parts of the manuscripts were filled with later additions, specifically in late-ninth-century and tenth-century hands. Likewise, numerous glosses dating from these periods were added in the margins of the codex.[163] Especially noteworthy, in the context of this study, are the additions of computistical and prognostic material on fol. 4v and 15v and the glosses on fol. 13r and 14v, for they imply that the computus in Pal. lat. 485 was actually studied and consulted. Moreover, glosses on fol. 14v and 113v show that methods to communicate secret messages using alphabetic and numeric permutations (i.e. A=1 or A=B), attached to the computus corpus on fols. 14r-4v, were actually used.[164] Interestingly, another cryptographic method involving the substitution of a

[162] P.R. Robinson, "Self-Contained Units in Composite Manuscripts of the Anglo-Saxon Period", in *Anglo-Saxon Manuscripts: Basic Reading*, edited by Mary P. Richards, *Basic Readings in Anglo-Saxon England* (London: Routledge, 2001), 25-35.
[163] *Abtei*, 55.
[164] MS/1, fol. 14r: 'IIII C VIII CCC II LXX II', which could be decoded as Δ P H T B O B and fol. 113r: 'z a c h a r i a s' = 'aa b d i b s k b t'; 'n a l e' = 'o p m p'; and 'R a z o' = 's b aa p'.

number of dots for vocals (A= ·, E = ⁖, I = ∴, O = ∵, and U = ⁘) is employed in glosses on fols. 13r and 100v,[165] and several three-dot marks in the margin of the calendar on fols. 6r-11v. Presumably, the three-dot marks encrypt the third vocal *i* as a sign for *inquire*.[166]

Based on the internal evidence, Pal. lat. 485's computus was actively used for a prolonged time, at least until the middle of the tenth century. Our central manuscript presumably remained in Lorsch until the abolishment of the abbey in 1556–1559, when the collection of Lorsch was transferred to the Bibliotheca Palatina in Heidelberg. In 1622/1623 the collection was moved to its current place of preservation: the Vatican Library.[167]

Computus

Evidently, most of the second quire deals with calendar science or the use of computus for prognostic purposes.[168] Moreover, the liturgy of baptism, crucial for entering the Christian community, has a central role in texts found throughout the codex.[169] Indirectly, this points in the direction of calendar science, for the moveable feasts of Easter and Pentecost were chosen as the only acceptable dates for baptism under Charlemagne.[170] Furthermore, several texts within this manuscript relate either to specific days during the Julian solar year or can be associated with the period around Easter, again implying a recourse to calendar science.[171] Finally, a capitulary mentioning computus as an essential subject for priests is included in

[165] MS/1, 13r: '*r · g i n b · l d*', decoding the name Raginbald and 100v: '*d r ⁘ t b ∴ d ∴*', meaning *drutbidi* (Old High German for "vomit" in reference to penance for vomiting in the church, see the penitential below).
[166] For these cryptographic methods, see Bischoff, "Geheimschriften", 120-148, esp. 125 and 137-138.
[167] "Bibliothek und Skriptorium des Klosters Lorsch – Zur Einführung", http://www.bibliotheca-laureshamensis-digital.de/de/kloster/bibliothek_skriptorium.html (16 February 2018).
[168] In this context, a crucial study is Carine van Rhijn, "Pastoral Care and Prognostics in the Carolingian Period: The Case of El Escorial, Real Biblioteca di San Lorenzo, MS L III 8", *Revue Bénédictine* vol. 127, no. 2 (2017), 272-297.
[169] Appendix 1: MS/1, fols. 36v-44v, 45v-63v.
[170] Palmer, "Adoption", 139, fn. 22. See also Keefe, *Water*, 41-51; Owen M. Phelan, *The formation of Christian Europe: the Carolingians, baptism, and the 'Imperium Christianorum'* (Oxford: Oxford Univeristy Press, 2014), 67, 71, 118, 159-162; Rhijn, "Rural", 141-142.
[171] Appendix 1: MS/1, fols. 1r-3v, 14v-15v, and 48r-49v.

Pal. lat. 485.[172] In conclusion, the presence of computus in this monastic schoolbook is not only explained by ninth-century royal and episcopal instructions, but also by the internal manuscript evidence. More specifically, the reckoning of time was not only present in Pal. lat. 485, but among its central subjects.

Purpose and audience

Based on its provenance, the better quality of its parchment, its bigger size, the wider dimensions of its margins, and the pastoral subjects of its contents, Pal. lat. 485 is set apart from the genres of clerical instruction-readers, bishop's pastoral manuals, or bishops' reference works. Rather, Pal. lat. 485 is a coherently organized monastic schoolbook or compendium for the education of local priests, created and used in the scriptorium and school of St. Nazarius Abbey in Lorsch.[173]

Carolingian monasteries as embedded intellectual centres

Having established that Pal. lat. 485 was created and used in the monastic scriptorium of Lorsch, it is informative to contextualise our central manuscript in the history of this royal abbey, its intellectual network, and the regional availability of other computus manuscripts. Let us first consider the "embeddedness" of Carolingian monasteries in general, searching for leads for the reconstruction of the history and intellectual network of Lorsch.

In principle, medieval monasteries were religious centres where monks devoted themselves to spiritual work in isolation of the outside world. By implication, it may seem rather improbable that an abbey maintained a wide network of relationships with other

[172] MS/1, fols. 95v-96v.

[173] E.g. Rhijn, "Rural", 131-146. For the underlying and ground-breaking analysis of manuscripts for priests, including a comprehensive discussion of different genres of clerical compendia, see Keefe, *Water*, esp. 1-38; Susan A. Keefe, *A catalogue of works pertaining to the explanation of the creed in Carolingian manuscripts*, Instrumenta Patristica et Mediaevalia (Turnhout: Brepols, 2012), 160-163.

intellectual centres. However, Carolingian monasticism was, according to Mayke de Jong, continuously impacted by and adjusted to interactions with the external world due to the necessary management of the monastic estate; the missionary, pastoral, and commemorative activities of monks; and the influx of new recruits and donations.[174] Besides, abbeys traditionally stood under strict episcopal control, unless they enjoyed some form of aristocratic or royal patronage. Monasteries increasingly received such royal protections and immunities during the Carolingian era. Liberated from the bishop's power, royal monasteries were placed in the service of the king.

However, royal status meant that abbeys continued to have fluid boundaries, for they became inextricably bound to royal influences. Royal abbeys were often settled in peripheral regions that had only recently entered into the Frankish sphere of influence. For the ruling dynasty, such monastic centres formed an excellent foundation for the emerging church and state structures. Through their accumulation of the ownership of vast amounts of land, not infrequently in the form of royal gifts, abbeys were responsible for the salvation of the people living there, by way of the education of the rural priests working in their holdings.

In royal service, Carolingian monasteries increasingly functioned as intellectual hubs that promoted learning, education, and the written word. Manuscripts were produced and copied in their scriptoria, and knowledge was preserved and transmitted within their libraries and schools. Here, monks studied and worked, and future priests were trained.[175] Clearly, a monks' intellectual work did not detract from the core values of monasticism, for the study of

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[174] Mayke de Jong, "Carolingian monasticism: the power of prayer", in *The New Cambridge Medieval History*, edited by Rosamond McKitterick, vol. 2 (Cambridge: Cambridge University Press, 1995), 622-653; Semmler, *Geschichte*, 80-82.

[175] Julia Becker, "Präsenz, Normierung und Transfer von Wissen: Lorsch als "patristische Zentralbibliothek"", in *Karolingische Klöster: Wissenstransfer und kulturelle Innovation*, edited by Julia Becker, Tino Licht, et al., *Materiale Textkultur* (Berlin/München/Boston: De Gruyter, 2015); Angelika Häse, *Mittelalterliche Bücherverzeichnisse aus Kloster Lorsch: Einleitung, Edition und Kommentar*, vol. 42 (Wiesbaden: Otto Harrassowitz Verlag, 2002); Albrecht Diem, "The emergence of monastic schools. The role of Alcuin", in *Alcuin of York. Scholar at the carolingian court*, edited by Luuk A.J.R. Houwen and Alasdair A. MacDonald (Groningen: Egbert Forsten, 1998), 27.

texts was considered to have spiritual significance. An opposition between intellectual and religious activity was, therefore, non-existent. Although monastic libraries and scriptoria were usually physically isolated from the outside world, their boundaries were frequently breached by the influx of manuscripts, students, and scholars; not to mention the knowledge and ideas they introduced.[176]

Based on several early library inventories, McKitterick asserts that the books in monastic libraries were usually gradually acquired by and from abbots, librarians, and monks 'through gift, inheritance, home production and possibly purchase and exchange as well.'[177] Even copies of the catalogues themselves appear to have circulated between libraries, informing scribes and librarians of the whereabouts of exemplars.[178] Moreover, travelling monks used to copy texts in the libraries which they visited during their careers.[179] Texts could even travel great distances, for they were not only copied from exemplars produced in nearby scriptoria, but also from insular volumes that were introduced on the continent, for instance through Irish and Anglo-Saxon missionary activity and Insular-influenced centres like Echternach, Werden and Fulda.[180]

The most important agents or representatives of abbeys were their foremen. Abbots often assumed positions in multiple monasteries at the same time and/or simultaneously functioned as an (arch)bishop in a local or nearby diocese. Moreover, these important figures attended synods, exchanged letters, and maintained relations with other abbots, bishops, and members of the royal court. Therefore, the activities of its abbots are especially relevant to the following examination of the history and intellectual network Lorsch.

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[176] Jong, "Prayer", 637.
[177] Rosamond McKitterick, *Carolingians and the Written Word* (Cambridge: Cambridge University Press, 1989), 165-210. For the citation, see 174.
[178] e.g. Vatican, BAV, Pal. lat. 1877.
[179] See, for instance, Richard Corradini, "Pieces of a puzzle: time and history in Walahfrid's *Vademecum*", *Early Medieval Europe* vol. 22, no. 4 (2014), 476-491.
[180] e.g. Warntjes, "Willibrord".

A brief history of the abbey of St. Nazarius in Lorsch

The members and abbots of Carolingian monasteries nourished all kinds of relationships with the outside world. Let us, therefore, look at the different kinds of aristocratic, episcopal, monastic, and royal connections which were established and maintained during the history of the monastery of St. Nazarius in Lorsch between 764 and ca. 900.[181]

Early relationships

The Benedictine monastery of Lorsch was founded on 12 July 764, when count Cancor and his mother Williswind signed the foundational charter.[182] From the onset, the monastery was entwined with the emergent Carolingian religious and political networks of power, as the founding family was part of the inner circle of the Frankish mayor of the palace and first Carolingian king Pippin III (r. 751-768).[183]

[181] The following description of the history of the abbey of Lorsch is based on the available literature on the history of Lorsch. Due to the overlap in the available sources, I have only included references to specific publications when they provide additional information, compared to other literature. In general, the following description is based on: *Abtei,* 17-100, esp. 61-66; Becker, "Präsenz", 73-5; Heinrich Büttner, "Lorsch und St. Gallen", in *Lorsch und St. Gallen in der Frühzeit* (Konstanz: Konstanz Universitäts-Druckerei, 1965); Richard Corradini, J. Müller et al., "Lorsch", in *Reallexikon der Germanischen Alterumskunde*, edited by Heinrich Beck and Rosemarie Müller, vol. 18 (Berlin/New York: De Gruyter, 2001), pp. 608-11; Johannes Duft, "Die Klosterbibliotheken von Lorsch und St. Gallen als Quellen mittelalterlichen Bildingsgeschichte", in *Lorsch und St. Gall in der Frühzeit* (Konstanz: Konstanz Universitäts-Druckerei, 1965); Franz Falk, *Geschichte des ehemaligen Klosters Lorsch an der Bergstraße* (Mainz: Verlag von J.A. Biani, 1866), 1-45; Friedrich Knöpp, "Die geschichtliche Bedeutung der Reichsabtei", in *Die Reichsabtei Lorsch: Festschrift zum Gedenken an uhre Stuftung 764*, edited by Friedrich Knöpp, vol. 1 (Darmstadt: Hessische Historische Kommission, 1973), 59-74; McKitterick, *Carolingians*, 185-191; Karl J. Minst, Hans Huth et al., *Kloster Lorsch*, Staatliche Schlösser, Gärten und Burgen in Südhessen (Deutscher Kunstverlag München-Berlin, 1965), 1-22; Semmler, *Geschichte*, 75-173. One of the most important primary sources for the history of Lorsch is the so-called Codex Laureshamensis, including the *Chronicon Laureshamense* and *Liber traditionum Laureshamensium*: Würzburg, Staatsarchiv, Mainzer Bücher verschiedenen Inhalts 72, see http://archivum-laureshamense-digital.de/view/saw_mainz72. For a recent digitization of the Codex Laureshamensis, including interactive maps, lists of persons and places, and references to editions and translations, see http://archivum-laureshamense-digital.de/de/codex_laureshamensis/codex.html.

[182] Falk, *Geschichte*, 2-4.

[183] For a detailed family tree of the Carolingian dynasty until the generation of Louis the Younger, see David Ganz, *Einhard and Notker the Stammerer: Two Lives of Charlemagne*, Penguin Classics (London 2008), xiii-xiv. Note that the rendition of dates of the reigns of Carolingian kings and emperors in my description has, in some cases, been simplified.

That same year, the ownership of the monastery was transferred to archbishop Chrodegang of Metz (ae. 747-766, abb. 764-765), a former courtier in the time of court mayors Charles Martell and Pippin, and appointee of the latter, renowned as an important church reformer.[184] In 757, Chrodegang founded a monastery in Gorze, near Metz. On 11 July 765, the relics of St. Naborius, St. Gorgonius, and St. Nazarius were simultaneously translated from Rome to, respectively, the monasteries in Lotharingen, Gorze and Lorsch.

The relationship between Lorsch and Gorze is also apparent in the person of Gundeland (abb. 765-778), Chrodegang's brother and his successor as abbot in Lorsch. Gundeland was a former monk in Gorze and may have been abbot there too. He maintained the strong relationship between Lorsch, Gorze, and Metz.[185]

Following a dispute concerning the legal status and ownership the abbey with Cancor's son count Heimerich, abbot Gundeland sought to transfer the ownership of the monastery to king Charlemagne in 772. The conflict was decided in favour of Gundeland by Charlemagne's grant of royal status and immunity to the abbey.[186] The Frankish king was, soon thereafter, present at the consecration ceremony of the monastery church by archbishop Lullus of Mainz (ae. ca. 781-786) on 1 September 774.[187]

On the one hand, this second transfer of ownership created a strong bond between Lorsch and the Carolingian dynasty. On the other hand, this royal connection severed the ties between the monastery and the episcopate of Metz. It is, therefore, important to keep in mind

[184] See Josef Semmler, "Chrodegang, Bishof von Metz 747-766", in *Die Reichsabtei Lorsch: Festschrift zum Gedenken an ihre Stiftung 764*, edited by Friedrich Knöpp, vol. 1 (Darmstadt: Hessische Historische Kommission, 1973), 229-245. See also M.A. Claussen, *The Reform of the Frankish Church: Chrodegang of Metz and the Regula canonicorum in the Eight Century* (New York: Cambridge University Press, 2004), 22.

[185] Claussen, *The Reform of the Frankish Church: Chrodegang of Metz and the Regula canonicorum in the Eight Century*, 21-22; Semmler, *Geschichte*, 79.

[186] Corradini, Müller et al., "Lorsch", 608; Semmler, *Geschichte*, 79-81. The resolution of the dispute seems to be typical of the time, see above and Jong, "Prayer", 623-627.

[187] Falk, *Geschichte*, 8; Semmler, *Geschichte*, 82-83. It has been suggested that Theodulf of Orleans was also present, or at least visited Lorsch from Worms, e.g. *Abtei,* 61 and 90, fn. 6.

that the existence relationships at one point in time not always guarantee their persistence for the decades to come.

Institutional stability

Due to the crucial role of abbots, their succession must have been a significant factor for the fluctuation of relations between Lorsch, other institutions, and specific persons. However, some degree of stability was simultaneously ensured by the strong relationship with the ruling dynasty. Moreover, starting with the successor of Gundeland, the members of the monastic community of Lorsch elected the next abbot from their midst, which could be interpreted as a further insurance of institutional stability, diminishing the role of external influences.[188]

Surely, the personal networks of abbots and the ongoing royal donations provide further evidence for a contextualisation of the abbey of Lorsch. Soon after its foundation, Lorsch became one the wealthiest monasteries of the Carolingian kingdoms, receiving staggering numbers of donations, especially from members of the royal family. Astonishingly, 1500 donations were made to Lorsch between 773-778. Subsequently, other important royal gifts were bestowed to the abbey during the short abbacy of Helmerich (abb. 778-784). Starting in 810, the number of annual gifts started to decrease.[189]

Helmerich's successor, Richbod (abb. 784-804), is known to have been a monk in Lorsch before his abbacy.[190] Remarkably, Richbod was a member of the intellectual elite surrounding Charlemagne and the scholar Alcuin of York. Together with Hrabanus Maurus

[188] A capitulary of 818/19 granted the right of free election of an abbot to all royal monasteries. However, kings continued to appoint abbots themselves, see Jong, "Prayer", 635.

[189] For an extensive analysis of the donations to and properties of Lorsch and St. Gall, see Büttner, "Lorsch", pp. 5-20. Interestingly, the *Codex Laureshamensis* shows that Lorsch owned properties in roughly 1150 places in the Netherlands, Belgium, Germany and the Switzerland by the year 1275.

[190] For instance, Richbod was identified as one of the hands in the *Annales Laureshamenses* and several charters from Lorsch. See Knöpp, "Richbod", 247-51, esp. 247.

and Grimalt, Richbod was one of Alcuin's students, perhaps at the alleged school at the royal court. After he became abbot, Richbod and Alcuin maintained contact.[191]

The members of the first-generation of students of Alcuin all became important intellectuals, whom usually visited different intellectual centres during their lives, corresponded with each other using nicknames, and often became abbots of influential monasteries or chancellors and (arch)chaplains at royal courts.[192] Their own students – such as Otfried von Weißenburg, Lupus of Ferrières, and Walafrid Strabo – had comparable careers.

Starting in the first half of the 790s, Richbod was simultaneously bishop of Trier (e. 791/794-804). He is, moreover, recognized as the abbot who presided over a period of great intellectual productivity and building activity in Lorsch. As foreman of a new generation of monks in the abbey of St. Nazarius, Richbod is thought to have terminated the traditional relationship between Lorsch and Gorze-Metz.[193] Moreover, Bernhard Bischoff discusses the presence of Anglo-Saxon influences in Lorsch, through the relationship of Richbod and Alcuin and by way of the influence of Lullus of Mainz.[194]

Adalung (abb. 804-837), a former writer of charters in Lorsch, was one of the few witnesses of to the will of Charlemagne in 811.[195] He maintained the strong relationship with the Carolingian court during the reign of Louis the Pious (r. 814-840).[196] In 808, Adalung also became foreman of the abbey of St. Vaast in Arras. In 815, Louis the Pious confirmed the immunity of Lorsch. The biggest donation to the monastery during the time of Adalung was made in 819 by of Imma and Einhard, the famous courtier of Charlemagne, author of the *Vita*

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[191] Alcuin, *Epistolae*, MGH Epp. II, no. 13: 38-39; no. 49: 93; no. 78: 119-120; no. 191: 318.
[192] Mary Garrison, "The Social World of Alcuin: Nicknames at York and at the Carolingian Court", in *Alcuin of York: Scholar at the Carolingian Court*, edited by L.A.J.R. Houwen and Alasdair A. MacDonald (Groningen: Egbert Forsten, 1998), 59-79; Springsfeld, *Einfluß*, 20-32.
[193] Semmler, *Geschichte*, 84-85.
[194] *Abtei,* 61-62. Interestingly, Bischoff recognizes insular influences within MS/1, see ibid. 55.
[195] McKitterick, *Charlemagne*, 298. The other abbots that were present were from St. Germain des Prés, St. Martin of Tours and St. Riquier.
[196] McKitterick, *Carolingians*, 189-190; Semmler, *Geschichte*, 85-86.

Karoli, and one of the central figures of the reforms of 816/817.[197] Moreover, the *Chronicon Laureshamense breve* originates from the years 806-814. Finally, Adalung was send to pope Paschalius I as an envoy of Louis the Pious in 823.[198]

Interestingly, Adalung was not among the leading abbots supporting the Aachen reforms of 816/817, whose names were entered in the Reichenau confraternity book in 824.[199] Nonetheless, the abbey of St. Nazarius implemented the Aachen reforms and was listed among the most powerful monasteries in the *Notitia de servitio monasteriorum* of 819. Based on this by-product of the Aachen reforms, Lorsch was one the few East-Frankish monasteries that owed the king both annual donations and military service, on top of the usual obligation of prayer for the royal family and realms.[200]

Samuel (abb. 837-856) came to Lorsch as a child oblate. He is known to have been a monk in Fulda, from where he was sent to study at the abbey of Tours, together with his friend Hrabanus Maurus (abb. Fulda 822-842, ae. Mainz 847-857) and Haito (abb. Lorsch 891-913).[201] Samuel returned to Fulda before he became abbot of Lorsch. In 840, Samuel was appointed as bishop of Worms. In 840 and 847, Samuel is respectively known to have attended the Synods of Ingelheim and Mainz. Moreover, he appears to have been responsible for an influx of books to the library of Lorsch, including contemporary works by Hrabanus Maurus from Fulda. No copies of Hrabanus' DC, attributed to the scriptorium or library of Lorsch, are extant. Nonetheless, Hrabanus' computistical handbook must have been available

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[197] Julia M.H. Smith, "Einhard: The Sinner and the Saints", *Transactions for the Royal Historical Society* vol. 13 (2003), 58 and 68; Jong, "Prayer", 634.

[198] *Abtei*, 62.

[199] Jong, "Prayer", 934. See Zürich, Zentralbibliothek, Ms. Rh. hist. 27, fol. 62v.

[200] John W. Bernhardt, "Servitium Regis and Monastic Property in Early Medieval Germany", *Viator* vol. 18 (1987), 53-87, esp. 54-55 and 72; John W. Bernhardt, *Itinerant Kingship and Royal Monasteries in Early Medieval Germany, c.936-1075*, Cambridge Studies in Medieval Life and Thought: Fourth Series (Cambridge: Cambridge University Press, 1993), 70-84, 112 n. 116 (note that pp. 85-135 is a reworked version of the 1989 article); For the Notitia de servitio monasteriorum, see *Notita de servitio monasteriorum*, ed. D.P. Becker, *Initia consuetudinis Benedictinae: Consuetudines saeculi octavi et noni*, Corpus Consuetudinum Monasticarum (Siegburg: F. Schmitt, 1963), 483-499.

[201] Hrabanus Maurus has written at least one letter to abbot Samuel, see Hrabanus Maurus, *Epistola 24*, MGH Epp. III, 430-431. Interestingly, Bischoff suggests that Hrabanus also maintained a friendship with a priest from Lorsch with the name Gerhoh, see *Abtei*, 62-63.

during the second half of the ninth century, for it is mentioned in an addition to a library catalogue which dates from ca. 860.[202] Under Samuel, Lorsch received several important donations, including royal gifts.[203]

The division of the Carolingian empire

During the civil wars of the 830s and early 840s, when the sons of Louis the Pious rebelled against their father in changing formations, abbots Adalung and Samuel sided with the emperor. The relationship between Lorsch and Louis the Pious was, thereafter, sealed by his retirement to the abbey near the end of his life. Louis the Pious was buried in Lorsch in 840.[204] After the division of the Carolingian empire in 843, Louis the German (r. 843-876) became king of the East-Frankish realms. A rapprochement between Lorsch and the new king happened in 847.[205] That the relationship with the ruling king was fully re-established by the 850s, is confirmed by subsequent royal donations and Louis the German's confirmation of the immunity of the Lorsch in 852.[206]

Enduring royal relations

The tradition of royal gifts was maintained during the second half of the ninth century during the successive reigns Louis the Younger (r. 876-882), Charles the Fat (r. 882-887), Arnulf of Carinthia (r. 887-899), and Louis the Child (r. 899-911). However, the period of impressive growth and productivity of the library scriptorium of Lorsch seems to have come to an end after the death of abbot Engilbert (abb. 857-863).[207] Abbots of Lorsch nonetheless continued

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[202] Vatican, BAV, Pal. lat. 1877, fol. 2v: '*Liber computandi item Hrabani*'. See Häse, *Bücherverzeichnisse*, 136 and 177. See also *Abtei*, 22-25.
[203] Falk, *Geschichte*, 36; Hellmuth Gensicke, "Samuel, Bischof von Worms 835-856", in *Die Reichsabtei Lorsch: Festschrift zum Gedenken an ihre Stiftung 764*, edited by Friedrich Knöpp, vol. 1 (Darmstadt: Hessische Historische Kommission, 1973), 253-255; McKitterick, *Carolingians*, 189-190.
[204] McKitterick, *Carolingians*, 186.
[205] Corradini, Müller et al., "Lorsch", 609.
[206] Falk, *Geschichte*, 37.
[207] McKitterick, *Carolingians*, 190. See also *Abtei*, 52-56 and 63-63.

to be important figures, as is apparent from Thiotroch's (abb. 863-875) attendance of the Synod of Worms in 868. Thiotroch is known to have been a former writer of charters in Lorsch. As a deacon, he wrote an extant letter concerning differences in the performance of mass in the abbeys of Fulda and Lorsch.[208]

During the troubled final decades of the ninth century, kings succeeded one another swiftly, and so did the abbots of Lorsch, such as Babo (abb. 875-881) and Walther (abb. 881-883). Still, the abbey's relationships with the ruling members of Carolingian dynasty in the Eastern kingdom appear to have persisted. In 880, Louis the Younger erected the famous *ecclesia varia* in Lorsch, where his illegitimate son Hugo was buried in 880 and the king himself was buried in 882.[209]

After the coup of 887, Arnulf confirmed the immunity of Lorsch at the request of abbot Gerhart (abb. 883-14 June 893), followed by an important royal donation to Lorsch in 889.[210] The relationship between the monks of Lorsch and Arnulf deteriorated after Gerhart's death. In 894, Arnulf personally visited the abbey of St. Nazarius. One year later, the disputed king and emperor intervened in Lorsch, attempting to restore order by appointing bishop Adalbero of Augsburg as reform-abbot during the Synod of Tribur. Adelbero is known to have travelled with Arnulf during his campaign in Italy.[211]

Under Arnulfs successor, Louis the Child, archbishop Haito of Mainz was appointed as abbot in Lorsch. Haito had, as mentioned above, been a monk in Fulda and Tours. Moreover, he was deacon in Reichenau, where he would later become abbot (abb. 888-913). Interestingly, Haito also became abbot in Weißenburg (abb. 902-913) and Ellwangen (abb. 905-913). Haito is further known to have presided over the Synods of Frankfurt and Tribur,

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[208] Semmler, *Geschichte*, 88, esp. fn. 220 on 149; Häse, *Bücherverzeichnisse*, 22, fn. 23. See also *Abtei*, 63. For the letter, see MS/525, fols. 1r-v.
[209] See also p. 69.
[210] For a connection between Gerhart and Arnulf, see also *Abtei*, 65 and Oxford, Boldeian Library, MS. Laud. Misc. 133, fol. 144v.
[211] See Knöpp, "Adalbero", 257-260.

respectively in 892 and 895. Adalbero and Haito were named godfather of Louis the Child in 893. Like Adalbero, Haito travelled with Arnulf during his campaign in Italy.[212]

Thus, albeit under duress, the royal and monastic relationships of abbots of Lorsch lasted until the end of the ninth century. With the appointment of bishops as abbots in violation of the right of free election of an abbot by the monks of Lorsch, the history of Lorsch again followed contemporary developments, in this case purporting a general tendency of bishops retaking control in monasteries.[213]

Arch-chancellors, abbots, and court librarians from Lorsch

Based on their appointments and personal relationships, the abbots of Lorsch formed an important binding factor between the monastery and the wider world. However, other members of monastic community played similar roles.

Firstly, Rado (+ 808) has been identified as one of the Older Lorsch Style hands in several early codices from Lorsch, and as a writer of some early charters in the time of Richbod. Later in his life, Rado was appointed as arch-chancellor at Charlemagne's court (ac. 776-795) and abbot of St. Vaast (abb. 790-808). As arch-chancellor, Rado was the successor of Angilram, whom in turn had been the successor of Chrodegang as archbishop of Metz. As abbot of St. Vaast, Rado was the predecessor of Adalung.[214]

Secondly, Louis the Pious' court librarian Gerward received his education in the monastery of Lorsch during the second decade of the ninth century. McKitterick suggests that Gerward was transferred to the palace by abbot Adalung.[215] As court librarian, Gerward may have formed an important link between the abbey of Lorsch and the Carolingian court.[216] That

[212] Falk, *Geschichte*, 37-44; Knöpp, "Hatto", 261-267; Corradini, Müller et al., "Lorsch", 609.
[213] Jong, "Prayer", 651.
[214] Licht, "Beobachtungen", 149-151.
[215] McKitterick, *Carolingians*, 189-190. See also *Abtei*, 62 and 64-65.
[216] Becker, "Präsenz", 83; McKitterick, *Carolingians*, 186, 189-90. *Abtei*, 5.

Gerward worked in the highest intellectual circles, is also apparent from a letter written to him by Einhard.[217]

Lorsch as an intellectual centre

The extant manuscript evidence provides further evidence, that allows a reconstruction of the library, scriptorium, and the intellectual network of the abbey of St. Nazarius. Julia Becker provides an insightful summary of the library collection of Lorsch, based on the ground-breaking work of Bernhard Bischoff and the critical edition of four preserved library catalogues by Angelika Häse's.[218] Becker contextualises the collection of Lorsch in the tradition of Carolingian educational reform and the signs of *correctio* and *renovatio* in manuscripts that were produced for other intellectual centres and for the community of Lorsch itself.[219]

Evidently, the abbey of St. Nazarius owned an exceptionally large collection of patristic works that surpassed the collections of ninth-century monasteries, such as Reichenau, St. Gall, Murbach, Bobbio, Fulda and Corbie. By implication, Lorsch appears to have been specialized in this subject, with an emphasis on works by Augustine. In total, the collection of Lorsch consisted of roughly 470 codices containing works by late-ancient and early-medieval authors, and encompassing subjects like Bible-exegesis, theology, chronology, grammar, poetry and hagiography. Furthermore, some codices were compilations of letters or glossaries.[220] The size of its collection is even more remarkable because Lorsch was a

[217] Einhard, *Epistola 52*, MGH Epp. III, 135.
[218] Häse, *Bücherverzeichnisse* and Bisschoff's *Abtei*.
[219] Becker, "Präsenz", 74-8. For the catalogues of the library of Lorsch, see Vatican, BAV, Pal. lat. 1877. In chronological order A (fols. 67-69), B (fols. 44r-66v), Ca (fols. 1r-33r), and Cb (33v-34r), see Häse, *Bücherverzeichnisse*. A Fulda booklist is also present in fols. 35r-43v.
[220] Becker, "Präsenz", 78-81.

relatively young foundation, lacking a collection dating from the before reign of Charlemagne.[221]

Apart from an emphasis on patristic works, Helmut Reimitz concludes that Lorsch also had an impressive collection of historical works. In the footsteps of Becker, Reimitz argues that old exemplars of historical texts were not merely collected and copied in Lorsch, but 'carefully read, checked against other traditions and meticulously edited to be brought into line with the new standards of the Carolingian *correctio'*. [222]

Lists of the names of monks from Lorsch have been preserved in two manuscripts, shedding some further light on the history of the monastic community of Lorsch during the abbacies of Adalung, Samuel, and Gerbod (abb. 951-972).[223] Interestingly, Chrodegang of Metz, abbots Gundoland, Heimerich, and Richbod, as well as Alcuin, and Lull of Trier are also mentioned in the Reichenau confraternity book. The fact that these lists were preserved outside the abbey of Lorsch, serves as important evidence for the relations between different monasteries.

The intellectual network of Lorsch

By now, numerous traces of a vast network of relationships between Lorsch, other monasteries, episcopates, the Carolingian court, and specific persons have been mentioned. Complementing the information provided by the extensive reconstruction of the library and scriptorium of the royal abbey by Bischoff, and his insightful analysis of writing

[221] *Abtei*, 72. In contrast, Bischoff mentions older centres in Verona, Lyon and Bobbio.
[222] Helmut Reimitz, "Transformation of Late Antiquity: the writing and re-writing of Church history at the monastery of Lorsch, c. 800", in *The Resources of the Past in Early Medieval Europe*, edited by Clemens Gantner, Rosamond McKitterick, et al. (Cambridge: Cambridge University Press, 2015), 262-282, for the citation see 264.
[223] Zürich, Zentralbibliothek, Ms. Rh. hist. 27, fol. 40v (Reichenau, ca. 804-856) and Vatican, BAV, Pal. lat. 169, fol. 151r (Northern-Italy, ca. 951-972).

provinces in the Age of Charlemagne, it is possible to perform a tentative reconstruction of the intellectual network of Lorsch.[224]

To my mind, this network consisted of at least two circles.[225] Starting at the centre, near the focal points of Lorsch itself, the abbey of St. Nazarius maintained strong relationships with the episcopates and monasteries of Trier, Metz, and Gorze. Soon, however, Lorsch became – above all – oriented towards the royal court due to the grant of immunity and the royal status. Although this shift in orientation appears to have resulted in weaker relationships with Metz and Gorze after 772, the connection with Trier was retained for the decades to come.

Bischoff's analysis of regional writing styles resonates with this sketch of the inner circle of Lorsch intellectual network. According to Bischoff, the imperial abbey of St. Nazarius in Lorsch was part of the Austrasian writing province and the so-called Carolingian court scriptorium. However, as made explicit by McKitterick, 'the groups of scribes and artists associated with the royal court need not have been based at the court itself'.[226] In practice, the mentioned writing provinces consisted of a network of scriptoria that were predominantly situated near the upper Rhine and the Moselle, with the royal palaces in Aachen and Ingelheim as their focal points. Intellectual centres that, according to Bischoff, also belonged to the court scriptorium and the Austrasian writing province are the abbey of St. Maximin in Trier, the cathedral library of Metz, the abbey of Sts. Peter and Paul in Weißenburg, and the episcopal library of Cologne.[227] Without doubt, Weißenburg, Cologne, Aachen, and Ingelheim should, therefore, be included in the inner circle of Lorsch. Meanwhile, Bischoff argues that the writing schools of Mainz and Worms were part of a

[224] For writing styles and provinces, see also McKitterick, *Charlemagne*, esp. 359-63.
[225] A heat map of the resulting intellectual network of Lorsch is available on: http://computus.lat/visualize/maps/lorsch-intellectual-network.
[226] McKitterick, *Charlemagne*, 362.
[227] See, Bischoff, "Mittelalterlichen Studien 3", 6-9; Bischoff, "Manuscripts".

different writing provinces, for these centres employed the Germanic-Insular writing style. Therefore, we encounter these intellectual centres in the border region of the inner and the outer circle of Lorsch. Intellectual centres like Ellwangen, St. Gall, Reichenau, Augsburg, Basel, Arras, Fulda, and Tours can cautiously be positioned further outwards. Finally, the contacts and exchanges of manuscripts with centres in Murbach, Echternach, St. Amand, Corbie, Reims, Luxeuil, and possibly Northern Italy and Northumbria, seemingly reside in the periphery of the outer circle of Lorsch's network of communication.

A sample of regional computistical manuscripts

Using this tentative reconstruction of the intellectual network of Lorsch, I selected a sample of eight other computus manuscripts, consisting of eleven codicological units. Each of the selected codex units is thought to have been created in or otherwise associated with writing centres connected to Lorsch. On the one hand, one or more of these manuscripts may have been consulted during the composition and use of Pal. lat. 485's corpus on the reckoning of time. On the other hand, some of these codices may have used Lorsch exemplars for their composition.

As mentioned in the introduction to the present study, it was necessary to limit the scope of my research. Firstly, I restricted my selection to manuscripts dating from 798 to 875. Secondly, I decided that each of the selected manuscripts should have been made within or associated with the inner circle of the intellectual network of Lorsch.[228] It is important to

[228] Hence, I explicitly excluded earlier and later computus manuscripts, as well as codex units that arrived in Lorsch at an unknown point in time (not necessarily before the turn of the ninth century), or simply show no considerable overlap with MS/1's computus. See, for example, MS/503 (computus in fasz. II: Lorsch, 950-1000); MS/524 (Northumbria, 8th century); MS/525 (Lorsch, ca. 900); MS/526 (Lorsch/Alsace, ca. 1025-1066); MS/527 (area of Reims, 850-900); M5/529 (computus in fasz. II: Italy or France, 8th century). Unfortunately, I was unable to have a look at MS/225 (area of Reims and Laon, AD 840), a manuscript which arrived in Trier between 875-900 and may, therefore, have been relevant to the composition of MS/1. Based on the available descriptions, fols. 16r-20r, 32r-35v and 71v-74v could be relevant, for these are undescribed folios between the works by Bede that potentially include shorter texts and tables. See John J. Contreni, "John Scottus and Bede", in *History and Eschatology in John Scottus Eriugena and his Time*, edited by

emphasize that I, thus, disregard manuscripts from the outer circle. Including manuscripts from centres like St. Gall, Reichenau, and Fulda would have significantly widened the geographical and temporal scope of my selection, increasing the number of manuscripts beyond what I was capable to analyse in preparation of this thesis. Note, however, that a majority of the extant computus manuscripts from these centres date from before or after the periodization of the present study, are interpreted as personal collections belonging to a specific scholar, and/or do not significantly overlap with the computus in our central manuscript. Moreover, none of the excluded manuscripts is associated with Lorsch. Therefore, it is unlikely that any of them was relevant to the creation or use of Pal. lat. 485's computus.[229]

Included in my selection are extant manuscripts from or associated with Trier, Cologne, Mainz, Worms, and Weißenburg. Moreover, an earlier computus manuscript from Lorsch is included. Finally, I chose to include two wildcards that are associated with Lorsch and/or Trier, namely a codex from Prüm and a manuscript that was vaguely localized in a writing centre in Western-Germany. An important confirmative ground for my selection was the fact that Borst – known for his monumental editions and studies of Frankish computistical works – considered the calendars within most of these codices to be part of the *Rheinfränkische Fassung* in his monumental study of the Carolingian imperial calendar; a calendar tradition which supposedly originated from Lorsch.[230]

The codicological units studied in preparation of the following chapter are:

James McEnvoy and Michael Dunne (Leuven: Leuven Univeristy Press, 2002); John J. Contreni, "Bede's Scientific Works in the Carolingian Age", in *The Venerable Bede: Tradition and Posterity*, edited by Stéphane Lebecq, Michel Perris, et al. (Lille: Ceges, 2005). Lacking significant overlap with MS/1, MS/143 (Abbey of St. Leodegar in Murbach, 820) may nonetheless be of interest for further research. This *Prachtexemplar* of *Lib. comp.* is thought to have been send to Prüm after 825, see *Schriften* 3, 1054-1334.

[229] MS/94 (St. Gall, 760-797); MS/98 (St. Gall, ca. 850: *vademecum* of Grimald of St. Gall); MS/99 (St. Gall, 9th or 10th century); MS/101 (Reichenau/Fulda, ca. 825-849: *vademecum* of Walahfrid Strabo); MS/194 (Fulda, 820-850); and MS/107 (Reichenau, 875-900). Both MS/101 and MS/194 contain copies of DC.

[230] Reichskalender I, 37-38 and 56-100.

MS/2 Vatican, BAV, Pal. lat. 1447 (Mainz, 800-813).[231]

MS/3 I Vatican, BAV, Pal. lat. 1448, fasz. I (Abbey of St. Maximin in Trier, 810).[232]

MS/3 II Vatican BAV, Pal. lat. 1448, fasz. II (Mainz, 837-840). This manuscript is associated with the court school of Louis the Pious, possibly in Aachen or Ingelheim. Moreover, a writer trained in Lorsch worked on parts of it.[233]

MS/4 Vatican, BAV, Pal. lat. 1449 (Abbey of St. Nazarius in Lorsch 800-849, likely 810-814).[234]

MS/7 I Vatican, BAV, Pal. lat. 834, fasz. I (West Germany, possibly Hornbach or Zell, 800-849). The manuscript contains a mark of ownership from Lorsch dating from the tenth or eleventh century.[235]

MS/7 II Vatican, BAV. Pal. lat. 834, fasz. II (Presumably: Eastern-France, 850-900). The manuscript contains a mark of ownership from Lorsch dating from the tenth or eleventh century.[236]

MS/37 Berlin, Staatsbibliothek, Phillipps 1869 (Abbey of St. Salvator, Prüm, 833-865). According to Borst, the calendar within this manuscript was copied from

[231] FKH 3, 418, no. 6577; *Reichskalender* 1, 73-74; *Schriften* 1, 298-299.
[232] FKH 3, 418, no. 6578; *Reichskalender* 1, 299-300; *Schriften* 1, 60-62.
[233] *Abtei,* 128-129; FKH 3, 419, no. 6579; *Reichskalender* 1, 299-300; *Schriften* 1, 60-62.
[234] *Abtei,* 51-53 and 128-129; FKH 3, 419, no. 6580; *Reichskalender* 1, 300; *Schriften* 1, 59-60.
[235] *Abtei*, 58 and 126-127; FKH 3, 417, no 6560.
[236] *Abtei*, 60 and 126-127; FKH 3, 417, no 6561.

a now lost exemplar from Lorsch. Moreover, the manuscript is associated with the abbey of St. Maximin in Trier.[237]

MS/88 I Cologne, EDD, 83-II, fasz, I (Cathedral of St. Peter in Cologne, 798).[238]

MS/88 II Cologne, EDD, 83-II, fasz. II (Cathedral of St. Peter in Cologne, 805).[239]

MS/89 Cologne, EDD, 103 (Cathedral of St. Peter in Cologne, 811-818).[240]

MS/247 Wolfenbüttel, HAV, Wissemburgensis 91 (Cathedral of St. Peter's in Worms, 800-820). Interestingly, this manuscript was later moved to the abbey of St. Peter and Paul in Weißenburg.[241]

[237] *Abtei,* 102-103; FKH 1, 92, no. 438; *Schriften* 1, 216. 'Codex sancti Maximin', fol. 1r.
[238] FKH 1, 395, no. 1907; *Reichskalender* 1,62-63; *Schriften* 1, 236-238.
[239] FKH 1, 395, no. 1907; *Reichskalender* 1, 62-63; *Schriften* 1, 236-238.
[240] FKH 1, 397, no. 1916; *Reichskalender* 1, 63-65; *Schriften* 1, 238.
[241] FKH 3, 512, no. 7427; *Schriften* 1, 316-317.

4. Computus in action

Step by step, the previous two chapters provided an explanation for the presence of a computistical corpus in Pal. lat. 485.[242] Completing the analysis of the primary question of this thesis, the present chapter considers the arrangement and function of the computus in Pal. lat. 485 in detail. Because the paleographical, codicological, philological, and computistical layers of evidence for the context of compilation and the context of consultation can hardly be explained apart from each other, my analysis repeatedly moves from one context to another.[243]

Several closely related aspects of the computus in Pal. lat. 485 are of interest to the examination of its constitution and modes of use. For instance, to gain an understanding of the particular arrangement of the computus in Pal. lat. 485, the computistical contents of our central manuscript should be contextualised in relation to computistical traditions, texts, and tables which were available the sample of regional computus manuscripts and may have been used during its creation process.[244] Moreover, further attention is due for the curriculum of clerical computus known as *computum minorem*, which may have influenced or determined the particular selection of computistical material in Pal. lat. 485 and its use for the education of future priests.[245] Furthermore, the function of our computistical anthology cannot be explained without a close reading of its most remarkable features, such as particular technical ambiguities and a range of uncorrected mistakes, which inform us about the preconditions that were required for a successful educational use of the computus in Pal. lat. 485. Finally, an analysis of the function of the computus in our central manuscript is not complete without

[242] See pp. 59-74.
[243] This sequential and ruminative approach is somewhat comparable a recent proposal of a new method for unlocking the compiler's intentions behind so-called scientific albums, see Wallis, "Albums", 195-224.
[244] See pp. 88-91.
[245] See pp. 59-62.

incorporating the prognostic and cryptographical material, appended at the end of the computistical anthology in Pal. lat. 485.

First encounters with the contexts of compilation and consultation

Little is known about the location or layout of the scriptorium, library and school in the monastic buildings of the abbey of St. Nazarius in Lorsch.[246] Although it is, therefore, impossible to determine the precise circumstances of the creation and use of Pal. lat. 485's computus corpus, a baseline of the environments of its compilation and consultation can be established by analysing the palaeographical and codicological residue on its folia.[247]

To be specific, several signs of common scribal techniques and tools, which were usually applied during the production and use of medieval manuscripts, are visible in the second quire of our central manuscript. A brief analysis of these marks informs us about the planned realisation of this computistical anthology, and the ways in which its consulters interacted with the quire after its composition.

Composition

In general, the computistical material in Pal. lat. 485 was neatly organized, written by a trained hand, and executed on parchment that must have been of reasonable to good quality. Evidently, the quality of the parchment is nowadays obscured by traces of extensive use.

[246] For an impression of the monastic layout of Lorsch, see Häse, *Bücherverzeichnisse*, 52.

[247] For the notion of such cultural residues, see Erik Kwakkel, "The Cultural Dynamics of Medieval Book Production", in *Manuscripten en miniaturen: Studies aangeboden aan Anne S. Korteweg bij haar afscheid van de Koninklijke Bibliotheek*, edited by Jos Biemans, Klaas van der Hoek, et al., *Bijdragen voor de geschiedenis van de Nederlandse boekhandel* (Zutphen: Walburg Pers, 2007), 243-252. The following analysis of the codicological evidence in MS/1's second quire is based on Bernhard Bischoff, *Latin Paleography: Antiquity & The Middle Ages*, translated by Dáibhí Ó Cróinín and David Ganz (Cambridge: Cambridge University Press, 2004), 7-19.

Contrasted to the messy computistical material in the regional manuscript Wissemburgensis 91, the high quality of the execution of the computus in Pal. lat. 485 really stands out.[248]

Preparations for the computistical section were made by consistently pricking and ruling the folia throughout the quire, presumably using a so-called *punctorium* and either the back of a knife or a stylus. Leaving considerable space at the outer edges or margins of its folia, a combination of horizontal and vertical rulings was added in anticipation of neatly aligned tables, text blocks, and initial capitals.[249] Subsequently, the scribe used ink horns filled with inks of brownish-blackish and red colours, suggesting the use of one or two quill pens. By implication, the scribe must have had a small knife or razor at his disposal, used to split, shape, and reshape the end of his quills, and to make minor erasures. Initial capitals and rubrics were frequently inserted using so-called uncials and canonized capitals, differentiating between the two available colours with a preference for the red ink.[250] Moreover, the red ink was used to differentiate between information within tables and the calendar.[251] Brownish-blackish characters were sometimes accentuated with red ink.[252]

On multiple occasions, a pumice stone appears to have been used for scraping off entries in the calendar; yet this was most likely done after the compilation of the quire.[253] Meanwhile, texts and tables must have been copied from one or more exemplars. Medieval scribes are usually thought to have worked on a sloping desk, possibly using a separate bookstand for exemplars. Finally, the feeble glow of candles or oil lamps may have provided light, although it is more likely that the available hours of daylight were utilized.

[248] See MS/247, fols. 89r-103r and 161r-176v.
[249] The prickling holes and rulings are visible on several folia, e.g. MS/1, fols. 4r-4v and 7r.
[250] e.g. MS/1, fol. 4v.
[251] MS/1, fols. 4r (LPZ-CLc/1) and 7v-11v (JSC-a/1).
[252] MS/1, fols. 5r (EMM/1) and 12v (DIE/1).
[253] Most clearly: MS/1, fol. 8r (2 Idus May).

Consultation

The internal evidence suggests that at least some of the users of Pal. lat. 485 had similar writing tools at their disposal. Apart from the abovementioned erasures, numerous additions were made in dark shades of ink, especially within the calendar.[254] Apart from several marginal notations, which are visible in the manuscript, pupils may have made temporary notes on waxed tablets, writing with a stylus. Possibly, other codices were studied and consulted simultaneously, to support the educative process with additional information about the reckoning of time. Furthermore, the presence of a schoolmaster could be hypothesized; assisting, supervising, and instructing one or more clerical pupils at once. Potentially, this teacher or some clerical users marked specific dates in the calendar, using the aforementioned three-dot signs.[255] Note, however, that nothing is known about the presence of a single master of computus in Lorsch.

The compiler's computistical horizon

Having outlined a lively scene for the creation and use of Pal. lat. 485's computistical quire, the following reading and comparison of the regional codicological units and our central manuscript's computistical corpus sheds further light on its contexts of compilation and consultation. As discussed in the previous chapter, Pal. lat. 485 was intended for and used to supply the needs of future rural priests during their computistical education in the abbey of St. Nazarius.[256] Hence, the analysis in the present chapter consistently frames the computistical material within the second quire of our central manuscript as the physical realisation of a project which was neatly carried out by a compiler with planning and purpose.

[254] I.e. MS/1, fol. 6v: '*Natalis sancti Vedasti confesso*ris' (8 Idus February) and 9v: '*Natalis sancti Bartholomei apostoli*' (8 Kalends September).
[255] See pp. 73.
[256] See ch. 3.

From this perspective, it is important to establish which elements of the regionally available computistical material were and which were not included in Pal. lat. 485's second quire. In other words, how does the selection of computus within this monastic schoolbook fit into to material available to the compiler?[257]

Computistical traditions

The presence of Bede's paschal works and the Dionysian computistical framework is apparent in most of the regional codicological units. Firstly, three full copies of DTR were available in Cologne, Lorsch, and Prüm.[258] Moreover, three partial embodiments and a versified rendition of Bede's famous handbook were available in Trier, Cologne, and Mainz.[259] Secondly, complete copies of Bede's *De natura rerum* (hereafter DNR) and DT appear together in manuscripts from Cologne and Lorsch.[260] Two codicological units from Mainz and Trier contain separate and identical copies of DT, in which the first chapter is replaced by a longer, anonymous chapter. [261] Another partial or unfinished version of Bede's catalogue of time from the smallest to the largest was available in another codex unit from Mainz.[262]

Bede's DNR was essentially a refashioned and supplemented version of Isidore of Seville's *De natura rerum*. Of the latter, copies were available in Trier, Cologne, and possibly in Lorsch.[263] Only one copy of Bede's martyrology was available, namely in a manuscript from an unknown writing centre in Western-Germany.[264] Finally, copies of the *Ex Bedae Computo*, presumably one of Bede's paschal works, were available in Lorsch and Mainz.[265]

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[257] For overviews of the underlying data and references to the used manuscript descriptions, see appendices 6 and 7.
[258] DTR chs. 1-71: MS/89, MS/4, and MS/37.
[259] Partial: MS/88 II (chs. 1-42), MS/3 I (chs. 1-46) and MS/3 II (chs. 2-4, 17-18, 33, 44-50, and 52-62). Versified: MS/3 II.
[260] MS/89 and MS/4. For DNR and DT as companion volumes, see Wallis and Kendall, *ONT&OT*, 1-5.
[261] MS2 and MS/3 I.
[262] MS/3 II.
[263] MS/3 I, MS/7 II, and MS/88 II.
[264] MS/7 I.
[265] MS/3 II and MS/4. See CCSL CXXIIIC, 658-659.

Several calendars which correspond to Bede's description of the columns of a calendar in DTR occur in the extant regional manuscripts.[266] Based on an analysis of their structural elements, available in appendix 4, different calendar-formats can be identified in Cologne,[267] Cologne and Lorsch;[268] Mainz and Prüm;[269] and Mainz and Trier.[270]

Regarding Dionysian Easter tables, it is striking that three renditions were available, namely versions with eight, fourteen, and nineteen columns.[271] Firstly, the eight-column format available for the years 532-1063 in Lorsch and Cologne;[272] 779-797 in Mainz;[273] and 836-1006 in an unknown centre in Western-Germany.[274] Secondly, a fourteen-column version for 798-854 was available in Mainz and Trier.[275] Thirdly, a single codex unit from Cologne comprised a nineteen-column Easter table for 798-911.[276] Note that eight-column format corresponds to Bede's description of the columns of an Easter table in DTR.[277]

The availability of a Dionysian Easter table and Bede's DT, DTR, and DNR in Lorsch around the years 830-860 is supported by entries in extant library catalogues.[278] None of these catalogue descriptions is precise enough to relate them to an extant manuscript with certainty, although Pal. lat. 1449 may be a plausible candidate.[279] According to the library catalogue, Isidore's *De natura rerum* must indeed have been available in Lorsch in the same period.[280]

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[266] *Reckoning*, 379-391. Remarkably, the calendar in the other computus manuscript from Lorsch is explicitly attributed to Bede, see MS/4, fol. 2v.
[267] MS/88 II: JSC-d/1.
[268] MS/1, MS/4, and MS/89: JSC-a/1.
[269] MS/3 II and MS/37: JSC-b/1
[270] MS/2 and MS/3 I: JSC-c/1.
[271] See appendix 8.
[272] MS/4 and MS/89: ET-DIONEXIG8COL/1.
[273] MS/3 II: ET-DIONEXIG8COL/2.
[274] MS/7 I: ET-DIONEXIG8COL/3.
[275] MS/2 and MS/3 I: ET-DIONEXIG14COL.
[276] MS/88 II: ET-MIXED19COL/1.
[277] DTR chs. 44-65. See also *Reckoning*, 392-404.
[278] Vatican, BAV, Pal. lat. 1877, fols. 21r ('*De temporibus et computum et chronica eiusdem et circuli Dionisii in uno codice.*') and 77r ('*Compotum Bedae et chronica eiusdem in uno volumine.*'); Vatican, BAV, Pal. lat. 57, fol. 5r ('*De temporibus et compotum et chronica eiusdem et circuli Dionisii in uno codice.*'). See Häse, Bücherverzeichnisse, 97 (no. 60), 154 (no. 259 and no. 264), 172 (no. 163), 190, 254, 264.
[279] MS/4.
[280] Vatican, BAV, Pal. lat. 1877, fols. 27v ('*Eiusdem de natura rerum liber, id est Liber rotarum, (...)*' and 66rb ('*Eiusdem de natura rerum liber I (...)*'); Vatican, BAV, Pal. lat. 57, fol. 5v ('*Eiusdem de natura rerum liber (...)*') See Häse, *Bücherverzeichnisse*, 134 (no. 168), 161 (no. 295), 173 (no. 191), and 273.

Collections of letters on the subject of computus are present in multiple manuscripts.[281] Two letters circulated most widely: 1) Dionysius Exiguus' letter to Boniface on the difference between common and embolismic years;[282] and 2) Bede's letter to Wicthed concerning 21 March or 22 March as the date for the spring equinox.[283] Moreover, an impressive number of miscellaneous collections of computistical fragments, *argumenta* and tables can be found in almost all of the regional codex units. Amongst these collections, two copies of Dionysius Exiguus formulary titled *Argumenta paschalia Aegyptiorum* stand out.[284]

The presence of the Bedan-Dionysian reckoning is also felt indirectly, through the presence of a letter connected to Alcuin, an influential defender of Bede's computus during the reign of Charlemagne. Five copies of the pseudo-Alcuin *Calculatio Albini magistri* of 776 were available, either complete and attached to Bede's letter to Wicthed in Lorsch and Cologne[285] or partial within miscellaneous compilations in Cologne, Mainz, and Worms.[286] The tract concerned an easy method to calculate the date and weekday of the Easter full Moon.[287] Moreover, a copy of Charlemagne's letter to Alcuin is extant in a codex unit from Lorsch, pertaining to the computation of dates for Septuagesima, Sexagesima, and Quinquagesima.[288]

Demonstrably, the Dionysian reckoning of time and Bede's paschal works provided the underlying tradition for calendar science in the intellectual network of Lorsch. However, traces of other computistical frameworks can also be found in the regional codex units, for

[281] See especially MS/88 II.
[282] MS/2, MS/4, MS/88 II.
[283] MS/4 and MS/89. *Reckoning*, 417 and Alden A. Mosshammer, *The Easter Computus and the Origins of the Christian Era*, Oxford Early Christian Studies (New York: Oxford University Press, 2009), 62-64. For editions and translations of Bede's letter to Wicthed, see CCSL CXXIIIC, 633-642 and *Reckoning*, 417-424.
[284] MS/2 and MS/3 I. See group B in Warntjes, "Argumenta".
[285] MS/4 and MS/89.
[286] MS/2, MS/3 II, and MS/247.
[287] Springsfeld, *Einfluß*, esp. 80-89. See also pseudo-Alcuin, *Calculatio Albini magistri*, Kerstin Springsfeld ed. and transl., *Alkuins Einfluß auf die Komputistik zur Zeit Karls des Großen*, 322-328.
[288] MS/4. Ibid., 33-61, esp. 42. Charlemagne, *Epistola 144*, MGH Epp. II, 228-230.

three codicological units from Cologne, Mainz, and Worms contain texts and tables comparing the Dionysian and the Victorian reckoning of time.[289] Moreover, non-Bedan computistical collections can be found in almost all of the regional codicological units, containing *argumenta*, tables, and explanations of numerous computistical notions, principles, and calculations that were not discussed in Bede's computistical works.

Most remarkably, the calculation of the dates for moveable liturgical feasts, using the so-called termini, was ubiquitous in the regional computus manuscripts, although Bede did not even mention this subject. Possibly, students in Lorsch learned the use of the terms for the moveable feasts from Hrabanus' discussion of these devices in DC, of which a now lost copy is mentioned in a library catalogue from Lorsch ca. 860.[290] No extant copies of Hrabanus' paschal work are available in the sample of regional codex units.

Frankish computistical works

Apart from computistical traditions, it is important to examine which Frankish computistical works were available in the inner circle of the intellectual network of Lorsch. Looking at Borst's editions of Frankish computistical works, the miscellaneous collections within the regional codicological units arguably bear witness to nine out of the twenty works edited by him.[291] However, based on the concordance in appendix 6, such a conclusion turns out to be deceptive. Clearly, most of the smaller computistical objects within the extant regional codex units are only recognizable as witnesses of singular chapters of the works edited by Borst, rather than longer sections or books of Frankish computistical works. The overlapping material at best resembles highly fragmented and scattered bits and pieces, that may have been copied from the computi of 764, 760/792, 793, 805, and 818, but could also have been

[289] MS/3 II, MS/88 II, and MS/247. See Warntjes, *Munich Computus*, 322-329.
[290] See pp. 81-82 and 118-119.
[291] Note that MS/1, MS/7 I and MS/7 II were not taken into account in Borst's *Schriften*.

taken from other sources. Nonetheless, some reliable copies of Frankish computistical works edited by Borst can be found in a manuscript from Cologne – *Quaest. Austr*. of 764,[292] *Add. Col*. (AD 798),[293] *Lect. comp*. (AD 760/792),[294] and *Comp. Col*. (AD 805)[295] – and a single codex unit from Trier – *Ser. Ant*. (AD 809).[296]

One Rhine-Frankish computistical work within the selected manuscripts was overlooked by Borst, namely the *Computus rhenanus* of 775.[297] In fact, Borst considered the extant copies of the *Computus rhenanus* in manuscripts from Cologne and Worms as witnesses for the computi of 793, 760/792, and 809.[298] A more comprehensive analysis of the extant witnesses of the *Computus rhenanus* within the regional codex units is included below.[299]

Chronology, numeracy, and prognostics

Some further aspects of the regional codex units deserve attention. Firstly, this sample contains a vast amount of texts on the subject of chronology. Although Bede's chronologies, attached to DT and DTR, occur most frequently, non-Bedan chronologies by Eusebius, Hieronymus, Isidore, and a few anonymous chronological tracts are also transmitted.[300] Secondly, several codex units contain explanations of the use of Roman numerals, enumerations of ordinal numbers, multiplication tables, numerated alphabets, and introductions to finger counting, which were probably used to teach pupils basic numeracy.[301]

[292] MS/88 II.
[293] MS/88 I.
[294] MS/88 II.
[295] MS/88 II.
[296] MS/3 I.
[297] The *Computus rhenanus* was first discussed in Warntjes, "Argumenta", 40-111.
[298] MS/89, fols. 184v-190v and MS/247, fols. 169r-173v, see *Schriften* 2, 539, 670 and 675.
[299] See pp. 129-130.
[300] MS/3 II, MS/4, MS/7 I, MS/37, MS/88 I, MS/88 II, and MS/89.
[301] MS/2, MS/4, MS/7 I, MS/89, MS/247. Also relevant from this perspective are DTR chs. 1-4. See also Contreni, "Counting".

Thirdly, it stands out that prognostic material was only appended to computus collections on a small scale in Lorsch and Cologne.[302]

A local exemplar

Finally, the prominent features of the other computus manuscript from Lorsch – Pal. lat. 1449 – presumably determined the vantage point of the compiler of the computus in Pal. lat. 485. The Bedan-Dionysian tradition already prevailed in this early ninth-century manuscript.[303] Apart from a calendar and a collection of computistical tables and fragments, Pal. lat. 1449 comprehends a Dionysian Easter table for the years 532–1063, and copies of DT, DNR and DTR. Moreover, small computistical tracts and letters are included, namely 1) pseudo-Alcuin's *Calculatio Albini magistri*; Bede's letter to Wicthed concerning different dates for the vernal equinox; 2) Dionysius Exiguus' letter to Boniface on the computation of a valid date for Easter; and 3) Charlemagne's letter to Alcuin concerning the dates of moveable feasts. Finally, the computus in Pal. lat. 1449 is supplemented with some scattered prognostic material.[304]

A work of reference for the reckoning of time[305]

Against the backdrop of the preceding description of the computistical material in the sample of regional codex units, and with consultation of the computistical glossary in appendix 1, I now turn to an introduction of the calendar science in Pal. lat. 485.

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[302] The exception to the rule is MS/88 II, fol. 218v, which contains the Sphere of Pythagoras that also occurs in MS/4, fol. 146v.

[303] MS/4.

[304] Michael Kautz, "Wissenschaftliche Beschreibung BAV Pal. lat. 1449," http://digi.ub.uni-heidelberg.de/sammlung51/werk/pdf/bav_pal_lat_1449.pdf.

[305] My descriptions of the technical details of the computistical material in MS/1 are based on comprehensive personal studies of and extensive comparisons of the contents of Pal. lat. 485's corpus with the available editions and translations of Bede's computistical works in TROT and CCSL CXXIII A-C, as well as the editions of Frankish computistical works in *Schriften,* and calendars in *Kalenderreform*. Moreover, a great number of studies provided indispensable information about computistical technicalities. From this

Note that the following analysis is based on an experimental object-oriented catalogue, which I compiled in preparation for the present study.[306] The catalogue with the underlying data is available on http://www.computus.lat/objects. Additional information about the discussed computistical objects, including transcriptions and translations of their contents, as well as further references to the available literature and the foliation of their occurrences in the regional codex units, can be found in the catalogue entry of each class and object. Entries in the catalogue can be identified using the abbreviations of the classes and objects, which are mentioned in the footnotes of the following paragraphs. Moreover, a concordance of the computistical objects in Pal. lat. 485 and the chapters of computistical works is available in appendix 5.

The course of the Moon and the Sun through the Zodiac

Several thematic clusters can be identified within Pal. lat. 485's computus. Firstly, the table on fol. 4r and the example-based explanation at the top of fol. 4v concern a method for locating the position of the Moon relative to the Sun against the backdrop of the twelve signs of the Zodiac during the months of the Julian solar calendar and the *cyclus decemnovenalis*.[307] According to the explanation, the lunar capitals in the table accord to the first column in the calendar on fols. 6r-11v. Notably, the only two regional occurrences of these instructions are extant in Pal. lat. 485 and Pal. lat. 1449.[308] Possibly, the compiler of Pal. lat. 485 concluded

perspective, the most informative descriptions can be found in Wallis' introduction and commentaries to *Reckoning* and the introduction and glossary included in Warntjes, *Munich Computus*. Moreover, I made extensive use of the descriptions in *Reichskalender*; Declercq, *Anno Domini*; Hermann Grotefend, *Taschenbusch der Zeitrechnung des deutschen Mittelalters und der Neuzeit* (Hannover: Hahnsche Buchhandlung, 2007); J.L. Heilbron, *The Sun in the Church: Cathedrals as Solar Observatories* (London: Harvard University Press, 1991); Mosshammer, *The Easter Computus and the Origins of the Christian Era*; Springsfeld, *Einfluß*; Warntjes, "Argumenta".

[306] For the object-oriented approach to computus manuscripts, see pp. 24-30.

[307] LPZ-CLc/1 = LPZ-CLa/1 + LPZ-EXPL/1; LPZ-CLa/1 = (CYCLDECNOV/1 + ZOD/1 + LPZ-TBL/1 + JSM/1). See *Reichskalender*, 400-401 and 485.

[308] Reichskalender, 405-406.

that the table on fol. 4r did not leave enough space to fit the explanatory text underneath, as is the case in Pal. lat. 1449.[309]

As a whole, this cluster cannot be considered separately from chapter 19 of DTR, in which Bede mentions that this table was attached to the beginning of his computus handbook. Based on striking textual similarities, the explanatory text turns out to be an excerpt from this chapter, although the given example is replaced by another.[310] Bede supposedly devised the table himself as a subsidiary that was explicitly 'adapted to the capacity of the intelligence' of 'someone rather less skilled in calculation'[311] – referring back to the more advanced methods described in the preceding chapters of DTR.[312] Although the table on fol. 4r, therefore, appears to be at home in the context of an educational work for reference of calendar science for future priests, Bede explicitly attached more intellectual value to computations.[313] Nonetheless, these and other tabular devices for computistical novices were frequently copied into Carolingian computus manuscripts, like Pal. lat. 485 and the regional codex units.

Leap years, bissextile days, and the *saltus lunae*

The following two clusters extend the preceding material. [314] In short, the discussed arithmetical devices – known as the bissextile day and *saltus lunae* – serve to keep the reckoning of time in phase with observable astronomical phenomena. By implication, the first two folia can be regarded as an introduction to the foundations of computus, namely the alignment of the lunar and the solar cycle.[315] Moreover, their contents can be interpreted as wrapping up a recto-verso cluster on time measured in relation to the stars (sidereal time);

[309] LPZ-CLc/1, see also MS/4, fol. 2r.
[310] *Reichskalender*, 405-406; DTR ch. 19.
[311] TROT, 63.
[312] For Bede as the creator of this table, see *Reckoning*, 291-293, esp. fn. 91.
[313] See especially DTR chs. 17-19 and 22-23.
[314] LPZ-CLc/1 + (BIS-FEBMARPAS/1 + BIS-CLa/1) + SAL/1.
[315] Interestingly, the course of the Sun and the Moon through the Zodiac, including the concepts of the bissextile day and different approaches to the leap of the Moon, were subject of debate during the time of Charlemagne and Alcuin (ca. AD 797-804), see Stevens, "Ars", 33-35.

time measured with respect to the course of the Sun (synodic time); and the differences between observable phenomena and their arithmetical approximations, which required corrective devices like the bissextile day and the *saltus lunae*.

Leap years and the bissextile day

The first cluster concerns the subject of the bissextile day, which has a solar and a lunar counterpart. The solar bissextile day is still employed in our modern calendar system to compensate for the difference between the length of common solar years (365 days) and the length of the solar cycle (approximately 365,25 days) by intercalating an extra day in February every fourth year, resulting in a bissextile year of 366 days. However, medieval computists intercalated the solar bissextile day by doubling 24 February, rather than adding a 29th day at the end of February.

The implementation of the bissextile day is not only a solar phenomenon, for like any other day in the Julian solar calendar, the bissextile day also has a lunar age.[316] In other words, the addition of an extra day in February not only increases the length of the solar calendar month February, but also adds an additional day to the calendrical lunar month ending in February. Hence, the first object in this cluster provides an explanation of the lunar bissextile day, which increases the length of the common, hollow February lunation (29 days) to a that of a full lunar month (30 days) during leap years.[317]

Subsequently, three possible dates for the intercalation of the solar bissextile day are mentioned, of which 24 February is said to be most frequently used.[318] The cluster is completed by an explanation of the accumulation of a bissextile day during a period ranging

[316] See DTR 41.
[317] BIS-FEBMARPAS/1.
[318] BIS-INTERCALATION/1.

from one month to four years, coupled with a brief explanation of the term *bissextus*.[319] Only the first object within this cluster vaguely resembles a chapter of DTR.[320]

Leap of the Moon

Thereafter, the subject shifts to the necessity of another arithmetical device, known as the *saltus lunae*. In two respects, the *saltus lunae* is a sibling of the bissextile day. Firstly, the *saltus lunae* compensates for deviations between the computed lunar cycle and the astronomical course of the Moon, rather than calculations pertaining to the solar cycle and the astronomical course of the Sun. Secondly, the *saltus lunae* is applied by skipping a lunar day, rather than doubling a solar day. In practice, the leap of the Moon is implemented every 19 solar years, whereas the bissextile day is intercalated every 4 solar years.

The objects concerning the *saltus lunae* describe the annual increment of the leap of the Moon during the course of the *cyclus decemnovenalis* and, thus, why the Moon does not always rise at the same time and in the same heavenly region, and a day is to be jumped over each 19th year of the regularized lunar cycle.[321]

Interestingly, the first object in the cluster concerning the *saltus lunae* derives from DT.[322] The choice for an excerpt from Bede's smaller and earlier computus handbook is striking, for a comparable description using different computistical units is available in DTR.[323] Moreover, the other objects belonging to this cluster were excerpted from DTR, rather than their equivalents in DT.[324]

Compared to the explanation of the possible dates for the bissextile day, it is striking that no mention is made of specific dates for the leap of the Moon, although it is mentioned

[319] BIS-INCREASE/1.
[320] DTR ch. 41.
[321] SAL/1 = SLC/1 + (SLA/1 + SLS/1).
[322] DT ch. 12.
[323] DTR ch. 42.
[324] See, again, DTR ch. 42 and DT ch. 12.

that the *saltus lunae* should be applied during the final year of the *cyclus decemnovenalis.* Again, an adherence to Bede's reckoning appears to be demonstrated, for Bede is also silent on the matter of an exact date for the placement of the leap of the Moon, although he is 'normaly quite clear and decisive on matters computistical'[325]. In chapter 42 of DTR, Bede argues for a placement of the leap of the Moon in the final year for the *cyclus decemnovenalis*. Moreover, he ambiguously mentions a most natural date for the *saltus lunae* on the day of the vernal equinox, as well as two unspecified conventional calendar dates in November according to the Romans and July according to the Egyptians. Thus, Bede does not provide a precise rule for the placement of the leap of the Moon.

Although a speculative case could be made for a placement of the *saltus lunae* on 24–25 November by Bede and computists in Lorsch, it is questionable whether such a pursuit is necessary in the context of this thesis.[326] However, if a precise placement was known and used in Lorsch, its absence in Pal. lat. 485 is all the more striking. Why not include a range of dates or a preferred date, like in the case of the bissextile day, if clerical computists were expected to employ a particular placement for the *saltus lunae*?

Looking back at the descriptions of *computum minorem* in the first capitulary of Willebert of Châlons and the *Admonitio synodalis*, the lack of a rule for the placement of the leap of the Moon may be explained on grounds of prioritization. According to both episcopal instructions, priests were first and foremost expected to account for the weekday and lunar age of the first day of each month, as well as a valid date for Easter.[327] Generally speaking, the placement of the *saltus lunae* was only relevant to a more detailed coordination of the lunar and the solar cycle throughout the *cyclus decemnovenalis*, such as calculations of the age of the Moon for every Julian calendar date.

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[325] *Reckoning*, 327, fn. 154.
[326] See appendix 11.
[327] See pp. 59-62 and, most explicitely, Willbert's capitulary: '*Ut de compoto kalendas et lunam et terminos adinvenire possit.*' in MGH Cap. ep. II, 93,11, ch. 7.

In calculations of the lunar age of the Kalends for months of the Julian solar calendar, the conventional placements of the *saltus lunae* would only affect the age of the Moon on the first day of August–December (July placement) or December (November placement) during the year 19 of the *cyclus decemnovenalis*. Regardless of the placement of the *saltus lunae*, the date for Easter could be computed without complications, for the leap of the Moon was always implemented after the latest possible Easter date (25 April). Therefore, the exact position of the leap of the Moon may have been deemed to be of little or no concern to priests. Nonetheless, members of the clergy were supposed to have a vague notion of the existence and purpose of this computistical device, because the *saltus lunae* is to some extent explained in Pal. lat. 485.

Memorizing the Easter term and the Easter regulars

At the bottom of fol. 4v, a popular alliterative poem *Nonae aprilis* was added by a tenth-century hand, aiding the memorization of the Easter term and the *regulares pasche* for each year of the *cyclus decemnovenalis*.[328] The *regulares pasche* are used in calculations of the weekday of the Easter full Moon, the date of which is known as the Easter term.

Age of the Moon

Fol. 5r is a cluster as a whole, consisting of three objects.[329] Firstly, a table listing the age of the Moon on the first day of each month of the Julian solar year for every year of the *cyclus decemnovenalis*, which can be associated with chapter 20 of DTR. Within the table, a list of Roman numerals is included, indicating the age of the Moon on 22 March during each year of the *cyclus decemnovenalis*: the so-called epacts.

[328] NAN-CLa/1. See *Reckoning*, xlvii, fn. 73.
[329] LKL-CLd/1 = (JSM + CYCLDECNOV/1 + EP-XIKLAPR/1 + LKL-TBL/1) + EMM/1 + PDA/1.

The relation of the table to DTR is disputed by Jones and Wallis.[330] However, their explanations appear to be riddled by, respectively, a mistranslation and incomprehensible inferences. Firstly, Jones suggests that a table such as the one in Pal. lat. 485 was attached to DTR. Secondly, he disregards this option based on a curious translation of a crucial sentence chapter 20 of DTR, suggesting that Bede refused to include the table. Wallis interpretation is also hard to grasp. On the one hand, she corrects Jones' translation, asserting that Bede explicitly indicates that a table was to be attached to the beginning of his handbook. On the other hand, she asserts that Bede referred to the abovementioned table on the course of the Moon through the signs of the Zodiac, which seems rather unlikely given the immediate context of the table-reference in a chapter concerning the age of the Moon on the first day of each month.

In my view, the only cogent explanation is that Bede alluded to the inclusion of a table that corresponds to this subject, such as the one on fol. 5r of Pal. lat. 485. Evidently, this table was the product of repeated calculations using the epacts and the lunar regulars; an arithmetical procedure which Bede elaborated immediately before the disputed statement. The fact that the explanation of this procedure, including some exceptions to its rule, was excerpted from chapter 20 of DTR and is included underneath the table in Pal. lat. 485, corresponds to this reading of the available evidence.

Secondly, an excerpt from the pre-Bedan table of *litterae punctatae* was included on the right, used to ascertain the age of the Moon without calculations, in conjunction with the third column of the calendar.[331] Remarkably, no version of the complete table was available in any of the regional manuscripts, although Bede describes the use of this full table and supposedly included a copy in DTR.[332] As the compressed table turns up in 7 regional codex

[330] TROT, 66, fn. 205 and BOT, 355-356.
[331] Pre-Bedan: TROT, 73, fn. 225.
[332] DTR 23. For literature, see *Reckoning*, 73, fn. 225.

units, it may have been was used independently from the original. The available rendition of the table only lists the letters corresponding to the first day of, respectively, each hollow lunar month (29 days) and each full lunar month (30 days) during every year of the *cyclus decemnovenalis*.

Finally, an explanation of the calculation that was used to create the bigger table above was added to the bottom of the folio. The followed procedure concerns the calculation of the age of the Moon by adding the epact of a particular year to the lunar regulars for each month of the Julian solar calendar. The explanation mentions crucial exceptions to the rule, due to the inclusion of extra, embolismic lunar months in seven years of the *cyclus decemnovenalis,* resulting in almost perfect coordination of 19 solar years and 19 lunar years. The discussed corrections account for the lack of an implementation of the embolismic months in the table.

Evidently, the bigger table was created using the Roman lunar regulars, as is apparent from the row of months of the Julian solar calendar at the top, which runs from January to December, rather than September to August for the Egyptian lunar regulars. However, the Roman lunar regulars were not included underneath the table, suggesting that it was copied from an exemplar, rather than constructed using calculations.[333]

Weekdays

Fol. 5v is another cluster consisting, firstly, of a table showing the weekday of the first day of each month of the Julian solar calendar for every year of the 28-year solar cycle.[334] Within the table, a list of Roman numerals, known as the concurrents, specifies the weekday on 24 March for each year of the solar cycle. Secondly, a short explanation of the method used to

[333] For the inclusion of the Roman lunar regulars underneath the table, see LKL-CLe/1 on MS/89, fol. 2r and LKL-CLf on MS/4, fol. 1v.
[334] Reichskalender, 487.

create this table is included, describing a formula using the concurrents for each year of the 28-year solar cycle and solar regulars for each month of the Julian solar calendar.[335]

Note that this table was created using the Egyptian solar regulars, as is evident from the row of months of the Julian solar calendar at the top, which runs from March to February, rather than January to December as it would have been in the Roman rendition. Interestingly, the Egyptian solar regulars were not included underneath the table, suggesting that the table was copied from an exemplar, rather than constructed using calculations.[336]

The Julian solar calendar

Fols. 6r-11v contain a Julian solar calendar consisting of a folio for each month.[337] At the top of each folio, a single line describes the Zodiac sign of each month according to the position of the Sun; the length of each month in solar days; and the length of the lunar month that ends in the respective month. Underneath, the backbone of the calendar consists of five columns. Each column has its own function and usually links to a table that decodes its contents: 1) lunar capitals used to ascertain the positions of the Moon within the Zodiac; 2) Roman numerals used to find the day of the week for all days of a year; 3) *litterae punctatae* used to establish the age of the Moon; 4) the day of the month based on the Kalends, Ides and Nones; and 5) calendar notes, including different liturgical dates and feasts, memorial notes, as well as computistical information. Respectively, calendar columns 1-3 refer to the tables on fols. 4r and 5r.

Most computistical notes specify the dates associated with concepts used on folia preceding and following the calendar, namely the first and latest possible new Moon of the

[335] FERIAKL-CLa = (JSM/4 + CYCLSOL/1 + CC/1 + FERIAKL-TBL/1) + FERIAKL-EXPL.
[336] For the inclusion of the Egyptian solar regulars underneath the table, see FERIAKL-Clb/1 on MS/3 II, fol. 77v; MS/89, fol. 2v; and FERIAKL-CLb/2 on MS/4, fol. 1r.
[337] JSC-a/1. Although his central thesis is disputed, the standard work for the study of medieval calendars is Borst's *Reichskalender*. See 386-455 for the structural elements of Carolingian calendars.

Easter lunation, the earliest acceptable Easter Sunday, the intercalation of embolismic lunar months, the position of the Sun relative to signs of the Zodiac, and the dates associated with the concurrents and the epacts. Meanwhile, other memoranda concern the dates of the beginnings of the seasons, Egyptian months, the solstices, the equinoxes, and Bede's interpretation of the historical dates for the first day of creation.[338]

Finally, a line describes the number of hours of day and night during each month, included at the bottom of each calendar folio.

At the top of fol. 12r, a small text is included describing the number of seasons, months, weeks, days, hours, and moments within a single year of the Julian solar calendar.[339] Because this object is usually included briefly after or on the calendar folio of December within the regional codex units, the calendar and this text could be described as a cluster.[340] Moreover, due to the relation of the calendar with the tables on the preceding folia, all computistical material up to this point could be interpreted as a single group of objects, which extend one another in the context of different computations. In other words, the preceding tabular elements of Pal. lat. 485 were generally distributed together and may be interpreted as a composite unit.

Calculating the date of the moveable feasts

The remaining material on fol. 12r forms a cluster on the calculation of the date for the moveable feasts, beginning with tables of the termini for four moveable feasts, respectively the beginning of the fasting period known as *Quadragesima*; the beginning of the three days

[338] All calendrical notes can be found in *Reichskalender* vols. 1-3. For Bede historical date of creation, see below.
[339] ANN-SOL/1.
[340] December folio: MS/89; MS/88 I; MS/3 II; MS/4; and MS/2 I. Moreover, the same text is included briefly after the calendar in MS/37 I. See ANN-SOL.

before Ascencion day known as *Rogationes*; Easter Sunday; and the Sunday of Pentecost. The tables for these moveable feasts are combined with tables of the *regulares pasche* and the concurrents.[341] Directly underneath, a small fragment considers the earliest and latest possible date for Easter.[342] Compared to the regional codex units, it is striking that the table for Pentecost was only available in the manuscripts from Lorsch.[343] A special concern for the calculations of the dates for several moveable feasts is also exemplified by the aforementioned inclusion of Charlemagne's letter to Alcuin in Pal. lat. 1449.[344]

As Bede's computistical handbooks do not consider the terms for the moveable feasts and the *regulares pasche*, an understanding of these tables may have been gained from Hrabanus' DC, which includes descriptions of their use, and copies of the Easter regulars, concurrents, epacts, and the terms for Quadragesima, Easter, and Rogationes.[345]

The Kalends, Ides and Nones

Fol. 12v is a collection of smaller computistical objects and clusters, starting with an explanation of the placement of and the number of days between the marker-days of each month of the Julian solar calendar; the Nones, Kalends, and Ides.[346] Bede discusses the marker-days in his bigger paschal work.[347]

The use of the solar and the lunar regulars

Then follows a cluster on the use of the solar and lunar regulars, consisting of four tables and an explanatory text, setting out: 1) the Roman and Egyptian arrangement of the solar regulars

[341] TER-CLa/1.
[342] PAS-TERMINI/1.
[343] MS/1 and MS/4: TER-PEN/1.
[344] MS/4.
[345] DC ch. 83.
[346] DIE/1.
[347] DTR ch. 13.

for each month of the Julian solar calendar, to be used in combination with the concurrents;[348] 2) a variant of the formula describing the use of the concurrents for each year of the 28-year solar cycle and the Roman and Egyptian solar regulars for each month of the Julian solar calendar to calculate the weekday of the first day of each month;[349] and 3) two tables describing the Roman and Egyptian arrangement of the lunar regulars for each month of the Julian solar calendar, to be used in calculations with the epacts.[350]

Canonical hours

The final text on fol. 12v is a horologium, describing the dimensions of a sundial based on the number of feet for every month of the Julian solar calendar.[351] The inclusion of this horologium should be understood in relation to the canonical hours, which governed the daily schedule of monks living in medieval monasteries.

Performing computistical calculations

The cluster on fol. 13r recombines and pairs most of the material on fols. 12r and 12v for several computations. Four smaller tabular groups can be identified. Firstly, a cluster based on the tables of the epacts and the Roman lunar regulars, used to calculate the lunar age on the Kalends of each month.[352] Secondly, a cluster combining the concurrents and Egyptian solar regulars, used to calculate the lunar age on the Kalends of each month.[353] Thirdly, a coalescence of the concurrents and the *regulares pasche*, used to calculate the weekday for the terms of Quadragesima and Easter.[354] Fourthly, a repetition of the termini for

[348] RFRE/1.
[349] FERIAKL-EXPL/2. See fol. 5r for FERIA-EXPL/1.
[350] RLRE/1.
[351] HOR/1.
[352] ERLR/1.
[353] CRFE/1. Interestingly, a gloss in a tenth-century hand shows that this cluster was actually used, see pp. 132-134.
[354] CC-RPA/1.

Quadragesima and Easter, providing the Julian calendar dates for the terms of both moveable feasts throughout the *cyclus decemnovenalis*.[355]

Remarkable features and lacunae

Several characteristics of the computistical dossier in Pal. lat. 485's provide leads for an understanding of its arrangement and function.

Bede's paschal works

It is, firstly, essential to note that the computus in Pal. lat. 485 is based on the Dionysian Easter reckoning, which also was provided the underlying computistical framework for Bede's paschal works.[356] Furthermore, the long range of excerpts from Bede's DTR and DT and tables associated with DTR imply that Bede's handbooks on calendar science provided the underlying computistical tradition for most of the included material.[357] Arguably, Pal. lat. 485's computus should, therefore, be read and understood in the light of the prevailing of the Dionysian Easter reckoning during the second half of the 8th century and Bede's computistical handbooks during the first half of the 9th century. Consequentially, Pal. lat. 485 neatly fits into the context of the sample of regional computus manuscripts.[358] However, the computus in our central manuscript only concerns the astronomical and arithmetical aspects of Bede's reckoning of time, resulting in little regard for his accounts of the units and divisions of time (hemerology), and an almost complete disregard of his account of salvation history (chronology), although material on these subjects was abundant in most of the regional codex units.[359]

[355] TER-QUA/1 + TER-PAS/1.
[356] E.g. p. 120.
[357] See pp. 101-114.
[358] See pp. 96-99.
[359] MS/1, fol. 12r: ANN-SOL/1.

Preconditions of educational use

The closest Pal. lat. 485 gets to the subject of chronology is Bede's historical date for the first day of creation on 21 March, marked in the calendar as '*Primus dies saeculi*'.[360] Arguably, chronology was a branch of Bede's computus which was not strictly necessary for engagement with calendar science by future priests. Therefore, it is not entirely surprising that chronology was of little concern in a monastic schoolbook for the education of secular members of the clergy. Hemerology, however, was crucial for an understanding of computus in general. The fact that only one brief text discusses the divisions of the Solar year into different units of time, suggest that prior knowledge concerning this subject was taken for granted or was provided in the form of oral instructions by a schoolmaster.[361]

A striking example of a resulting terminological ambiguity in Pal. lat. 485's computus concerns the notion of a month, which had different lengths depending on whether a text or table concerned the synodic lunar month (29 days and 12 hours distributed into alternations of 29 and 30 days); a sidereal lunar month (27 days and 8 hours); a sidereal solar month (30 days, 10 hours, and 30 *minutae*); or the solar months of the Julian solar calendar (28–31 days).[362] All of these different kinds of months are invoked in Pal. lat. 48 without an explanation of their characteristics. Prior knowledge, which could have been derived from DTR and/or a teacher's instructions, appears to have been expected.[363]

On an even more fundamental level, numeracy was simply indispensable for a consultation of the calendar science in Pal. lat. 485.[364] It is, then, remarkable that no tracts, tools, or works of reference were included in our central manuscript pertaining to basic numeracy, apart from a numerated alphabet.[365] Meanwhile, explanations of Roman numerals,

[360] DTR 6 and 66; See also *Reckoning*, 271-275.
[361] MS/1, fol. 12r: ANN-SOL/1.
[362] See DTR ch. 11-12 and *Reckoning*, 281-284.
[363] DTR chs. 11-12.
[364] For numeracy, see Contreni, "Counting".
[365] MS1, fol. 14r.

enumerations of ordinal numbers, multiplication tables, and introductions to finger counting circulated widely in the regional codex units and copies of Bede's DTR.[366] Most of this introductory material was, furthermore, available in the other computus manuscript from Lorsch.[367] As a result, the available evidence again feeds into a supposition of propaedeutic instructions preceding the use of Pal. lat. 485's computus.

The basic or elementary material is not included in our central manuscript. What is transmitted in Pal. lat. 485 is almost all advanced material. Meanwhile, it stands out that an array of technical details, discussed in detail below, was left unexplained in Pal. lat. 485's computus.[368] For instance, essential *argumenta* for computations of the age of the Moon, the weekday, and the dates the moveable feasts are not included in Pal. lat. 485. In particular, formulas for establishing the year the *cyclus decemnovenalis* and the 28-year solar cycle from the year AD are lacking. Similarly, the corpus does not include a formula for establishing whether a year is bissextile. Without such calculations, even the most basic reckonings of time could not have been performed, for a clerical-monastic user of Pal. lat. 485's computistical dossier would simply not have known how to pick the applicable data from any of the table, because most tables consist of rows that correspond to the years of either the *cyclus dememnovenalis* (19 rows for 19 years) or the solar cycle (28 rows for 28 years). Although the available tables and excerpts could, therefore, have been used independently as a works of reference by experienced computists, first encounters with calendar science by future priests using Pal. lat. 485 are hardly imaginable.

Neither Pal. lat. 485 nor Pal. lat. 1449 contain a formulary comprehending these and other *argumenta,* although collections like the *Computus rhenanus* or Dionysius' *Argumenta paschalia Egyptiorum* were regionally available.[369] Perchance, such omissions in the

[366] Especially DTR chs. 1-4.
[367] MS/4.
[368] See pp. 131-145.
[369] Computus rhenanus: MS/89 and MS/247; Argumenta paschalia Egyptiorum: MS/2 and MS/3 I.

manuscripts from Lorsch imply a local preference for the use of DTR. Yet, although Bede describes how to calculate the year of the *cyclus decemnovenalis* from the year AD[370] and how to establish whether a year AD is bissextile,[371] a computistical novice would still be needing a formula for the year in the solar cycle. That users of Pal. lat. 485 were, indeed, able to successfully calculate the year in the 28-solar cycle based on the year AD, is implied by the use of the concurrents in the gloss on fol. 13r.[372] Hence, it seems possible to rule out that users of the computus in our central manuscript had no access to the required formulas. In my view, the lack of the relevant formulas in Pal. lat. 485 is best explained on the ground of a now lost collection of computistical formulas in the library of Lorsch or a combination of studies of DTR and an unwritten tradition of oral instructions by a schoolmaster.

Generally speaking, propaedeutic studies of Bede's paschal works and/or a computistical formulary could have accounted for most of the required prior knowledge. Regarding prior studies of DTR it is, however, important to note that this work was quite lengthy, i.e. covering both sides of a hundred folia in Pal. lat. 1449.[373] It is, therefore, questionably whether Bede's bigger handbook was read from beginning to end. If Bede's paschal works were read selectively, it seems unlikely that computistical novices were able to find and choose the relevant and/or essential chapters in relation to the texts and tables in Pal. lat. 485. The aid of a teacher or a detailed reading list would, in that case, have been essential.

Regarding the suggested necessity of prior knowledge, propaedeutic instructions, and perhaps the supervision of a schoolmaster, it seems plausible that the use of Pal. lat. 485's corpus formed a more advanced phase in the numerical and computistical education of priests. Plausibly, studies and consultations of the computus in our central manuscript followed detailed propaedeutic studies of Pal. lat. 1449, which served – amongst other things – to teach

[370] DTR ch. 58.
[371] DTR ch. 54.
[372] See pp. 132-134.
[373] MS/4, fols. 28r-104r and 121r-145v.

pupils several computus concepts and devices by heart. Pal. lat. 485 and Pal. lat. 1449 may also have been consulted or studied simultaneously. However, an understanding of Pal. lat. 485's computistical dossier would, in that case, still have relied on the elementary information provided by Pal. lat. 1449, either in the form of preceding readings by students, or by way of an experienced mediator.

In conclusion, the computistical material provided in Pal. lat. 485 is too concise, selective, and complex for first encounters with the study of numbers and the reckoning of time. Hence, the computus in our central manuscript could be characterized as a computistical work of reference for priests who are already familiar with computus. As such, it may have served to make sure that priests were especially familiar with those aspects of the reckoning of time that were deemed most important for pastoral care: working with the liturgical calendar and performing *computum minorem*.

Hrabanus' computistical handbook

Although no extant copy of Hrabanus' DC is available in the regional codex units, a copy of his manual probably was available in Lorsch ca. 860.[374] Arguably, DC would have been a useful handbook, in addition to Bede's paschal works, for it contains numerous chapters that concern subjects that are relevant to Pal. lat. 485's computistical dossier, including explanations of material that was not discussed by Bede, such as the terms for the moveable feasts and the discussion of several *argumenta*.[375] Perhaps the computus in our central manuscript should therefore be interpreted as a work of reference for the joined computistical traditions of Bede and Hrabanus, and the underlying Dionysian Easter reckoning.

Note however, that the relation with Hrabanus' DC is speculative. The connection relies on the presumed existence of a copy of this handbook in the library of Lorsch, which is

[374] See pp. 81-82.
[375] DC ch. 83.

mentioned in a library catalogue around the middle of the ninth century, rather than a copy in an extant manuscript associated with Lorsch.[376] Although an acquisition of a copy by abbot Samuel is plausible, the inclusion of *Nonae aprilis*, the Easter regulars, and the terms for the moveable feasts in Pal. lat. 485 may more directly have been based on the objects in Pal. lat. 1449, or copies of Frankish computistical works like *Lect. comp*, *Lib. ann.*, *Lib. comp.* and *Lib. calc.* Each of these alternative sources predate Hrabanus' DC.

Displays of surplus

Some computistical material in our central manuscript, such as the terms for some moveable feasts, is included more than once. This redundancy, which is a common feature of computus manuscripts,[377] may result from differing thematic juxtapositions. Evidently, the doubled material was relevant in more than one computational context. Providing the same table more than once may have facilitated its use in each of these contexts. Moreover, duplications of objects may constitute evidence for clusters of texts and tables that were copied as composite objects from different parts of exemplars, without economizing the available space on the folia in Pal. lat. 485 at the expense of the unity and usability of these clusters.[378]

Faith Wallis suggests that such displays of surplus may have been intended as a means for understanding, validating, and correcting calculations and/or the information provided by tables. It should, furthermore, not be ruled out that such redundancy was nothing more than a source of intellectual satisfaction or a sign or a regular working habit.[379]

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[376] Vatican, BAV, Pal. lat. 1877, fol. 2v: '*Liber computandi item Hrabani*'. See Häse, *Bücherverzeichnisse*, 136 and 177. See also *Abtei*, 22-25.
[377] Wallis, "Albums", 209.
[378] For thematical juxtapositions, see especially the two occurrences of the table for the concurrents on fol. 13r next to the Egyptian solar regulars in CRFE/1 and the Easter regulars in CC-RPA/1. The copying of clusters of composite objects deriving from exemplars results in the inclusion of two variants of FERIAKL at the bottom of fol. 5v and in the middle of fol. 12. See pp. 110 and 113.
[379] For redundancy as a source of intellectual satisfaction, see Wallis, "Albums", 209.

Diversity and doctrine

A small number of computistical objects offer differing explanations of and approaches to specific technicalities, whereas other texts dictate the doctrine of one particular computistical tradition. Arguably, such objects inform us about the scope of the computistical education of future priests.

A remarkable example of diversity are the three different dates for the inclusion of the bissextile day, which are mentioned in Pal. lat. 485, although doubling the 24th of February is said to be preferred.[380] In contrast, the explanation of the *terminus a quo* and the *terminus ad quem* for Easter in our central manuscript only elaborates the acceptable range of dates for Easter Sunday, based on the lunar limits of the Dionysian tradition.[381] The provision of an alternative range of dates, supplemented with an explicit preference for the included range of 22 March and 25 April, may be expected in line with the different implementations of the bissextile day. The obvious alternative for the Dionysian lunar limits would have been the Victorian range of dates, which had been conventional until the Frankish embrace of the Dionysian Easter reckoning during the eight century.

However, it makes perfect sense that any reference to a different and less coherent Easter reckoning like was avoided, for doing so would have been a departure from the Dionysian framework. Meanwhile, it was unproblematic to discuss different approaches to particular aspects of the Dionysian Easter reckoning, such as alternative dates for the intercalation of the bissextile day.[382]

[380] BIS-INTERCALATION/1: MS/1, fol. 4v.
[381] PAS-TERMINI/1: MS/1, fol. 12r.
[382] *Reckoning*, XXXIV-XL; Declercq, *Anno Domini*, pp. 58-60; Warntjes, *Munich Computus*, p. XXXV-XXXVI.

Agency and *correctio*

Some objects within the second quire appear to have been rewritten, for their phrasing does not accord to other instances of the same class in other regional codex units, nor to any of the variants of objects of the corresponding class which are documented in the *critical apparatus* of Borst's *Schriften.*[383]

Apart from small textual changes, like substitutions of *ergo* for *autem*, three adaptations stand out. Firstly, the explanation of the accumulation of a bissextile day in a period of four years on fol. 4v includes a unique middle part, reading '*in quattuor annis XXIIII horas hoc est diem integrum sibi vindicate*', rather than the more common '*II annis dies et nox*' or '*in quattuor annis dies et nox accrescunt*'.[384] Hence, the accumulation of day and night is replaced by a day of 24 hours.

Arguably, the emphasis on a *dies* of 24 hours is a better match to the units that are applied in the described increment, than the increment of the periods of daylight and night: 20 moments in 1 month → 1 hour in 2 months → 6 hours in a year → 24 hours in 4 years. Moreover, it is likely that the substitutions are an example of Carolingian *correctio,* based on Bede's preference for the 'proper' definition of the Latin noun *dies* as a sidereal day of 24 hours at the expense of the 'common parlance' of the 'ordinary folk', whom define *dies* as the period of daylight between sunrise and sunset.[385]

Secondly, the prescriptions concerning the acceptable dates for Easter at the bottom of fol. 12r begins with '*Ratio paschae Christianorum* (…)', rather than '*Christianorum vero pascha* (…)'.[386] On this occasion, the textual difference could be read as a modest shift from an emphasis on computistical *orthodoxy*, to a more subjective embrace of a particular *reckoning* of time.

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[383] See appendix 5.
[384] See BIS-INCREASE for the different objects in the regional codex units. *Schriften* 2, 686; *Schriften* 3, 1193.
[385] DTR ch. 5. Also, see DT ch. 2. Here, I cite the translation in *Reckoning*, 19-24, esp. 19.
[386] Idem, see PAS-TERMINI. *Schriften* 2, 629-630 and 733; *Schriften* 3, 1217 and 1418.

Thirdly, Pal. lat. 485 includes a one of a kind prolonged explanation of the implications of the leap day for the length of the lunar months of February and March:

> *Quando vero bissextus est Februarii habet dies XXVIIII et ideo anno bissextili luna Februarii mensis XXX dies habet. Similiter et luna Martii mensis XXX dies habet sicut semper habere debet ne Paschalis lunae ratio vacillet.*[387]

In the other regional codex units, two other objects of the same class occur, which accord to Borst's edition of the 48th chapter of *Lib. ann.*:

> *Memento quod anno bissextili lunae Februarii mensis XXX dies conputes et tamen luna Martii mensis XXX dies habeat sicut semper [consuete] habet ne paschalis lunae ratio vacillet.*[388]

Arguably, the extension of this object in Pal. lat. 485 serves to amplify the consequences of the intercalation of the bissextile day, by contrasting the common length of the February lunation (29 days) to the bissextile length of the February lunar month (30 days)

The extent of these changes implies that they were thoughtfully made. Firstly, the modifications appear to be congruent, for each alternation introduces a small shift in the emphasis of the description, clarifying or refocussing the content of the explanation at hand. Evidently, these are examples of Carolingian *correctio* in a computistical context. Secondly, it is notable that the adjustments transcend the level of linguistic changes, for they purport a technical understanding of computus. More specifically, the correction in the first example may have been induced by the redactor's familiarity with the second chapter of DTR. The use of Bede's handbook implies that the creator of Pal. lat. 485's computus was aware that DTR

[387] BIS-FEBMARPAS/1.
[388] BIS-FEBMARPAS/2 and BIS-FEBMARPAS/3 (including *consuete*). *Schriften* 2, 744; Springsfeld, *Einfluß*, 366. *Reckoning*, 111, fn. 356.

was the main source for its computistical objects, although these elements were probably copied from earlier computus collections, rather than excerpted from copies of Bede's scientific works. Either way, the redactor was able to explain certain computistical technicalities in a slightly different way, without introducing errors. Again, this implies that the redactor knew what he was doing. As the rewrites could not have been executed by someone uneducated in computus, the question arises whether a local expert of the reckoning of time was involved in the process compilation of Pal. lat. 485's computistical corpus.

Computistical ambiguities or flaws?

Among the most remarkable features of the computistical tables in Pal. lat. 485, in contrast with the aforementioned examples of *correctio*, is the fact that quite a few of the included tables are riddled by uncorrected mistakes. If a local master of calendar science was indeed involved during the compositions of the computus in Pal. lat. 485, why were these mistakes not noticed and corrected? The most important examples of uncorrected computistical flaws and their consequences are discussed in detail below.[389] Here, it is essential to emphasize that, sometimes, what might seem to be a mistake, not necessarily has to be.

The remarkable case of the mixed use of Roman and Egyptian solar regulars in our central manuscript serves to exemplify this point.[390] The two renditions of the solar regulars show considerable variations. Firstly, the Roman list runs from January to December, whereas Egyptian list begins with March and ends with February. Secondly, the Roman and Egyptian renditions have diverging solar regulars for January (II or III respectively) and February (V or VI respectively). Note, however, that Pal. lat. 485's Roman weekday regulars on fol. 12v mention the Egyptian numbers for January and February in the Roman list:

[389] See pp. 131-143.
[390] RFRE/1 and RLRE/1: MS/1, fol. 12v. For analyses of the technical details of both traditions, see Springsfeld, *Einfluß*, 130-138.

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
III*	VI**	V	I	III	VI	I	IIII	VII	II	V	VII

At first sight, these deviations from the Roman solar regulars may seem to be the result of uncorrected scribal mistakes. However, these deviating Roman weekday regulars for January and February are mentioned in more than half of the regional codex units. [391] Whenever they occur, the Egyptian numbers for January and February are consistently employed in the context of the Roman solar regulars. Strikingly, the adapted numbers are also mentioned in context other than this table, like in a single regional copy of DTR 21 and a tabular addition to chapters 4-5 of Isidore's *De natura rerum*.

Consequentially, it seems implausible that the adapted numbers for January and February resulted scribal mistakes. Rather, it appears to have been a regional tendency to conflate the Roman and Egyptian solar regulars, substituting the Roman numbers for the Egyptian one. A possible explanation for this phenomenon might be a regional preference for the Egyptian rendition, which is also exemplified throughout the computus in Pal. lat. 485.[392] Because Bede explicitly mentions his preference for the Roman solar regulars,[393] the adoption of the Egyptian solar regulars is another interesting departure from Bede's preferences.

Computistical kernels

At first sight, the core of the computistical assemblage in Pal. lat. 485 is its calendar, which could be characterized as a map for a proper observance of the liturgy. The Julian solar

* The Roman solar regular for January should be II. The Egyptian solar regular for January is III.
** The Roman solar regular for February should be V. The Egyptian solar regular for February is VI.

[391] See appendix 9.
[392] MS/1, 5v and 13v.
[393] In particular, the copy of DTR ch. 21 on MS/4 fols. 60v-61r mentions the correct numbers for January and February in its representation of the Roman solar regulars. Moreover, a vertical table of the Roman solar regulars with the valid numbers for both months was locally available: MS/4, fol. 9v.

calendar appears approximately in the middle of the second quire, leaving considerable space before and afterwards for the inclusion of other computistical material. Based on its structural elements, the calendar in our central manuscripts is identical to the format of the calendars in Pal. lat. 1449 and Cologne 103.[394] Moreover, most of its columns are connected to the tables on fols. 4r-5v and 12r.[395] The remaining objects on fols. 4r and 12r-12v neatly amplify the available material, resulting in a broad rendering of important concepts and procedures of the reckoning of time.

With the calendar, one of the two key elements of Bede's computistical tradition is present in Pal. lat. 485. Strikingly absent, however, is an Easter table, which would have been an ideal tool for verifying computations, for it provides – amongst other computistical information – the dates for Easter for a great number of years in advance. Possibly, users of Pal. lat. 485 relied on the Easter table in Pal. lat. 1449, which spans the years 532–1073.[396]

Looking more closely, it could be suggested that the computus in Pal. lat. 485 has another key element, namely the curriculum for clerical computus known as *computum minorem*.[397] All of the required tables for calculations of the age of the moon, the weekday, and the dates for moveable feasts are included on fols. 12r and 13r, namely the epacts, lunar regulars, concurrents, solar regulars, Easter regulars, and terms for the moveable feast. However, if we consider this computistical corpus strictly from the perspective of the prescription of Willebert's capitular and the *Admonitio synodalis*, the compiler of Pal. lat. 485 could have limited his selection and arrangement to the tables on fols. 12r and 13r. The decision to include more computus objects could be explained as a comprehensive approach to *computum minorem*, which may have emanated from a reading between the lines and/or local educational ambitions.

[394] See appendix 4.
[395] See pp. 102-111.
[396] MS/4, fols. 17r-23v.
[397] See pp. 59-62.

More specifically, the majority of the computistical objects surrounding and including the calendar on fols. 4r-5r and 12v can be read in two ways. Firstly, these computistical tables and texts formed a composite unit with the calendar. Secondly, the included material supported the understanding and use of the most important arithmetical devices of *computum minorem*. However, if this was the case, what was the added value of Pal. lat. 485 compared to Pal. lat. 1449, which provided all the necessary material for *computum minorem*, studies of the liturgical calendar, and more?[398] Perhaps, the specific purpose and significance of Pal. lat. 485 arrangement of computistical objects derived from the computistical objects that were not available in the earlier manuscript from Lorsch. With exception of the instruction considering the range of acceptable Paschal dates on fol. 12r, such material is concentrated on fols. 4v and 12v.[399]

In fact, the three examples of *correctio* are all found in instances of classes of which no object occurs in Pal. lat. 1449.[400] Notably, varying objects belonging to all three classes were only available in Cologne 103,[401] whereas other regional codex units contain instances of no more than one or two of these classes.[402] Not only does this point in the direction of Cologne 103 being used as a source of Pal. lat. 485's computus, it also suggests that the extensive time was devoted to including and correcting explanations that were not yet available in Lorsch. The dedication to these objects suggests that these texts were of special interest.

As the curriculum of *computum minorem* was already incorporated in the more comprehensive and propaedeutic instructions of Pal. lat. 1449, Pal. lat. 485's computus corpus may best be understood as a work of reference which complemented its local counterpart. As

[398] See p. 101.
[399] I.e. BIS-FEBMARPAS/1; BIS-INTERCALATION/1; BIS-INCREASE/1; SLC/1; SLA/1; SLS/1; PAS-TERMINI/1; RFRE/1; FERIAKL-EXPL/1; and RLRE/1, see pp. 103-107 and 112-113.
[400] I.e. BIS-FEBMARPAS/1; BIS/-INCREASE/1; and PAS-TERMINI/1, see pp. 121-123.
[401] MS/89. See appendix 3.
[402] Two: MS/247 and MS/3 II. One: MS/2 and MS/37.

suggested above, the computus in our central manuscript may have been used during a later and more advanced phase of the educational process.[403] The redacted explanatory texts in Pal. lat .485 can, from this perspective, be read as reminders of specific aspects of Bede's reckoning of time, stimulating the intended audience to recollect material of DT and DTR which they had already studied during prior studies of calendar science.

Meanwhile, it should not be ruled out that Pal. lat. 485's computus consciously provided a second copy of some of the computistical material that was already available in Lorsch, perhaps to be taken abroad by members of the clergy or distributed to other monastic or episcopal centres. However, due to its complexity and nature as a work of reference, which did not include all of essential material for computistical calculations, it is unlikely that the computus in Pal. lat. 485 was created and used for portable and standalone use.[404] Moreover, the size of our central manuscripts exceeds the general dimensions associated with medieval portable books, like clerical instruction-readers or almanacs. Even portable use of the second quire as an independent booklet seems unlikely, for the folia could not have been carried along easily, without folding the quire like a folded almanac.[405] Turning to signs of use and provenance, it is important to note that none of the folia of Pal. lat. 485's second quire appear to have ever been folded lengthwise or widthwise. Moreover, no signs of provenance suggest that Pal. lat. 485 was ever taken outside of the abbey of St. Nazarius before it was moved to Heidelberg between 1556–1559.[406]

In conclusion, the computus in Pal. lat. 485 was, most plausibly, produced as a complementary and briefer work of reference for advanced studies of calendar science by secular members of the clergy in the monastic school of Lorsch, in particular concerning the use of the Julian solar calendar and the calculations prescribed as *computum minorem*.

[403] See pp. 115-118.
[404] See pp. 115-118 and 132-143.
[405] See p. 74.
[406] See pp. 68-73.

Exemplars

Further insights concerning the arrangement of the computus in Pal. lat. 485 can be gained from a comparison of its computistical contents with the texts and tables that were regionally available. Is it possible to determine which regional manuscripts and works were used as exemplars for the computus in Pal. lat. 485?[407]

Apart from the adoption of Bede's paschal works and perhaps also Hrabanus' DC in Lorsch, Pal. lat. 485 bears witness to the prolonged use of computistical objects which circulated in the Frankish empire before the dominance of the Bedan-Dionysian reckoning of time and/or independent of the transmission of Bede's scientific works. Although it could be argued that parts of Pal. lat. 485's computistical compilation were excerpted from Frankish computus works edited by Arno Borst, such as *Lect. comp.* and *Lib. ann.*, such textual relationships remain vague and loose at best. At best, the compiler of Pal. lat. 485's computus haphazardly selected small groups of up to three paragraphs or tables, which may have circulated in copies of computistical formularies and encyclopaedia's but were more frequently available in self-contained computus collections.[408]

More suitable and telling than a comparison with the editions of Borst, is the comparison of Pal. lat. 485 with such miscellaneous collections in the regional codicological units. As mentioned above, the relationships between Pal. lat. 485 and two other regional codex units from Lorsch and Cologne are especially striking: Pal. lat. 1449 and Cologne 103.[409] Most of the tabular material within Pal. lat. 485's computistical corpus may have been copied from Pal. lat. 1449, including an explanation and table that was only available in this sister manuscript.[410] Whenever the contents of the two manuscripts from Lorsch diverge from

[407] A brief examination of the wider circulation of computistical material in the inner circle of the intellectual network of Lorsch is included in appendix 12.
[408] See appendix 5.
[409] MS/4 and MS/89, see appendix 3.
[410] MS/1 and MS/4: LPZ-EXPL/1 and TER-PEN/1.

one another, Cologne 103 may have served as an additional source. As Cologne 103 appears to have been the most important source for Pal. lat. 1449, this earlier exchange between Lorsch and Cologne may have been revived during the compilation of Pal. lat. 485.[411] However, it is also thinkable that all three manuscripts were informed by a hypothetical, now lost exemplar.

It should be noted that Cologne was among the crucial scientific centres for the core era of Carolingian computus, namely between 789-820, as is evident from three regional codicological units, which Borst used as crucial sources for his editions of Frankish computistical works.[412] Examining the extant codex units from Cologne, Immo Warntjes convincingly argues for the special role of the library and scriptorium of the cathedral of Cologne as the most important computistical centre during the early phase of Frankish computus before 789. Moreover, Warntjes notes that the earliest comprehensive Frankish study of Bedan-Dionysian reckoning of time is extant within the *Kölner* manuscripts.[413] Hence, it is not hard to imagine why members of the monastic community of Lorsch would have turned to the cathedral of St. Peter in Cologne for a computistical exemplar.

Computus rhenanus

Compared to the overlap between Pal. lat. 485 and Pal. lat. 1449, and the scriptorium of Lorsch as a shared place of origin, the evidence for the use of Cologne 103 during the creation of the computus in our central manuscript is suggestive at best. Therefore, it is important to keep an open mind concerning other or additional exemplars or sources. Unfortunately, it is hard to tell whether other regional codex units were consulted during the creation of Pal. lat.

[411] See pp. 96-99.
[412] MS/88 I, MS/88 II, and MS/89. Four out of the twenty texts edited by Borst are only extant in manuscript from Cologne.
[413] MS/89. See Warntjes, "Köln", 49-85.

485's computus. In general, objects belonging to the same classes circulated widely in the intellectual network of Lorsch.[414]

A case could be made for use of Pal. lat. 1448 II, which was probably created in Mainz between 837-840, and contains texts written in a hand trained in Lorsch.[415] Comparing Pal. lat. 1448 II with Pal. lat. 485, comparable clusters comprising the horizontal representations of the solar and lunar regulars and an explanatory text stand out. However, the cluster in Pal. lat. 1448 II contains a horizontal representation of the concurrents after the explanatory text, which does not occur in Pal. lat. 485.[416]

In turn, it is remarkable that these particular clusters cannot be found in any of Borst's editions. Meanwhile, a cluster that is identical to the one in Pal. lat. 1448 II is part of the *Computus rhenanus* of 775 (chs. 43-45), which escaped Borst's attention. Complete copies of this formulary are only extant in regional codex units from Cologne and Worms.[417] Immo Warntjes convincingly argues that this collection of *formulae* originated in a Rhine-Frankish computistical centre, such as Trier or Cologne, placing it neatly in the inner circle of the intellectual network of Lorsch.[418]

Supposing that Cologne was indeed the place of origin for the *Computus rhenanus*, the manuscript Cologne 103 again emerges prominently at the computistical horizon of the compiler of Pal. lat. 485's computus corpus. Nonetheless, the possibilities of copying from Pal. lat.1448 II, a now lost copy of the *Computus rhenanus*, or some earlier collection, which served as an exemplar for both the *Computus rhenanus* and the clusters in Pal. lat. 485 and Pal. lat. 1448 II, should not be ruled out.

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[414] See appendix 3.
[415] See p. 90.
[416] REGULARES-CLa/1, see MS/1, fol. 12v and MS/3 II, fol. 101r.
[417] MS/89, fols. 184v-190v, esp. 189v-190r and MS/247, fols. 169r-174v, esp. 173r. Lacking an edition of the *Computus rhenanus*, the numbering of its chapters is my own. Note that the cluster in MS/3 II (chs. 43-46) is more comprehensive than the one in MS/1 (chs. 43-44 and 45).
[418] MS/89. See Warntjes, "Willibrord", 198-203, esp. 203.

Advanced studies of *computum minorem*

To shed further light on the educational function of the computus in Pal. lat. 485, my analysis once more returns to the computistical objects within our central manuscript, focusing on the details of the reckonings of time that future priests may have learned to perform using this computistical material. The scope of the following examination is restricted to calculations prescribed as relevant to priests in Willibert's first capitulary and the *Admonitio synodalis*, namely calculations of the age of the Moon and the weekday on the first day of the month and computations of the dates for moveable feasts.[419] Moreover, I consider whether priests exceeded this basic computistical level by learning to calculate the lunar age and weekday for any Julian calendar date.

Studying the function of the computus in Pal. lat. 485, it is crucial to incorporate the required prior knowledge and the full range of flaws in its computistical material. The fact that many tables in Pal. lat. 485 are riddled by mistakes contradicts the level of computistical expertise and education in Lorsch which is otherwise suggested by the purposeful and neat design of its computus, the previously discussed examples of Carolingian *correctio*, and ample signs of prolonged use.[420]

Note that the availability of a computistical formulary, extensive prior knowledge, or the presence of an experienced master, allowing users of Pal. lat. 485 to establish the year of the solar cycle and the *cyclus decemnovenalis* using the year AD, would have been essential. None of the computistical devices that are discussed underneath could have been used correctly without knowledge of these formulas.[421]

[419] See pp. 59-62.
[420] See, especially, pp. 72-73.
[421] See pp. 115-118.

Calculating the weekday of 1 January

The computistical dossier in Pal. lat. 485 was not only used to make notes in its calendar, but also to perform basic calculations. This is proven by a gloss on fol. 13r, written by a tenth-century hand. The gloss is an application of the table of the concurrents and the Egyptian solar regulars, which was available on the same folio and was used for computations of the weekday on the first day of any month of the year.[422] Moreover, an explanation of the application of these arithmetical devices was present on the previous folio.[423]

The gloss describes the use of the solar regular 3 for January and concurrent 6 for what must have been a 5th, 11th, 17th, 22nd or 28th year of the solar cycle. As implied by the use of the concurrents, which mentions the weekday on 24 March throughout the 28-year solar cycle, the writer of this gloss was familiar with a formula for establishing the year in solar cycle. This formula indeed exists, but is not provided in Pal. lat. 485. The addition of solar regular 3 to concurrent 6 results in 9. Because there are no more than 7 days in the week, a modulo operation is performed. In other words, the remainder after division of the result by 7 is found, resulting in 2 and therefore the *secunda feria*. Consequentially, 1 January was a Monday in that particular year. Interestingly, the applied revision of the result, if it exceeded the total number of weekdays, is not mentioned in Pal. lat. 485. That it is nonetheless applied, confirms the availability of some prior knowledge to the writer of this marginal notation.

Note that the calculation of the weekday of 1 January is relatively simple for non-bissextile years. In a leap year, however, 24 February is doubled, resulting in a shift of the weekdays during the remainder the year. In the table for the concurrents, this phenomenon is implemented by an increment of 2 rather than 1, compared to the previous number, whenever

[422] CRFE/1. For the gloss see MS/1, fol. 13r: '*Januarii II. VI Concurrens. Siunt VIIII. Tolle VII. Remanent II. Hoc est in secunda feria.*'

[423] FERIAKL-EXPL/2, MS/1 fol. 12v: '*Qui videlicet regulares iuxta utrosque idest secundum romanos et secundum aegyptios hoc specialiter indicant quotasit feria quo vii concurrentes ad scriptisunt dies ceteris vero annis addes concurrentes quotquot in praesenti fuerint ad notati ad regulares mensium singulorum et ita diem kalendarum sine errore repperies.*'

a year is bissextile. Thus, the table lists I, II, III, IIII, *B VI*, VII, et cetera, with B for bissextile. As is explained in chapter 21 of DTR, the dropped number is nonetheless used to calculate the weekday of the Kalends of January and February, for these days precede the date of the concurrents (24 March) and the intercalation of the bissextile day (24–25 February).

Because this deviation from the table of the concurrents for January is not mentioned in the gloss, the described calculation was probably performed for a non-bissextile year, and therefore either a 11th, 22nd, or 28th year of the solar cycle. Even so, should the gloss relate to a bissextile year, it would concern the 17th year of the solar cycle. In both scenarios, the performer of this calculation may have been familiar with a formula for establishing whether a particular year was bissextile, although he could alternatively have relied on the B's in the table of the concurrents for this purpose. Unless the writer of this marginal note was mistaken, and his calculation unknowingly concerned a bissextile year (and thus year 5 of the solar cycle), the gloss again confirms a level of knowledge of the reckoning of time which transcended the instructions provided by Pal. lat. 485.

It is telling that the calculation using the concurrents and Egyptian solar regulars was actually performed. The table on fol. 5v could have been consulted instead, for it provides the results of this computation for any year of the solar cycle and any month of the Julian solar calendar.[424] Curiously, the table on fol. 5v also does not incorporate the correction for January and February in bissextile years. As a result, the weekdays for 1 January and 1 February are one day off during years 1, 5, 9, 13, 17, 21 and 25 of the solar cycle.

In the Egyptian variant of the solar regulars, January and February are listed as the final two months in a cycle of twelve months. Setting them apart may have served as a reminder to the exceptions during bissextile years. In other words, the choice for the Egyptian

[424] FERIAKL-CLa/1.

rendition of the solar regular in this table may indicate the availability of knowledge for a correction for the first two months of the year during bissextile year.

The amount of evidence for a positive assessment of a priest's ability to successfully calculate the weekday on the first for any month for each year of the 28-year solar cycle seems convincing. Firstly, the gloss on fol.13r implies the availability of prior knowledge to users of Pal. lat. 485's computus. Secondly, the bissextile day is explained in detail on fol. 4v. Thirdly, the intercalation of the bissextile day was of crucial importance for almost any reckoning of time. Consequentially, it seems plausible that advanced users of Pal. lat. 485 were indeed able to correctly calculate the weekday of the first day of any month throughout the 28 years of the solar cycle. Without knowledge of the correction for January and February during bissextile years, users of the computus in Pal. lat. 485 would, nonetheless, have been able to calculate valid weekdays for the Kalends of most months of the Julian solar calendar, during most of the years of the 28-year solar cycle.

Calculating the age of the Moon

Unfortunately, no other glosses provide direct evidence for the use of any of the tables or texts in Pal. lat. 485's computistical corpus. However, let us assume that its contents were indeed used for other reckonings of time according to the curriculum of *computum minorem*, like calculations of the age of the Moon.

If a consulter of our central manuscript was interested in calculating the lunar age on the first day of any month, he could have used the table of the epacts and the Roman lunar regulars on fol. 13r[425] or the tabular shortcut for their application on fol. 5r.[426] Note that the seven embolismic lunar months are not implemented in any of these computistical devices, although the embolisms affect the lunar age on the Kalends of May and July in year 8;

[425] ERLR/1.
[426] LKL-Cld/1

February in year 11; and March in year 19 of the *cyclus decemnovenalis*. Instead, the relevant corrections are elaborated in the explanatory text on fol. 5r.[427] The *saltus lunae* is, however, not implemented or explained in any of these computistical tables or texts, resulting in wrong ages of the Moon in the final year of the *cyclus decemnovenalis* on the first days of August–December (July placement) or the first day of December (November placement). Recall that a precise date for the subtraction of the *saltus lunae* is neither discussed in Pal. lat. 485, nor in DTR.[428] If the implementation of the leap of the Moon was among the subjects taught to priests, knowledge of this subject would have relied on propaedeutic studies and/or instructions by a master of computus.

Like computations of the weekday, calculations of the age of the Moon on the Kalends also involved a modulo operation. In other words, if the sum of the epact and the lunar regular exceeded 30, the remainder after division of the result by 30 should be found. Once again, some prior knowledge is required and presumed, for this detail is not explained in Pal. lat. 485.

In conclusion, clerical users of the computus in our central manuscript should have been able to successfully calculate the lunar age of the Kalends of all months of the Julian solar calendar for most years of the *cyclus decemnovenalis*. Potentially, the first day of the months during the second half of the final year of this cycle posed problems, due to a lack of knowledge of the implementation of the *saltus lunae*.

The change of the epacts and concurrents

The lack of a specification of the change of the epacts and the concurrents in Pal. lat. 485 also implies a presumption and/or necessity of prior knowledge. To use the lists of the epacts and concurrents, it is essential to know how their Roman numerals correspond to the respective

[427] PDA/1.
[428] See pp. 105-107.

years of the *cyclus decemnovenalis* and the 28-year solar cycle. At first sight, this correspondence may seem straightforward. The list of epacts provides 19 Roman numerals: one for each year of the *cyclus decemnovenalis*. In turn, the list of concurrents provides 28 Roman numerals: one for each year of the 28-year solar cycle. In practice, the use of these devices depends on the Julian calendar date on which you move from the epact or concurrent for one year, to the epact or concurrent for another year. In the context of medieval calendar science, the change of years was not necessarily observed on 1 January.

According to an object in two regional codex units from Mainz and Worms, the change of the epacts occurred on 1 September and the lapse of the concurrents on 1 March.[429] The same delineation circulated in chapter 62 of *Lib. ann.*[430] Meanwhile, Bede only discussed the lapse of the epact on either 1 January (Roman) or 1 September (Egyptian) in DTR. Bede does not mention a date for the change of the concurrent.[431]

Judged by the use of the epacts and the concurrents in the tables on fols. 5r-v, the change of both arithmetic devices was observed on 1 January, for no corrections were made throughout the year. Concerning the epacts, this implies that a change of the epacts was observed on 1 January in line with the Roman tradition. The fact that the arrangement of the months in the table on fol. 5r corresponds to that of the Roman lunar regulars, appears to confirm that the Roman tradition was followed in the context of calculations of the age of the month. In contrast, the months in the table on fol. 5v follow the order of the Egyptian reckoning, implying a change of the concurrent on 1 March, which is not prescribed or applied anywhere in Pal. lat. 485. Users of Pal. lat. 485's computus probably observed the change of the concurrents on 1 January as well.

[429] MS/3 II, fol. 70r and MS/247, fol. 174r. MS/247 wrongfully appoints 1 September for the change of the concurrents.
[430] *Schriften* 2, 760; Springsfeld, *Einfluß*, 369. According to Borst, MS/237 is the only manuscript mentions 1 September, rather than 1 March for the lapse of the concurrent.
[431] DTR ch. 20.

In short, the placement of the epacts and the concurrents by users of the computus in Pal. lat. 485 remains an equivocal subject. The available evidence could be interpreted as an indication of a local lack of knowledge of the proper placement of the concurrents in Lorsch, resulting in a pragmatic use of 1 January. However, a change of the concurrents on 1 January may also have been a consciously employed local convention. In both cases priests would, from a local perspective, have learned to use the accepted changes of the epacts and concurrents, if knowledge is again assumed.

Establishing the age of the Moon throughout the year

Let us have a closer at the compressed version of the table of *litterae punctatae* on the right side of fol. 5r.[432] Using this table, the lunar age on the Kalends and – moving beyond the scope of *computum minorem* – any of day of each Julian solar calendar month could have been ascertained without any calculations. Note that the letters in this shorthand table correspond only to the first day of each hollow lunar month (first column) and each full lunar month during the years of the *cyclus decemnovenalis* (second column). However, no indication is provided in Pal. lat. 485 of which column corresponds to the hollow and the full lunation, implying a need of prior knowledge or oral instructions about how this table should be consulted.

Originally, the table of *litterae punctatae* was created using repetitions of three alphabets (A-U, A.-U., and .A-.T), comprising one full and one hollow lunar month, and therefore 59 days. The letters of the first alphabet had no distinguishing mark, whereas the letters of the second were followed by a dot, and the letters of the third alphabet were preceded by a dot.[433] Whatever the letter is in the abbreviated table points to the beginning of either a hollow or a full lunation whenever the corresponding *litterae punctatae* occurs in the

[432] EMM/1.
[433] DTR ch. 23.

third column of the Julian solar calendar.[434] Depending on whether a user of the computus in Pal. lat. 485 was establishing the age of the Moon during a full or a hollow lunation, he could count inclusively from that point in the calendar for respectively 30 or 29 days, to ascertain the age of the Moon for any day of that particular lunation.

Using the *litterae punctatae* on fol. 5r together with the third columns of Pal. lat. 485's calendar folia, should in theory have provided the opportunity to find the beginning of each full lunation and each hollow lunation throughout the entire year. In practice, however, doing so would have been impeded on multiple grounds. First of all, a user of the computus in our central manuscript would have to know how to relate the letters in the table to the column in the calendar. The required procedure is not explained in Pal. lat. 485, but could have been learned from chapter 23 of DTR or the instructions of a teacher. Moreover, the implementation of the embolismic lunar months would have posed a series of exceptions to the rule, yet no specifications of their consequences for the *litterae punctatae* are made explicit.[435] Likewise, the consequences of the subtraction of the *saltus lunae* for the employment of the *litterae punctatae* are nowhere explained. Finally, a number of errors made the use of the *litterae punctatae* in Pal. lat. 485 impossible. Firstly, the *litterae puncatae* in the shorthand table on fol. 5r were confused for the hollow and full lunations of the 3rd year of the *cyclus decemnovenalis*. Secondly, no dots were inserted in the third column of any calendar folio, leaving only the length of each alphabet as a characteristic trait.

Combined, the required prior knowledge and impact of these uncorrected flaws seriously detracted from the value and usability of this aid for establishing the age of the Moon without any calculations. As a result, it is unlikely that anyone, even an expert computist, could have used the *litterae punctatae* in Pal. lat. 485 to establish the age of the Moon for all Julian calendar dates during the *cyclus decemnovenalis*.

[434] JSC-a/1: Ms/1, fols. 6r-11v.
[435] Reckoning, 299.

The same conclusion applies to the alternative approach to this problem, namely counting back forth from the age of the Moon on the Kalends of each month. Although this procedure could have resulted in valid lunar ages for most Julian calendar dates, the risk of false results would have been significant, especially for dates surrounding the beginnings and endings of lunar months.

In practice, extensive prior knowledge was required for successful use of this procedure. Firstly, users of the computus in Pal. lat. 485 should have known how to apply the corrections for the lunar age on the Kalends of particular months due to the implementation of embolismic months in the 8th, 11th and 19th year of the *cyclus decemnovenalis*. As mentioned above, these corrections are explained on fol. 5r.[436] Moreover, exact knowledge of the correspondence of the alternation of full and hollow lunar months to Julian calendar dates is required. At the top of each calendar folio, the length of the common lunation of each Julian calendar month is explained.[437] The common Julian calendar dates of the beginning or ending of each common lunar month is not mentioned at all. Finally, users of the computus in Pal. lat. 485 should have known all exceptions to the common alternation of full and hollow lunar months, caused by 1) the implementation of all seven embolismic months throughout the years of the *cyclus decemnovenalis*; 2) the subtraction of the *saltus lunae*; and 3) the implementation of the lunar bissextile day. Of these three technical details, only the intercalation of the lunar bissextile day is explained at a sufficient level of detail.[438]

Consequentially, it seems implausible that users of the computus in our central manuscript were able to successfully establish or calculate the age of the Moon for all Julian calendar during and each year of the *cyclus decemnovenalis*. Presumably, such a detailed

[436] See pp. 107-109 and 134-135.
[437] See pp. 110-111.
[438] See pp. 104-105.

level of computistical knowledge was not required or expected from a priest's engagements with calendar science.

Establishing the weekday throughout the year

Much like the connection between the *litterae punctatae* on fol. 5r and the third column of Pal. lat. 485's calendar, there exists a relationship between the objects concerning calculations of the day of the week and the second column of the calendar. Whenever a computist in training would have established the day of the week of 1 January, he could have turned to the second column of the calendar. Let us assume that the Kalends of January was a Monday, as is established in the gloss on fol. 13r. In the second column of the calendar, we encounter the Roman numeral I next to 1 January.[439] Therefore, the numeral I refers to Mondays in the entire calendar during that particular year. Should the Kalends of January have been a Tuesday, each I would have referred to this particular weekday, and so on. Counting back and forth form the weekday of the Kalends of January or the first day any other month, would have enabled users of the computus in Pal. lat. 485 to establish the week day for any day of the year.

Like in computations of the weekday, bissextile years form an exception to the use of the second column of the calendar. The doubling of 24 February not only increased the lengths of the solar and lunar month of February, but also affect the weekday cycle, for the bissextile day has a weekday. Thus, should a computist in training have calculated the weekday of 1 January or 1 February in a bissextile year, administering the correction of the concurrent of the corresponding year by subtracting 1 from the concurrent, the Roman numerals in the second calendar-column would only have been valid for the period 1 January up and including the common 24 February. For the rest of the year, the Roman numerals

[439] MS/1, fol. 6r.

would have to be corrected by adding an extra weekday. Reversely, computations of the weekday for the Kalends of March–December could have successfully been combined with the Roman numerals in the second calendar column for the bissextile 24 February–31 December. A weekday would have to be subtracted for 1 January up and including the common 24 February.

Prior knowledge would, again, have been essential for establishing the day of the week throughout the year. Although direct evidence is unavailable, it seems fairly plausible that clerical users of Pal. lat. 485's computus were able to establish corrects days of the week for any Julian calendar date during all 28 years of the solar cycle, assuming that propaedeutic instructions or instructions by a teacher provided a relatively small amount of prior knowledge concerning corrections during bissextile year. If this was not the case, priests should at least have been able to establish valid weekdays for any Julian calendar date during common solar years and some Julian calendar dates during bissextile solar years.

Calculating the dates for the moveable feats

Calculating a valid date for Easter was the primary purpose of medieval calendar science. Therefore, it is of the utmost importance to establish whether a user of Pal. lat. 485's corpus would have been able to calculate a correct date for Easter using the table of the Easter term. Note that knowledge of the use of these computistical devices could not have been gained from Bede's computistical works. Such prior knowledge could, instead, have been derived from Hrabanus' DC.[440]

Remarkably, two mistakes occur in the tables of the Easter term and they are not corrected. On fol. 12r, the term for the fourteenth Moon of Easter is mistaken by one day for the 9th year of the *cyclus decemnovenalis* (VI Idus Aprilis instead of VII Idus Aprilis). The

[440] See pp. 118-119.

same table on fol. 13r provides the correct date for the 9th year of the *cyclus decemnovenalis*, but skips the date for the 16th year, resulting in a table of 18 rows, rather than 19. Depending on whether a user of this table would have counted the years of the *cyclus decemnovenalis* from the top or the bottom of the table, he could unknowingly have run into serious trouble in calculations of the Paschal date for several years.

Due to these mistakes, no correct table of the Easter term was available in Pal. lat. 485. Clearly, both flaws could have been circumvented and corrected by comparing the tables for the Paschal term on fols. 12r and 13r, yet no correction was made. That the missing line for the 16th year was not corrected is all the more striking, for the table for the Easter term on fol. 13r is juxtaposed to a 19-line table of the term for Quadragesima, visually demonstrating that a row was skipped in the table for Easter. Perhaps the inclusion of *Nonae aprilis* on fol. 4v by a tenth-century hand was eventually made as a correction, for this popular verse was used to memorize both the *terminus paschalis* and the *regulares pasche* and provides the correct data.[441]

As mentioned above, the *regulares pasche* indicate the difference of weekdays between 24 March and the day of the Easter full Moon for every year of the *cyclus decemnovenalis*. Because the concurrents represent the weekday of 24 March during each year of the 28-year solar cycle, the addition of the concurrent for a particular year to the Easter regular of the corresponding year in the *cyclus decemnovenalis* results in the weekday for the full Moon of the Paschal feast in the same year. Again, prior knowledge is assumed, for Pal. lat. 485 does not provide an explanation of the fact that the day of 24 March is not included in reckonings with the Easter regulars, although medieval reckonings of time were usually based on inclusive counting.[442]

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[441] NAN-CLa/1.

[442] For instance, Thus, *II Kalends Januarii* indicates the final day of February, rather than the second to last day before 1 January.

Although separate tabular representations of the *concurrentes* and the *regulares pasche* were available on multiple folia, they appear together on fols. 12r and combined on fol. 13r.[443] Presumably, the table on fol. 13r was preferred, for it juxtaposes both arithmetical devices directly besides one another. Like any other calculation applying concurrents, the output of the calculation would again have to be corrected using a modulo operation if the result exceeds the number 7, for there are only 7 days in the week.

Notwithstanding the mentioned mistakes and taking *Nonae aprilis* into account as a potential method for tenth-century users of Pal. lat. 485 to find the correct term for the Easter full Moon, it seems plausible that users of its computistical corpus were at least able to correctly use the *terminus paschalis* for some and perhaps all years of the *cyclus decemnovenalis*. Thus, they could have used the Easter regulars and concurrents to calculate the weekday of the Easter full Moon. As soon as the date and weekday of the Easter full Moon were established, the second column of the calendar could be used to find the next Sunday, and thus the Paschal date. Finally, such computations could have been checked using the Paschal date of that particular year AD in the Easter table in Pal. lat. 1449.[444]

Concerning the dates of the other moveable feasts, which depended on the Paschal date, no mistakes impeded the use of the table for the termini of Quadragesima, Rogationes, and Pentecost on fols. 12r and 13r. Thus, using these tables would have provided a solid foundation for the calculation of the dates for these moveable feasts. Alternatively, users of the computus in Pal. lat. 485 could have counted back or forth from the date of Easter, for all other moveable feasts were celebrated on a fixed number of days or Sundays before or after Easter.

[443] Respectively in TER-CLa/1 and CC-RPA/1.
[444] MS/4, 17r-23v. Often the B's for bissextile years are missing, i.e. fol. 21r. As a result, fol. 21v lists invalid and uneven years as bissextile days.

Computus, prognostics, and cryptography

Although it transcends the prescriptions of Willebert's first capitulary and the *Admonitio synodalis*, knowledge of the Julian solar calendar and experience with calculations of the weekdays and age of the Moon would also have enabled priests to use the prognostic texts that were included in Pal. lat. 485's second quire.

According to Carine van Rhijn, priests were not only concerned with the spiritual well-being of their local lay communities, for they were also called upon for knowledge about health and disease. Alternative practises like the diagnosis of diseases and divinations about their development, using the intellectual framework of computus, probably were not deemed suspect or superstitious, as long as they were performed by an educated rural priest using the right texts.[445] Seen in this light, it is understandable that knowledge of calendar science blends into other forms of clerical expertise on fols. 13v-14v without a clear distinction.

Firstly, the employment of the *dies aegyptiaci* on fol. 13v relied on knowledge of the calendar, for it provides a list of unfavourable Julian calendar dates for bloodletting and the use of medicines throughout the year. Secondly, the lunation underneath indicates the prospects of sickness based on the age of the Moon on the first day of illness. Thus, this text requires the calculation of the age of the Moon on any day of the year. Thirdly, the diet for every month of the year on fols. 14v and 14r again relies on knowledge of the Julian solar calendar. Finally, added by a tenth-century hand, a badly effaced copy of the *Lunationes Danielis* is included on fol. 15v, describing good and bad days for bloodletting based on the lunar age.[446]

[445] See Rhijn, "Rural", 141-145; Rhijn, "Prognostics", 272-297.
[446] Presumable, this lunation was copied from MS/4, fol. 9r. Lorenzo Ditomasso, "Greek, Latin, and Hebrew Manuscripts of the *Somniale Danielis* and *Lunationes Danielis* in the Vatican Library", *Manuscripta* vol. 47-48 (2004), 1-42.

Finally, the cryptographic texts included on fols. 14r and 14v are at home in the context of Bede's reckoning of time, for DTR includes a description of a method to encode messages using Roman numerals (I =A, V=E, X=K, et cetera), the signs used for finger counting corresponding to the letters of the alphabet (I =A, V=E, X=K, et cetera), and the letters of the Greek alphabet (α=I, ι =X, μ=L, et cetera).[447]. The inclusion of a table of alphabetical permutations on fol. 14v (b=a, c=b, d=c, et cetera) concerns another cryptographic method. Evidently, the method using the Greek alphabet was used in a gloss at the bottom of fol. 14r. Moreover, another encoding method involving the substitution of a number of dots for vocals (A= ·, E = ⁖, I = ∴, O = ∵, and U = ⁘) is employed in glosses on fols. 6r-11v, 13r, and 100v.[448]

What held computus, prognostics, and cryptography together, according to Faith Wallis, was a shared notion of wisdom, exemplified in the intricate problems of computus, secret codes, and divinations.[449] In practice, the material provided by Pal. lat. 485's computus and its supplements allowed priests to interpret the obscurities and veiled truths of symbols, diseases, and celestial phenomena.

[447] DTR ch. 1. See also DC ch. 7.
[448] See p. 72-73.
[449] Wallis, "Albums", 195-224.

Conclusion

With these explorations of the case of the computistical collection in Vatican, BAV, Pal. lat. 485, my analysis comes to a close. All things considered, the presence, arrangement, and function of the computus in our central manuscript can, indeed, to a large extent be explained using a contextual, comparative, and object-oriented approach. However, although the presence and arrangement of the computus in Pal. lat. 485 can be explained with great certainty, the answer to the question of its precise function as an educational work of reference for future priests turns out to be inextricably bound to some important caveats.

In the preceding chapters, I examined the question of reading the computus in Pal. lat. 485 right in a comprehensive way. In particular, I regarded this computistical dossier as the product of a continued commitment to the Carolingian educational reforms, created in the scriptorium of Lorsch (ca. 850/860–875) and used for the benefit of future priests in its monastic school (ca. 850/860–950).[450] In short, my analysis shed new light on two subject, namely 1) the clerical-monastic engagements with calendar science in the abbey of St. Nazarius during the creation and use of the computus in Pal. lat. 485; and 2) the nature of the Carolingian educational and computistical reforms.

Presence

Let us first reconsider the presence of a computistical collection in a monastic schoolbook, which was created and used for the education of future rural priests in the monastic school of Lorsch.[451] In short, the presence of computus in Pal. lat. 485 can be explained using numerous royal and episcopal instructions, issued and distributed between the years 789–964. In these

[450] See pp. 68-69.
[451] See pp. 65-74.

legislative or normative texts, calendar science is described as one of the crucial subjects for the education of future priests. In particular, a capitulary by Waltcaud of Liège, mentioning computus as one of the subjects of a curriculum for the education of priests, is included Pal. lat. 485 itself.[452] Other internal evidence also confirms that computus was one of the central subjects for the education of secular members of the clergy. Generally speaking, the observance of particular liturgical dates – and by implication their computation – are relevant throughout the contents of this clerical compendium.[453] Given the available evidence, the presence of computus in Pal. lat. 485 is easily explained.

Arrangement and function

The constitution and use of the computus collection in Pal. lat. 485 are more disputable than its presence in this clerical compendium. Because basic or elementary computistical material is not included in Pal. lat. 485, studies and consultations of the computus in this monastic schoolbook presumably followed propaedeutic or simultaneous studies of other computus manuscripts from Lorsch, like Pal. lat. 1449, and in particular copies of Bede's computistical handbooks.[454] Without doubt, the calendar science in Pal. lat. 485 was, therefore, created and used as a work of reference for advanced studies of computus by future priests.

More specifically, it is possible to identify two kernels in the computus of Pal. lat. 485, namely its calendar (and a range of connected texts and tables) and the clerical-computistical curriculum known as *computum minorem* (and a range of supportive texts and tables).[455] As supplements, the prognostic material and methods to communicate secret messages, appended to the computus in Pal. lat. 485, could be added as a third item in the preceding list.[456] By

[452] MS/1, fols. 95v-96v.
[453] MS/1, fols. 36v-44v, 45v-63v.
[454] MS/4, see pp. 115-118.
[455] See pp. 59-62.
[456] See pp. 124-127 and 131-145.

implication, the arrangement of the computistical collection in Pal. lat. 485's second quire emanated from a combination of factors, such as a reading between the lines of description of *computum minorem* in Willebert's first capitular and/or the *Admonitio synodalis*, local educational ambitions pertaining to varying computistical practices, the agency of its compiler, and existing clusters found in one or more exemplars.[457]

Without doubt, the dominant computistical framework underlying Pal. lat. 485's computus is the Dionysian Easter reckoning. More specifically, most of this clerical-monastic computus dossier appears to have been compiled in relation to Bede's computistical handbooks. As such, the computus in our central manuscript probably served as a work of reference for the Bedan-Dionysian computistical tradition.[458] Additionally, an argument could be made for the influence of a lost copy of Hraban's computistical textbook, based on the inclusion of the terms for moveable feasts and the Easter regulars.[459]

The elements of the computus in Pal. lat. 485 should not be interpreted as direct excerpts from these manuals, for they were presumably selected from collections of computistical texts and tables that were already available in at least two exemplars: Pal. lat. 1449 (Lorsch, ca. 810-814) and Cologne 103 (ca. 811-818).[460] By implication, the continued commitment to the educational reforms in Lorsch between 850/860–875 relied on resources that were already available in its intellectual network during the first half of the ninth century. Moreover, the prolonged use of formularies like the *Computus rhenanus* of 775 as a source for the computus in Pal. lat. 485, offers an important insight in the practice of the computistical reforms. Demonstrably, new collections and works did not supersede older ones, but fruitfully coexisted in the form of local computistical resources.[461]

[457] For examples of existing clusters, see pp. 102-103, 107-109, and 129-130.
[458] See pp. 96-99 and 114.
[459] See pp. 118-119.
[460] MS/4 and MS/89, see pp. 88-91 and 129-130.
[461] See pp. 129-130.

The extent of the clerical-monastic engagements with computus using Pal. lat. 485 by future priests receiving a computistical education in the monastic school of Lorsch, is debatable. In turn, the impact of the Carolingian educational reforms aimed at the computistical education of priests in monastic and episcopal schools, is questionable as well.[462] In short, whether members of the secular clergy were indeed able to compute the day of the week, the age of the Moon, the dates for moveable feasts like Easter and Pentecost, and use the included calendar and supplements, depends on the computistical engagements and experience of rural priests which one is willing to assume, as well the supposition of a number of preconditional contextual factors.[463] Successful computistical calculations using Pal. lat. 485, performed by future priests, are not unthinkable, especially with the aid of a master of the reckoning of time and preceded by extensive propaedeutic instructions of numeracy and handbooks of calendar science like DT, DTR, and DC.

Weighing the available evidence, the worst-case scenario reads as follows. If supervision by a master of the reckoning of time was unavailable and studies and consultations of the computus in Pal. lat. 485 by computistical novices did not follow extensive propaedeutic studies, priests may not have been able to use the calendar in Pal. lat. 485 or master any of the calculations prescribed as *computum minorem*. However, this worst-case scenario seems implausible, because a gloss on fol. 13r proves that at least one user of the computus in Pal. lat. 485 was able to successfully perform a calculation of the weekday on the Kalends of January for some year.[464] Moreover, notes were made in the calendar of Pal. lat. 485 by approximately 20-25 different hands.[465]

In the best-case scenario, a priest's engagements with calendar science using the computus in Pal. lat. 485 would have tended towards the level of expertise of a computistical

[462] See pp. 59-62.
[463] See pp. 115-118 and 131-143
[464] See pp. 132-135.
[465] See p. 72.

master. If so, extensive prior knowledge of a range of computistical technicalities should have been acquired during propaedeutic studies, which preceded the more advanced phase of studies and consultations of the computus in Pal. lat. 485, ideally under supervision of an experienced schoolmaster. For instance, comprehensive knowledge was required of how to circumvent exceptions to the common uses of Pal. lat. 485 computistical tables. Furthermore, use of the computus in our central manuscript would have relied on knowledge of how to identify and correct the errors in its included tables. With extensive prior knowledge of the reckoning of time, priests could, indeed, have learned how to consult the calendar, calculate the lunar age and weekday of any Julian calendar date, or compute valid dates for the moveable feasts during all of the years of the *cyclus decemnovenalis*. Note, however, that no direct evidence exists for the presence of a computistical master in Lorsch at any point of time or an extensive programme of propaedeutic studies. Combined with the fact that a range of flaws in the computus of Pal. lat. 485 remains uncorrected to this day, this best-case scenario appears to be implausible as well.

A more moderate and balanced answer to the question of the educational function of the computistical corpus in Pal. lat. 485 seems in place. Firstly, it is plausible that at least some prior knowledge of numeracy and calendar science was acquired before the computus in our central manuscript was studied and consulted by students of the monastic school of Lorsch. At least, such knowledge must have acquired by the writer of the aforementioned gloss on fol. 13r. Moreover, only a moderate level of prior knowledge is required for use of the calendar, calculations of valid lunar ages and weekdays for the first days of Julian calendar months and most Julian calendar dates, and computations of valid dates for the moveable feasts for most years of the *cyclus decemnovenalis.* Assuming that this moderate level of computistical experience was acquired before turning to the computus in Pal. lat. 485, a priest's engagements with calendar science in the monastic school of Lorsch were – most

likely – moderately successful, especially if a master of computus was present. Finally, the presence of a computistical expert in Lorsch during, at least, the period of its composition, is implied by some explanatory texts in Pal. lat. 485, which bear witness to unique and advanced adaptations by an experienced computist.[466]

Thus, the challenges and problems posed by the use of Pal. lat. 485's computistical dossier can be interpreted as pointing to either level of a priest's engagements with calendar science in Lorsch, depending on the presumed preconditional contextual factors. Meanwhile, it can be concluded with certainty that the common assumption that clerical computus implies nothing more than straightforward and basic procedures, does not do justice to the complexity of working with the computus in Pal. lat. 485.[467] Moreover, combined with the royal and episcopal capitularies mentioning computus, the available calendar science in Pal. lat. 485 points towards another important conclusion: both in theory and practice, the medieval science of computus was not only an affair of a small elite of the greatest minds of the Carolingian era.[468]

The nature of reform

Regarding the nature of reform, a comparison of the computus in Pal. lat. 485, the sample of regional codex units, and the editions in Borst's *Schriften* corresponds to a characterization of the Carolingian reforms as an affair of diversity within unity.[469] On the one hand, the adoption of the Bede's reckonings of time in Lorsch – and arguably Hrabanus' paschal work – matches the general Carolingian tendency of the ninth century.[470] Likewise, the embrace of a particular

[466] See pp. 121-123.
[467] See pp. 59, fn. 124.
[468] See chs. 3 and 4.
[469] See pp. 36-47 and 53-59.
[470] See, especially, p. 52.

clerical-computistical curriculum known as *computum minorem*, described in episcopal instructions, points towards some extent of unity.[471]

On the other hand, no evidence exists for the use of canonized manuals and royally promoted encyclopaedias on the subject of computus in Lorsch. By implication, the evidence for a centralized computistical reform programme or great influence of the Carolingian court in the intellectual network of the abbey of St. Nazarius is lacking.[472] Each of the studied codex units provides a creative and unique composition of computistical texts and tables, indicating varying local approaches to common ambitions, which denote the circumstantiality of the resources of each intellectual centre, and their reliance on exchanges of computistical material between some of them, rather than a wide circulation of standard works throughout the intellectual network of Lorsch. In conclusion, the local reality of reform was less schematic and centralised than is assumed by Arno Borst.[473]

Although the intellectual network of the abbey of Lorsch stretched throughout the Frankish kingdoms, it is telling that the compiler of Pal. lat. 485's computus appears to have relied on a local resource and a manuscript from Cologne. As such, the creation process appears to have been a fairly local affair. The turn to Cologne is, moreover, understandable, for the cathedral of St. Peter was the most important Eastern-Frankish centre of computistical knowledge. Hence, the case of Pal. lat. 485 is informative for studies of the scope and depth of early medieval networks of communication.[474]

[471] See pp. 59-62.
[472] See pp. 128-130. Note, in contrast, that a strong royal influence is evident in Lorsch regarding the Carolingian reforms of works written by the church fathers, see pp. 85-86.
[473] See pp. 96-99 and 128-130.
[474] See pp. 87-88 and 128-130.

The object-oriented approach

Furthermore, the case study of this thesis serves as a proof-of-concept for the employment of the object-oriented approach.[475] Using this new methodology, the present study shows that it is possible and insightful to describe and analyse the contents of the computistical corpus in Pal. lat. 485 using the notions of objects, classes, occurrences, and clusters. Moreover, it turns out to be productive to employ this methodology in comparisons of the computistical elements of manuscripts produced in or associated with the intellectual network of Lorsch.[476] By following thematic patterns in the arrangement of the computus in Pal. lat. 485, with special attention for the regionally available objects and clusters that were and were not included, it was possible to shed new light on the arrangement and use of this computistical collection.[477] As a result, this thesis exemplifies the potential of the object-oriented approach for studies of computus manuscripts.

Perspectives for future research

The conclusions of this thesis provide several leads for further research. Because my analysis only concerns the clerical-monastic engagement with computus in Lorsch, it would be interesting to examine the compilation and consultation of computus dossiers in other clerical manuscripts and other intellectual centres.[478] Moreover, it may be feasible to widen the scope of the sample of regional manuscripts to include manuscripts from St. Gall, Reichenau, Fulda, and other centres from the intellectual network of Lorsch, including codices from the tenth and eleventh century.[479] In particular, incorporating extant copies of the computistical handbooks by Hrabanus and Helperic is desirable, for my examination is obviously biased

[475] For the object-oriented approach, see 23-30. For its application to the case study of this thesis, see ch. 4.
[476] See, especially, pp. 128-130 and appendices 3, 5, 6 and 7.
[477] See ch. 4.
[478] At least four other clerical manuscripts contain computus, according to the description provided in Keefe, *Water*: MS/67, MS/296, MS 307, and MS308.
[479] Suggestions can be found on p. 89, fn. 228-229.

from the perspective of Bede's paschal works. A close reading of the handbooks of Hrabanus and Helperic, including their manuscript context, may shed new light on developments in the prolonged use of Pal. lat. 485's computus during the tenth century. Generally speaking, developments and fluctuations in the educational use of the computus in Pal. lat. 485 warrant scrutiny, for the present study only hints at their existence.[480]

Apart from clerical computus, an analysis of the miscellaneous and elusive nature of a bigger sample of extant Carolingian computistical collections in their own right, rather than in relation to computistical works, is a desideratum for studies of medieval calendar science. Here, especially, the prospects of comprehensive applications of the object-oriented methodology seem promising. As a matter of fact, the object-oriented approach has been embraced by Immo Warntjes, who will apply this methodology in the context of a funded project concerning the Irish Foundations of Carolingian Europe, studying the influence of Irish computistics on the continent.

In addition, the object-oriented approach to the contents of manuscripts may be fruitful in studies of other kinds of miscellaneous medieval sources as well. For instance, use of the methodology may prove worthwhile for cataloguing and analysing the relations between the contents of glossaries, hagiographies, and collections of canon law.

Final considerations

A final and personal note is in place. At times, the diverging positions in the available literature and the sheer amount of relevant and extant sources seemed to swamp me, as I prepared the present study. Often, I instinctively struggled to get free of the hold of competing interpretations by diving deeper into the available primary sources, increasing the burden of my research and aggravating my predicament. My broad interest in medieval calendar

[480] See, especially, p. 18.

science, without doubt, turned out to be my strongest asset and my greatest weakness. Eventually, I realised that what I ought to do, was find the peace of mind to oversee the landscape of the source material that surrounded me, patiently breathing life into the case of Pal. lat. 485's computus as a creature of circumstance.

Appendices

Appendix 1. Vatican, BAV, Pal. lat. 485: A manuscript description

Place and library of preservation: Vatican, Biblioteca Apostolica Vaticana

Shelf mark: Palatinus latinus. 485

Place and date of origin: Imperial abbey of Saint-Nazarius in Lorsch, 850/860-875.[481]

Written language: Latin, Old High German

Composition: $(I + 1)^3 + VI^{15} + \ldots + 5\ IV^{55} + III^{61} + I^{63} + 3\ IV^{87} + 3\ III^{105} + IV^{113}$

Contents:

fols. 1-3 Different kinds of texts on the subjects of penance, sins and confession.

fols. 1r-2r Readings for masses and prayers on the theme of penance.[482] Some of the liturgical readings may derive from Bede's Homilies. In turn, the votive masses may be associated with the weeks around Easter.[483]

For this manuscript description, I am indebted to the descriptions by Michael Kautz, Susan A. Keefe, and Frederick S. Paxton. For the incipits and explicits of the described contents, and references to additional editions and literature, see Kautz, "Wissenschaftliche Beschreibung BAV Pal. lat. 485"; Susan A. Keefe, *Water and the Word: Baptism and the Education of the Clergy in Carolingian Europe*, vol. 2 (Paris: Notre Dame Press, 2002), 100-103; Keefe, *A catalogue of works pertaining to the explanation of the creed in Carolingian manuscripts*, 360; Paxton, "Bonus", 1-30. All dates of hands have been based on the description by Kautz, whom in turn based himself on *Abtei*. The footnotes in this manuscript description pertain to the literature that I consulted based on the references in the aforementioned descriptions.

[481] KFH III, 414, no. 6531.

[482] Paxton, "Bonus", 8-9; Klaus Gamber, *Codices liturgici latini antiquiores*, vol. 2 (Freibourg: Universitätsverlag Freibourg Schweiz, 1963), 568-569, no. 1582; Keefe, *Water*, 100. Keefe wrongly assumes that Gamber identified the readings from the New Testament. The identifications are Paxton's. According to Gamber, the contents of fol. 1r are a fragment of the votive mass on the Holy Trinity.

[483] As far as I know, a relationship with Bede's Homilies and the period around Easter has not been suggested in earlier studies. Note, in particular, that some of the incipits of the liturgical readings occur in Bede's Homilies, but not in the New Testament. See J.A. Giles, *Homilies*, vol. 5, The Complete Works of Venerable Bede (London: Whittaker and Co., 1843). Rm, 11:35-36 (in III, p. 20, 4th Sunday after Easter); Jn. 15:26-27, 16:1-4 (subject of VIII, pp. 57-69, 6th Sunday after Easter); Rom. 7:22-25; Gal. 6:1-2 (completely in LII, p. 400, 3rd Sunday of Quadragesima; partially in LIV, p. 417, 1st Sunday of Quadragesima); Lk. 11:9-13 and Mt. 7:9-11 (the former is partially the subject of LVI, p. 432-441, April 25; both are subject of VII, pp. 46-56, April 25 and the three days before Ascension Day); Mk. 11:22-26 (partially in VII, p. 50, April 25). For the prayers, described as a '*Missa votiva Alcuini*', see Jean Deshusses, *Le sacramentiare Grégorien. Ses principales formes d'après les plus anciens manuscrits.*, vol. 16, Editions Universitaires Fribourg Suisse (Freiburg: 1992), 432, no. 1293-6.

Moreover, the prayers are associated with votive masses for the Queen, living friends and/or the emperor.

fols. 2r-3v Othmar of St. Gall's letter on the procedure of confession. The Latin text is immediately followed by the so-called "Lorscher Beichte" in Old High German on the subject of sins by the laity. Both texts were added by the same, later hand, which has been dated to the fourth quarter of the ninth century.[484]

fols. 4r-15v Computistical texts, tables and a calendar, with attached material on the subject of prognostics and cryptography. The folios contain additions and glosses, mostly within the calendar. The additions were written by approximately 20-25 later hands dating from the late ninth century and the tenth century (fol. 4v, 6r-12v, 13r, and 14r, some of which are encoded using cryptography, see also 100v and 113v). Votive masses were added to the empty space at the end of this quire.

fol. 4r LPZ-TBL/1.

fol. 4v LPZ-EXPL/1 + BIS-FEBMARPAS/1 + BIS-CLa/1 + SAL/1. Added by a tenth-century hand: NAN-CLa/1.

fol. 5r LKL-CLd/1.

[484] Paxton, "Bonus", 9-10.

fol. 5v FERIAKL-CLa.

fols. 6r-11v JSC-a/1.

fol. 12r ANN-SOL/1 + TER-CLa/1 + PAS-TERMINI.

fol. 12v DIE/1 + RFRE/1 + FERIAKL-EXPL/2 + RLRE/1 + HOR/1.

fol. 13r ERLR/1 + CRFE/1 + CC-RPA/1 + TER-QUA/1 + TER-PAS/1 and a gloss applying the material of CRFE/1.

fol. 13v-14r Medical and dietary prognostics: *dies aegyptiaci* or unlucky days for bloodletting and the use of medicines; a lunation indicating the prospects of sickness based on the age of the Moon on the first day of illness; and a diet for every month of the year.[485]

fols. 14v-15r Explanations of two cryptographic methods using alphabetic and numeric permutations, including working examples and a concordance of Latin and Greek alphabets.[486]

fols. 14v-15v Votive Masses, including one for the date of the Birth of Christ (25 December, some liturgical songs, and a mass for people with fever in

[485] Rhijn, "Rural", 142.
[486] For cryptography, explained on fol. 14v and applied on fols. 13r, 14r, 100v, and 113v, see Bischoff, "Geheimschriften", 125 and 137-8.

honour of St. Sigismund. Both are later additions dating from the late ninth or the tenth century.[487]

fol. 15v A badly effaced lunation on the subject of bloodletting, known as the *Lunationes Danielis*, written by a tenth-century hand.[488]

fols. 16r-48r Discursive and explanatory writings on the terminology of the Old Testament, the church, its ministers and their ministry.[489]

fols. 16r-17v Excerpts from Isidore, *Origines* VII and VIII on the interpretation of Greek terms and Hebrew names from scripture and the ministry, relevant to a clerical audience, attributed to Jerome. The text includes a brief Greek-Latin glossary of grammatical and orthographical-type words from Isidore, *Origines* I.[490]

fol. 17v Excerpt from Bede's exposition on the Gospel of Luke on the theme of humility and penance.[491]

fols. 17v-27v Exposition on the Mass (Ps. Alcuinus).[492]

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[487] Paxton, "Bonus", 11; Frederick S. Paxton, "Liturgy and Healing in an Early Medieval Saint's Cult: The Mass in honore sancti Sigismundi for the Cure of Fevers", *Traditio* vol. 49 (1994), pp. 23-43.

[488] An identical text is included in Vatican, Biblioteca Vaticana, Palatinus Latinus 1449, fol. 9r. See Lorenzo DiTommaso, "Greek, Latin, and Hebrew Manuscripts of the Somniale Danielis and Lunationes Danielis in the Vatican Library", *Manuscripta. A Journal for Manuscript Research* vol. (2003/2004), 1-42.

[489] Paxton associates this material with a letter of Abbot Thiotroch on the differences between the performance of mass in the abbeys of Fulda and Lorsch dating from AD 846, see Paxton, "Bonus", 14.

[490] See, Keefe, *Water*, 100; Paxton, "Bonus", 12-13.

[491] Lc 14:11.

[492] See also, Bamberg, Staatliche Bibliothek, Lit. 131 (s. IX 4 or IX/X, fols. 30v-50v.

fols. 27v-36v Exposition on the Mass (Ps.-Alcuinus), known for its incipit *Dominus vobiscum*.[493]

fols. 36v-44v Jesse, Bishop of Amiens (ca. 799-836, perhaps 802), a letter on the *ordo* of baptism addressed to priests of his diocese, written partly in question-response form and explicitly linked to the foregoing texts.[494]

fols. 44v-45r Excerpts from Isidore's *Ethymologies* on the church and its ministers in question-response form, known as the *Collectionis Sangermanensis XXI titulorum*.[495]

fols. 45r-45v *Discipulus Umbrensium* II, 1-11, on the subject of sacred structures and their use, including the first chapter from Book II of the Penitential of Theodore.

fols. 45v-46v Instruction on the ceremonies of baptism, partly in question-response form. Related to a baptismal text that may have been written by Alcuin, abbot of Tours (796-804), ca. 798.[496]

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[493] According to Van Rhijn, this text was very popular with local clergy and is part of 19 extant manuscripts, see Van Rhijn, "Handbooks", 694, fn. 12, and 701, fn. 25. See also Keefe, *Water*, 126, fn. 2; Yitzhak Hen, "Educating the clergy: canon law and liturgy in a Carolingian handbook from the time of Charles the Bald", in *De Sion exibit lex et verbum domini de Hierusalem: Essays on medieval law, liturgy and literature in honour of Amnon Linder*, edited by Yitzhak Hen (Turnhout: Brepols, 2001), 52-53, fn. 56-61.

[494] Paxton, "Bonus", 14. Jesse of Amiens, *Epistola 1*, MGH Epp. III, 300. Text 30 in Keefe, *Water*, 405-428. See also, Florence, Bibl. Med. Laurenz. Ashb. App. 1923, fols. 1-13 (s. IX in., Corbie); St. Gall, SB Cod. Sang. 124, fols. 310-326 (ca. 804-820, area of St. Amand, no.-east France); and Paris, BNF, Latin 13372, fols. 91r-103r (s. XII).

[495] Paxton, "Bonus", 14. For the *Collectio Sangermanensis XXI titulorum*, see Kautz, "Wissenschaftliche Beschreibung BAV Pal. lat. 485", 10.

[496] Text 42 in Keefe, *Water*, 546-549.

fols. 46v-48r Compilation of excerpts from Isidore's *Ethymologies* explaining the definition of baptism and the Trinitarian formula.[497]

fols. 48r-63v Liturgical directions, prayers and benedictions, mostly based on the Gregorian sacramentary known as the Hadrianum, its supplement, Frankish Galesian sacramentaries, and Celtic liturgy. Some of these rites are directly related to the Paschal liturgy, or indirectly through the liturgical rites of baptism.[498]

fols. 48r-49r Two Prayers from the *ordo* for the Easter Vigil on Holy Saturday, the day before Easter, concerning the blessing of the Paschal candle.[499]

fols. 49r-63v Episcopal and clerical rites and readings from the New Testament for the sick, dying and dead, including rites for serenity and purification, and a baptismal rite for sick children.[500] Additions were made by one or more hands dating from the tenth century on fols. 50v/51r and 61r-v.

fols. 64r-113r Canon law, penitential books and episcopal capitularies; amounting to a fully developed program for the order of clerical life and work, as well as Christian life for the laity.[501]

[497] Including Text 60 in ibid., 629.
[498] Paxton, "Bonus", 15-18.
[499] Ibid., 15.
[500] Iac. 5:13-16; Lc 7:1-10. Frederick S. Paxton, *Christianizing Death: The Creation of a Ritual Process in Early Medieval Europe* (Cornell University Press: Ithaca and London, 1990), 188.
[501] Paxton, "Bonus", 24-27.

fols. 64r-72v	Excerpts addressed to a clerical audience, taken from *Collectio Dionysio-Hadrian* on the creed, and Canons of the First Council of Nicaea, and the Canons of the Apostles.[502]
fols. 73r-80v	Ps. Egbert, Penitential.[503]
fol. 80v	Orations on the subject of thunder and the purification of vessels.
fols. 80v-91r	Theodulf of Orléans, First Capitulary (789-817/8).[504]
fols. 91r-92r	Ps. Boniface, sermon 15 on the renunciation of Satan.[505]
fols. 92r-93v	Garibald of Liège, Third Diocesan Capitulary (802-809).[506]
fols. 93v-95v	Garibald of Liège, Second Diocesan Capitulary (802-809).[507]
fols. 95v-96v	Waltcaud of Liège (811/2-814), Capitulary, including Charlemagne's Questionnaire in *Cap.* I.[508]

[502] Ibid., 18-19.
[503] Presumably an improved version based on Vatican, BAV, Pal. lat. 554, fols. 5r-13r. See ibid., 19-21.
[504] MGH Cap. ep. I, pp. 73-142. Paxton suggests that it may have been based on a manuscript from Cologne, that according to this theory was was sent to Lorsch for correction, namely Vatican, BAV, Ottob. Lat. 3295. See Paxton, "Bonus", 22, fn. 107.
[505] Presumably based on Vatican, BAV, Pal. lat. 554, fols. 12r-v. See ibid., 19-21.
[506] MGH Cap. ep. I, pp. 32-42.
[507] MGH Cap. ep. I, pp. 22-32. Again, a relation with a manuscript from Cologne is presumed by Paxton, in this case Cologne, EDD, 120, fols. 124v-127r. See Paxton, "Bonus", 22, fn. 111.
[508] See appendix 2. MGH Cap. ep. I, pp. 43-69. For Charlemagne's Questionnaire, see Text 14A in Keefe, *Water*, 264.

fols. 96v-101r	Ps. Bede and Ps.- Egbert, Penitential.[509]
fols. 101r-v	Ps. Bede, *Admonitio Bedae.*[510]
fols. 101v-107v	Penitential of Cummean with the addition of glossed songs with neums dating from the tenth century on fols. 101v, 102r and 106v.[511]
fols. 107v-113r	Prologue and Book I of the Penitential of Theodore as transmitted by the *Discipilus Umbrensium*.[512] In the margin, a glossed song with neums has been added by tenth-century hand on fols. 109v/110r.
fol. 113v	Pen trials by several hands. I.e. practicing the alphabet; the cryptographic method described on fol. 14v; some names (i.e. Razo/Rather, and Zacharias); a call upon Jesus Christ to have mercy on us; and what appears to be a badly effaced prayer.

[509] Paxton, "Bonus", 22-23. With an encoded gloss by a tenth- or eleventh-century hand writing *drutbidi*, Old-High German for vomit, in reference to the paragraph underneath on vomiting in the church (fol. 100v, see also the effaced gloss on fol. 13r).
[510] Presumably based on Vatican, BAV, Pal. lat. 554, fols. 12r-v. See ibid., 19-23.
[511] Ibid., 23.
[512] Ibid., 23-24.

Appendix 2. Clerical computus in 9th-century episcopal instructions

	Capitulary	Date of origin	Place of origin
1	*Admonitio Synodalis*[513]	800-820, or ca. 888-966, or ca. 906-964	Region of Lorraine and Rhineland-Palatinate? Mainz? Region of Metz/Trier/Prüm/ Mainz?
2	*Capitula Corbeinsia*[514]	803-5	Western France
3	Haito of Basel[515]	806-13	Region of Besançon (Basel/ Reichenau?)
4	Waltcaud of Liège[516]	811/12-14	Region of Köln (Liège?)
5	*Capitula florentina*[517]	ca. 820-30	Region of Besancon (Basel?)
6	*Capitula Eporediensia*[518]	> 827	Region of Milan
7	*Capitula Sangallensia*[519]	840-50	Western France
8	*Capitula Frisingensia* I[520]	< 850	Region of Salzburg (Freising?)
9	*Capitula Moguntiacensia*[521]	ca. 850	Region of Mainz (Mainz?)
10	Hincmar of Reims I[522]	853-66	Region of Reims (Reims?)
11	Herald of Tours[523]	16-05-858	Region of Tours (Tours?)
12	*Capitula Cottoniana*[524]	ca. 860-925	Western-France (region of Reims?)
13	Willebert of Châlons I[525]	869-870	Region of Reims (Reims?)
14	Walter of Orleans[526]	25-05-869/70	Region of Sens (Bou?)
15	Riculf of Soissons[527]	889	Region of Reims (Soissons?)

[513] Respectively, see *Admonitio Synodalis*, 12-82, computus: 68, ch. 96; *Sermo synodalis*, 1-57, computus: 51, ch. 96; Robert Amiet, "Une *Admonitio Synodalis* de l'époque carolingienne: Étude critique et Édition", *Mediaeval Studies* vol. 26 (1964), 12-82; Friedrich Lotter, "Ein kanonistisches Handbuch über die Amtspflichten des Pfarrklerus als gemeinsame Vorlage für den Sermo synodalis "Fratres presbyteri" und Reginos Werk "De synodalibus causis"", *Zeitschrift der Savigny-Stiftung für Rechtsgeschichte: Kanonistische Abteilung* vol. 62 (1976), 1-57; Rudolf Pokorny, "Nochmals zur Admonitio synodalis", *Zeitschrift der Savigny-Stiftung für Rechtsgeschichte: Kanonistische Abteilung* vol. 71 (1985), 20-51. For the existence of a now lost early ninth-century predecessor to the *Admonitio Synodalis*, see Paul Willem Finsterwalder, "Die sogenannte Homilia Leonis IV., ihre Bedeutung für Hinkmars Capitula und Reginos Inquisitio", *Zeitschrift der Savigny-Stiftung für Rechtsgeschichte: Kanonistische Abteilung* vol. 27 (1938), 638-664. In reference to Amiet, Contreni refers to the *Admonitio synodalis* as a Carolingian episcopal instruction, see Contreni, "Counting", 66. The *Admonitio Synodalis* is associated with several episcopal capitularies, including no. 3, 8, 9, 11, 13, 14, 15, *Capitula Treverensia* (ca. 830-900*)* and Gharbald's capitularies (see appendix 1), as well as Regino of Prüm's *De synodalibus causis* (906). See also Peter Brommer, "Capitula episcoporum: Bemerkungen zu den bischöflichen Kapitularen", *Zeitschrift für Kirchengeschichte* vol., no. 91 (1980), 207-236.

[514] MGH Cap. ep. III, 3-15, computus: 12,3 (c.5).

[515] MGH Cap. ep. I, 203-219, computus: 211,5 (c. 6).

[516] MGH Cap. ep. I, 43-69, computus: 47,9 (c. 11). See MS/1, fols. 95v-96v and appendix 1.

[517] MGH Cap. ep. I, 220-224, computus: 223,3 (c. 7).

[518] MGH Cap. ep. III, 235-42, computus: 238,5 (c. 1).

[519] MGH Cap. ep. III, 110-118, computus: 117,9 (c. 7).

[520] MGH Cap. ep. III, 199-205, computus: 205,1 (c. 8).

[521] MGH Cap. ep. III, 175-180, computus: 180,1 (c. 7).

[522] MGH Cap. ep. II, 3-70, computus: 38,4 (c. 8).

[523] MGH Cap. ep. II, 115-157, computus: 154,7 (c. 125).

[524] MGH Cap. ep. III, 133-40, computus: 137,12 (c. 9).

[525] MGH Cap. ep. II. 90-95, computus: 93,11 (c. 7).

[526] MGH Cap. ep. I, 185-193, computus: 193,1 (c. 22).

[527] MGH Cap. ep. II, 96-111, computus: 103,3 (c. 7).

Appendix 3. Pal. lat. 485 and the regional codex units

The following tables compare computistical classes within Pal. lat. 485 with the clusters and objects that occur within the codicological units of the selected regional manuscripts. Each table is based on the classes and objects that occur on one or more folios within Pal. lat. 485, identified using their abbreviations. Manuscripts are listed using their *sigla*. References to the objects belonging to each class are listed using their identification numbers. Occurences are marked with an asterisk (*) whenever they are part of a bigger cluster within that particular manuscript. The objects and classes belonging to clusters are mentioned in their clustered form and their separate form, see the indentation.[528]

[528] The tables within this appendix are based on the experimental object-oriented catalogue on http://www.computus.lat/objects. Visit the website for more information, including the specific foliation of each occurrence of computistical objects.

Vatican, BAV, Pal. lat. 485, fols. 4r and 4v: Clusters

	MS/1	MS/2	MS/3 I	MS/3 II	MS/4	MS/7 I	MS/7 II	MS/37	MS/88 I	MS/88 II	MS/89	MS/247
LPZ-CLa	*		1	1	*						2	
CYCLDECNOV	*		1	1	*						1	
ZOD	*		2	2	*						2	
LPZ-TBL	*		1	1	*						1	
JSM	*		2	2	*						3	
LPZ-CLb	*		*	*	*			1			*	
CYCLDECNOV	*		*	*	*			1			*	
LPZ-TBL	*		*	*	*			1			*	
LPZ-CLc	1				1							
CYCLDECNOV	1				1							
ZOD	2				2							
LPZ-TBL	1				1							
JSM	2				2							
LPZ-EXPL	1				1							

Vatican, BAV, Pal. lat. 485, fols. 4r and 4v: Independent objects

	MS/1	MS/2	MS/3 I	MS/3 II	MS/4	MS/7 I	MS/7 II	MS/37	MS/88 I	MS/88 II	MS/89	MS/247
CYCLDECNOV	1 2	1 2	1 2	1 2	1 2			1			1 2	
ZOD	2		2	2	2			2			2	
LPZ-TBL	1		1	1	1						2	
JSM	1 2 4 5 6 7	1 8	1	1 2 4 5 7	1 2 4 6 7 8	7 8				7 8	1 3 4 5	1 4 5
LPZ-EXPL	1				1							

Vatican, BAV, Pal. lat. 485, fol. 4v: Clusters

	MS/1	MS/2	MS/3 I	MS/3 II	MS/4	MS/7 I	MS/7 II	MS/37	MS/88 I	MS/88 II	MS/89	MS/247
BIS-CLa	1											
BIS-INTERCALATION	1											
BIS-INCREASE	1											
SAL	1	2		2							2	2
SLC	1	1		1							1	1
SLA	1	2		2							2	2
SLS	1	1		1							1	1
NAN-CLa	1	*	1	*	1	*						
RPA	1	*	1	*	1	*						
NAN	1	*	1	*	1	*						
NAN-CLb		1		1		1						
RPA		1		1		1						
TER-PAS		1		1		1						
NAN		1		1		1						

Vatican, BAV, Pal. lat. 485, fol. 4v: Independent objects

	MS/1	MS/2	MS/3 I	MS/3 II	MS/4	MS/7 I	MS/7 II	MS/37	MS/88 I	MS/88 II	MS/89	MS/247
BIS-FEBMARPAS	1			2				3			2	
BIS-INTERCALATION	1										1	1 2
BIS-INCREASE	1	3		3							2	2
SLC	1	1		1							1	1
SLA	1	2		2							2	2
SLS	1	1		1							1	1
RPA	1	1	1	1	1	1				1		
NAN	1	1	1	1	1	1						

Vatican, BAV, Pal. lat. 485, fol. 5r: Clusters

	MS/1	MS/2	MS/3 I	MS/3 II	MS/4	MS/7 I	MS/7 II	MS/37	MS/88 I	MS/88 II	MS/89	MS/247
LKL-CLc	*	2	1	2							*	
JSM	*	1	1	1							*	
CYCLDECNOV	*	2	2	2							*	
LKL-TBL	*	1	1	1							*	
EMM	*	2	1	2							*	
LKL-CLd	1										*	
JSM	1										*	
CYCOLDECNOV	2										*	
EP-XI-KLAPR	1										*	
LKL-TBL	1										*	
EMM	1										*	
PDA	1										*	
LKL-CLe											1	
JSM											1	
CYCOLDECNOV											2	
EP-XI-KLAPR											1	
LKL-TBL											1	
RLR											1	
EMM											1	
PDA											1	
LKL-CLf					1							
JSM					1							
CYCOLDECNOV					2							
EP-XI-KLAPR					1							
LKL-TBL					1							
RLR					1							
PDA					1							

Vatican, BAV, Pal. lat. 485, fol. 5r: Independent objects

	MS/1	MS/2	MS/3 I	MS/3 II	MS/4	MS/7 I	MS/7 II	MS/37	MS/88 I	MS/88 II	MS/89	MS/247
JSM	1 2 4 5 6 7	1 8	1	1 2 4 5 7	1 2 4 6 7 8	7 8				7 8	1 3 4 5	1 4 5
CYCOLDECNOV	1 2	1 2	1 2	1 2	1 2			1			1 2	
EP-XI-KLAPR	1	2	2		1	1				1	1	
LKL-TBL	1	1	1	1	1						1	
EMM	1	2	2	1	1			3			1	
PDA	1			1	1						3 1	2

Vatican, BAV, Pal. lat. 485, fol. 5v: Clusters

	MS/1	MS/2	MS/3 I	MS/3 II	MS/4	MS/7 I	MS/7 II	MS/37	MS/88 I	MS/88 II	MS/89	MS/247
FERIAKL-CLa	1			*	*						*	
JSM	4			*	*						*	
CYCLSOL	1			*	*						*	
CC	1			*	*						*	
FERIAKL-TBL	1			*	*						*	
FERIAKL-EXPL	1			*	*						*	
FERIAKL-CLb				1	2						1	
JSM				4	4						4	
CYCLSOL				1	1						1	
CC				1	1						1	
FERIAKL-TBL				1	1						1	
RFE				1	1						1	
FERIAKL-EXPL				1	3						1	

Vatican, BAV, Pal. lat. 485, fol. 5v: Independent objects

	MS/1	MS/2	MS/3 I	MS/3 II	MS/4	MS/7 I	MS/7 II	MS/37	MS/88 I	MS/88 II	MS/89	MS/247
JSM	1 2 4 5 6 7	1	1	1 2 4 5 7	1 2 4 6 7 8	7 8				7 8	1 3 4 5	1 4 5
CYCLSOL	1			1	1						1	
CC	1	2	2	1 3	1	1				5	4 1	4 1
FERIAKL-TBL	1			1	1						1	
RFE				1	1						1	
FERIA-EXPL	1 2			1	3						1	2

Fols. 6r-11v: Calendars

Based on the structural elements of the calendars in the regional codex units (see appendix 4), a distinction can be made between four kinds of calendars:

	MS/1	MS/2	MS/3 I	MS/3 II	MS/4	MS/7 I	MS/7 II	MS/37	MS/88 I	MS/88 II	MS/89	MS/247
JSC-a	1				1						1	
JSC-b				1				1				
JSC-c		1	1									
JSC-d										1		

Vatican, BAV, Pal. lat. 485, fol. 12r: Clusters

	MS/1	MS/2	MS/3 I	MS/3 II	MS/4	MS/7 I	MS/7 II	MS/37	MS/88 I	MS/88 II	MS/89	MS/247
TER-CLa	1				1							
RPA	1				1							
TER-QUA	1				1							
TER-PAS	1				1							
TER-ROG	1				1							
TER-PEN	1				1							
CC	1				1							

Vatican, BAV, Pal. lat. 485, fol. 12r: Independent objects

	MS/1	MS/2	MS/3 I	MS/3 II	MS/4	MS/7 I	MS/7 II	MS/37	MS/88 I	MS/88 II	MS/89	MS/247
ANN-SOL	1	3		2	2			4	2		2	
RPA	1	1	1	1	1					1		
TER-QUA	1	1	1		1	1				1		
TER-PAS	1	2	2	2 1	2 1	1				1	2	1
TER-ROG				1	1	1				1		
TER-PEN	1			1								
CC	1	2	2	1 3	1	1				5	4 1	4 1
PAS-TERMINI	1										2	3 2

Vatican, BAV, Pal. lat. 485, fol. 12v: Clusters

	MS/1	MS/2	MS/3 I	MS/3 II	MS/4	MS/7 I	MS/7 II	MS/37	MS/88 I	MS/88 II	MS/89	MS/247
REGULARES-CLa	1			1							1	1
RFRE	1			1							1	1
FERIAKL-EXPL	2			2							2	2
RLRE	1			1							1	1
RFRE	1			1							1	1
RFR-CLa	1			1							1	1
RFE-CLa	1			1							1	1
RLRE	1			1							1	1
RLR-CLa	2			2							2	2
RLE-CLa	2			2							2	2
RFR-CLa	1			1	2						1	1
JSM	6			6	1						6	6
RFR	1			1	3						1	1
RFE-CLa	1 2			1 2	2	2				2	1	1
JSM	4 7			4 7	7	7				7	4	4
RFE	1 1			1 1	1	1				1	1	1
RLR-CLa	2 1			2	1						2	2
JSM	1 6			1	6						1	1
RLR	2 1			2	1						2	2
RLE-CLa	2	1		2	1	1				1	2	2
JSM	5	8		5	8	8				8	5	5
RLE	2	1		2	1	1				1	2	2

Vatican, BAV, Pal. lat. 485, fol. 12v: Independent objects

	MS/1	MS/2	MS/3 I	MS/3 II	MS/4	MS/7 I	MS/7 II	MS/37	MS/88 I	MS/88 II	MS/89	MS/247
DIE	1	2			1	2		3	3			2
JSM	1 2 4 5 6 7	1	1	1 2 4 5 7	1 2 4 6 7 8	7 8				7 8	1 3 4 5	1 4 5
RFR	1		3	3 1	2	4		3			1	3 1
RFE	1 2			1 2	1 2	1				2	1	1
FERIAKL-EXPL	1 2			1 2	3						1 2	2
RLR	1 2	4	4	2 4	1 2	3		4			2	2
RLE	2	1		2	1	1				1	2	2
HOR	1											

Vatican, BAV, Pal. lat. 485, fol. 13r: Clusters

	MS/1	MS/2	MS/3 I	MS/3 II	MS/4	MS/7 I	MS/7 II	MS/37	MS/88 I	MS/88 II	MS/89	MS/247
ERLR	1				1							
EP-XIKLAPR	1				1							
JSM	6				6							
RLR	1				1 2							
ERLE		1				1				1		
EP-XIKLAPR		3				3				3		
JSM		8				8				8		
RLE		1				1				1		
CRFE	1	2		3	1					4		
CC	1	2		3	1					5		
JSM	7	2		7	7					7		
RFE	2	7		2	2					2		
CC-RPA	1			1								
CC	1			1								
RPA	1			1								

Vatican, BAV, Pal. lat. 485, fol. 13r: Independent objects

	MS/1	MS/2	MS/3 I	MS/3 II	MS/4	MS/7 I	MS/7 II	MS/37	MS/88 I	MS/88 II	MS/89	MS/247
EP-XIKLAPR	1	2	2		1	1				1	1	
JSM	1 2 4 5 6 7	1	1	1 2 4 5 7	1 2 4 6 7 8	7 8				7 8	1 3 4 5	1 4 5
RLR	1 2	4	4	2 4	1 2	3		4			2	2
CC	1	2	2	1 3	1	1				5	4 1	4 1
RFE	1 2			1 2	1 2	1				2	1	1
RPA	1	1	1	1	1	1				1		
TER-PAS	1	2	2	2 1	2 1	1				1	2	1
TER-PEN	1				1							

Appendix 4. Structural elements of calendars

The following table represents the structure of the calendars within the regional codicological units.[529] The number of each calendar series within Jones' appendix are mentioned in the first column. Additional structural elements have been assigned a letter. Underneath the name of each calendar its structural elements are marked by the number of their order of appearance, counting from left to right and bottom to top.

	Structural element	**JSC-a**	**JSC-b**	**JSC-c**	**JSC-d**
1	Golden numbers, 1-19. Indicates the year in a 19-year lunar cycle.				
2	Series A-O, skipping one line.	4	7	8	
3	Lunar letter series / *litterae punctatae*, A-U, A.-U., .A-.T.	6	9	7	4
4	Dominical letter series, A-G.			9	3
5	Days of the month by Kalends, Nones and Ides.	7	10	10	5
6	Series AEIOU, skipping one line.				
7	Series A-K, skipping two lines.				
8	Series A-P, skipping one line.				
9	Series A-U, skipping two lines.				
10	Concurrents, I-VII.	5	8		
11	Series A-U, A.-I., skipping one line.				
12	Golden numbers in Greek letters.				
A	Roman solar regulars		3	3	
B	Egyptian solar regulars				
C	Roman lunar regulars		4	4	
D	Egyptian lunar regulars				
E	Zodiac signs	1	2	2	1
F	Length of solar month	2	5	5	2
G	Length of lunar month	3	6	6	
H	Hours of the night	8	11	11	
I	Hours of the day	9	12	12	
J	Greek month		1	1	

[529] Charles W. Jones, "Bedae Pseudepigrapha (with indices)" in *Bede, the Schools and the Computus*, ed. Wesley M. Stevens (Aldershot: Variorum, 1994), 108-110.

Appendix 5. Computistical classes and computistical works

Pal lat. 485	De temporibus (AD 703)[530]	De temporum ratione (AD 725)[531]	Lect. comp. (AD 760/792)[532]	Comp. rhen. (AD 775)[533]	Lib. ann. (AD 793)[534]	Lib. comp. (AD 809)[535]	Lib. calc. (AD 818)[536]
LPZ-CLa		19				I 2	4
LPZ-EXPL		19					
BIS-FEBMARPAS		41[537]		32	48		
BIS-INTERCALATION							
BIS-INCREASE				40	5	III 10 B	
SAL	12	42		41a-c	50		
SLC	12			41a	50		
SLA		42		41b	50		
SLS		42		41c	50		
NAN-CLa					32		7 A
RPA			I 13		32		7 A
NAN			6		32		7 A
LKL-CLd		20				IV 1 A	9
EP-XIKLPAS		50	I 7		13	II 15; IV 1 C	9; 16 A
EMM		23				I 2 D	9
LKL-TBL							
PDA		20		46		IV 12	10
FERIAKL-CLa							
CC		53-54	I 1 A-B	44		I 1; II 15 A	6 A; 7 E; 16 A
FERIAKL-TBL							
FERIAKL-EXPL		51		43			
JSC-a							
ANN-SOL					64		
TER-CLa							7 C
TER-QUA						II 21	7 B
TER-PAS			I 13		32	II 21	7 A
TER-ROG			I 14				7 C
TER-PEN							7 D
PAS-TERMINI			6 C	29	37	IV 18 D	55 D
DIE			I 9 A			II 14	
RFRE		21		42a-b			
RFR-CLa		21	I 3 A-B	42a			
RFE-CLa		21	I 3 B-C; II 2	42b		II 15 B	16 A
FERIAKL-EXPL		51		43			
RLRE		20	I 4	45a-b			
RLR-CLa		20	I 4 B	45a			
RLE-CLa		20	I 4 A; II 3	45b		II 15 C	16 C

[530] See DT and OT.
[531] See DTR and TROT.
[532] *Schriften* 2, 527-659.
[533] Lacking an edition, the numbering of the chapters of the *Computus rhenanus* is my own.
[534] *Schriften* 2, 660-772.
[535] *Schriften* 3, 1054-1334.
[536] *Schriften* 3, 1367-1454.
[537] Interestingly, an object belonging to this class was usually attached to the ending of pseudo-Bede/Philippus *De ordinatione feriarum paschalium* in manuscripts from Cologne, e.g. MS/89, fols. 190v-192v. See Bruno Johann Krusch, *Studien zur christlich-mittelalterlichen Chronologie: Der 84jährige Ostercyclus und seine Quellen* (Leipzig: Verlag von Veit & Comp., 1880), 303-310. In turn, this text was an important source for DTR ch. 42. See Charles W. Jones, "Bedae Pseudepigrapha (with indices)", in *Bede, the Schools and the Computus*, edited by Wesley M. Stevens (Aldershot: Variorum, 1994), 44-45.

Pal lat. 485	De temporibus (AD 703)[530]	De temporum ratione (AD 725)[531]	Lect. comp. (AD 760/792)[532]	Comp. rhen. (AD 775)[533]	Lib. ann. (AD 793)[534]	Lib. comp. (AD 809)[535]	Lib. calc. (AD 818)[536]
ERLE		20				II 15	16 A
CRFE		21					
CC-RPA							
JSC		19; 23					

Appendix 6. Regional codex units and Borst's *Schriften*[538]

	Quaest. Austr. (AD 764)[539]	**Quaest. Langob. (ca. AD 780)**[540]	**Add. Col. (AD 798)**[541]	**Lect. comp. (AD 760/792)**[542]	**Lib. ann. (AD 793)**[543]	**Comp. Col. (AD 805)**[544]	**Ser. Ant. (AD 809)**[545]	**Lib. comp. (AD 809)**[546]	**Lib. calc. (AD 818)**[547]
	I 1-13 II 1-11	1-7	I 1-9 II 1-3	I 1-16 II 1-10 III 1-6 IIII 1-7 V 1-12 VI 1-9a VII 1-6 VIII 1-12a VIIII 1-9a	I-70	I 1-2 II 1-5 III 1-9 IIII 1-10 V 1-13 VI 1-8	1-8a	I 1-11 II 1-22 III 1-14 IIII 1-27 V 1-12 VI 1-VII VII 1	I-CXI
MS/2				I 3 I 1 I 4 I 7 I 9 I 11 I 6 I 5 III 1-2 III 5 IIII 1-2 IIII 5-6 IIII 3-4 IIII 7 V 5 VII 2	49 64 32 14 69a 69b 69c 19 50 56-67 36 5 65 42 11 33 12 12a 30 68a 70			II 15 I 2 IIII 1 III 1 V 7 V 9 V 8 II 14 II 18 II 20 II 19 II 13 IIII 18 IIII 17 I 9d	

[538] Note that MS/1, MS/7 I, and MS/7 II are not included in Borst's *Schriften*.
[539] *Schriften* 1, 462-508.
[540] *Schriften* 1, 509-526.
[541] *Schriften* 2, 773-795.
[542] *Schriften* 2, 527-659.
[543] *Schriften* 2, 660-772.
[544] *Schriften* 2, 885-950.
[545] *Schriften* 2, 1009-1020.
[546] *Schriften* 3, 1054-1334.
[547] *Schriften* 3, 1367-1454.

	Quaest. Austr. (AD 764) I 1-13 II 1-11	**Quaest. Langob. (ca. AD 780)** 1-7	**Add. Col. (AD 798)** I 1-9 II 1-3	**Lect. comp. (AD 760/792)** I 1-16 II 1-11 III 1-6 IIII 1-7 V 1-12 VI 1-9a VII 1-6 VIII 1-12a VIIII 1-9a	**Lib. ann. (AD 793)** I-70	**Comp. Col. (AD 805)** I 1-2 II 1-5 III 1-9 IIII 1-10 V 1-13 VI 1-8	**Ser. Ant. (AD 809)** 1-8a	**Lib. comp. (AD 809)** I 1-11 II 1-22 III 1-14 IIII 1-27 V 1-12 VI 1-VII VII 1	**Lib. calc. (AD 818)** I-CXI
MS/3 I					36 32 61 60 65		1-6 7a		
MS/3 II				I 7 VI 2 IIII 4 IIII 1-2 IIII 5-6 IIII 3 I 3 I 1 I 4 I 11	(65) 69 47a 55 63 (36) 48-49 64 50 56-57 14 52 51 (32) 5 62 69a 69b 69c (17) (43) 19 2 6 24 29-31 25 8-12 3 15-16 40-43 17-18 44-47 54			I 1-2 IIII 1 I 6 IIII 19-20 II 1 I 3-6 IIII 8 II 16-17 II 7-12 (IIII 20) V 13a	52 59 10 28-29
MS/4				I 9 I 7 I 4 I 1 I 3 I 12-14 I 11 I 5-6 VI 2	64 56 32 14 19 65			IIII 1 I 2 I 4 V 13a	

	Quaest. Austr. (AD 764) I 1-13 II 1-11	**Quaest. Langob. (ca. AD 780)** 1-7	**Add. Col. (AD 798)** I 1-9 II 1-3	**Lect. comp. (AD 760/792)** I 1-16 II 1-11 III 1-6 IIII 1-7 V 1-12 VI 1-9a VII 1-6 VIII 1-12a VIIII 1-9a	**Lib. ann. (AD 793)** I-70	**Comp. Col. (AD 805)** I 1-2 II 1-5 III 1-9 IIII 1-10 V 1-13 VI 1-8	**Ser. Ant. (AD 809)** 1-8a	**Lib. comp. (AD 809)** I 1-11 II 1-22 III 1-14 IIII 1-27 V 1-12 VI 1-VII VII 1	**Lib. calc. (AD 818)** I-CXI
MS/37					48 64 36			V 6a 10 I 2 B V 2 C-D II 14 I 2 A V 1-2 A	
MS/88 I			I 1-9 II 1-3						
MS/88 II	I 1-13 II 1-11	1-3		I 1-15 II 1-3 II 5-11 III 1-6 IIII 1-7 V 1-10 V 11a-12a VI 1-7 VI 8a-9a VII 1-6 VIII 1-11 VIII 12a VIIII 1a VIIII 2-7 VIIII 8a-9a		I 1-2 II 1-5 III 1-9 IIII 1-10 V 1-13 VI 1-8			
MS/89				III 1-3 IIII 2 IIII 6 IIII 5 (IIII 2) IIII 3 (IIII 5-6) I 3 I 1 I 4	64 19 65 33-35 37 58-59 38 56-57 47a 5 50 55 36 48			I 2 IIII 1 I 4 V 13a IIII 19 IIII 26 IIII 18 II 7 III 1	

	Quaest. Austr. (AD 764) I 1-13 II 1-11	**Quaest. Langob. (ca. AD 780)** 1-7	**Add. Col. (AD 798)** I 1-9 II 1-3	**Lect. comp. (AD 760/792)** I 1-16 II 1-10 III 1-6 IIII 1-7 V 1-12 VI 1-9a VII 1-6 VIII 1-12a VIIII 1-9a	**Lib. ann. (AD 793)** I-70	**Comp. Col. (AD 805)** I 1-2 II 1-5 III 1-9 IIII 1-10 V 1-13 VI 1-8	**Ser. Ant. (AD 809)** 1-8a	**Lib. comp. (AD 809)** I 1-11 II 1-22 III 1-14 IIII 1-27 V 1-12 VI 1-VII VII 1	**Lib. calc. (AD 818)** I-CXI
MS/91				III 1 III 3 III 2 IIII 4 IIII 1-3 I 8 IIII 7 (IIII 1-2) I 9 I 11 I 5-6 (III 3, 2) I 3-4 I I I 7 I 12-13 V 1 (IIII 5) IIII 5 (IIII 1-2) (IIII 4) (III 3)	68a (42) (37) (58-59) (38) (17) 1-2 6 24 29-31 25 8-12 3 15-16 40-43 17-18 44-47 54 19 33-35 37 58-59 38 56-57 47a 5 50 55 52 62 69a 69b 69c 65				

Appendix 7. Significantly overlapping works, objects, and clusters

This appendix is based on a study of the available digital manuscript facsimiles and manuscript descriptions.[548]

* complete
\+ complete, with additions
/ partial
v versified

	MS/1	MS/2	MS/3 I	MS/3 II	MS/4	MS/7 I	MS/7 II	MS/37	MS/88 I	MS/88 II	MS/89	MS/247
Bede, DTR			/	/ v	*			*		/	*	
Bede, DT		+	+	/	*						*	
Bede, DNR					*						*	
Bede, *Ex Bedae Computo*												
Bede, letter to Wicthed					*						*	
Ps.-Alcuin, *Calculatio Albini magistri*		*		*	*						*	*
Charlemagne, letter to Alcuin					*							
Isidore, DNR			*				*			*		
Dionysius Exiguus, letter to Boniface		*			*					*		
Dionysius Exiguus, *Argumenta paschalia Aegyptiorum*		*	*									
ET-DIONEXIG8COL (AD 532-1063)					*						*	
ET-DIONEXIG8COL (AD 779-797)				*								
ET-DIONEXIG8COL (AD 836-1006)						*						
ET-DIONEXIG14COL (AD 798-854)		*	*									
ET-MIXED19COL (AD 798-911)										*		

[548] See the corresponding manuscript entries on http://www.computus.lat or visit http://bibliotheca-laureshamensis-digital.de, http://www.ceec.uni-koeln.de, http://dbs.hab.de, and http://digi.ub.uni-heidelberg.de for the available digital manuscript facsimiles and manuscript descriptions. The manuscripts descriptions and bibliographies of MS/1, MS/2, MS/3, MS/4, and MS/37 by Michael Kautz are only available on the website of the Digital Bibliotheca Laureshamensis. Printed copies of the manuscript descriptions of MS/1, MS/2, MS/3, MS/4, MS/88, MS/89 and Wolfenbüttel 91 are available in Philipp Jaffé and Wilhelm Wattenbach, *Ecclesiae metropolitanae Coloniensis codices manuscripti* (Berlin: 1874), MS/88: 29-31 and MS/89: 40-42; Keefe, *Water*, MS/1: 100-103; Keefe, *A catalogue of works pertaining to the explanation of the creed in Carolingian manuscripts*, MS/1: 360; Ludwig Schuba, *Die Quadriviums-Handschriften der Codices Palatini Latini in der Vatikanischen Bibliothek* (Weisbaden: Reichert, 1992), MS/2, MS/3, and MS/4: 257-269; Springsfeld, *Einfluß*, MS/89: 8; MS/4 and MS/3: 83-85; Hans Butzmann, *Die Weissenburger Handschriften*, Kataloge der Herzog August Bibliothek Wolfenbüttel: Neue Reihe (Frankfurt am Main: Klostermann, 1964), MS/247: 257-268.

	MS/1	MS/2	MS/3 I	MS/3 II	MS/4	MS/7 I	MS/7 II	MS/37	MS/88 I	MS/88 II	MS/89	MS/247
JSC-a	*				*						*	
JSC-b				*				*				
JSC-c		*	*									
JSC-d										*		
Computus rhenanus	/			/							*	*
Sphere of Pythagoras **(prognostics)**					*					*		
Lunationes Danielis **(prognostics)**	*				*							

Appendix 8. Structural elements of Easter tables

The following table displays the structural elements of the different formats of the Easter tables encountered in the regional codex units. The numbers in the table represent the order of the columns in each format. Note that this appendix and my count of the total number of columns of each format (8, 14, and 19) excludes auxiliary columns without a heading.

	ET-DIONEXIG8COL	ET-DIONEXIG14COL	ET-MIXED19COL
Year AM			1
Year AD	1	1	2
Weekday of 1 January		2	16
Age of the Moon on 1 January		3	17
Indiction	2	4	3
Date for the *terminus quadragesimae*		5	
Date of the *initium quadragesimae*		6	9
Age of the Moon on the *initium quadragesimae*		7	10
Epacts	3	8	5
Concurrents	4	9	4
Year of the *cyclus solaris*			13
Year of the *cyclus lunaris*	5	10	14
Year of the *cyclus decemnovenalis*			15
Date of the *terminus paschalis*	6	11	6
Weekday of the *terminus paschalis*		12	
Date of Easter Sunday	7	13	7
Age of the Moon on Easter Sunday	8	14	8
Date for *rogationes*			11
Age of the Moon on *rogationes*			12
Year of the Spanish Era			18
Beginning of the First Month			19

Appendix 9. Roman solar regulars in the regional codex units

The following table provides an overview of the different representations of the Roman solar regulars in the regional codex units and their characteristics.

Codex unit	Foliation	January	February	Context
MS/1	12v	III	VI	Horizontal table; *Computus rhenanus*, ch. 43.
MS/2	12r-17v	III	VI	Calendar.
MS/3 I	6r-11v	III	VI	Calendar.
MS/3 I	52r	III	VI	DTR. ch. 21.
MS/3 II	63r-68v	III	VI	Calendar.
MS/3 II	101r	III	VI	Horizontal table; *Computus rhenanus*, ch. 43.
MS/4	9v	II	V	Vertical table.
MS/4	60v	II	V	DTR, ch. 21.
MS/7 I	34r-35v	III	VI	Addition to Isidore's *De natura rerum,* chs. 4-5.
MS/37	1r-11r	II	V	Calendar.
MS/37	45v	II	V	DTR, ch. 21.
MS/89	87v	II	V	DTR, ch. 21.
MS/89	189v	II	V	Horizontal table; *Computus rhenanus*, ch. 43.
MS/247	173r	III	VI	Horizontal table; *Computus rhenanus*, ch. 43.

Appendix 10. Glossary of computistical terms

The following list of definitions is designed to define and explain the technical terminology used in the present study.

Sources

In the context of a glossary, clarity and correctness transcend the importance of originality. Moreover, technical and mathematical concepts can only be described in a small number of ways. Hence, the following definitions and explanations derive, by and large, from earlier descriptions. Although I have tried to reformulate the given explanations and definitions in my own words, they should be regarded as restructured and abbreviated versions of existing descriptions by other scholars, adapted to the context of Carolingian computus. In particular, the 'Basic computistical glossary' in Immo Warntjes' *Munich Computus* was essential for the creation of the present list of definitions and explanations.[549]

Simplified descriptions

I have consciously restricted the scope of this glossary to the technical details that are strictly necessary for a basic understanding of the computistical terms and frameworks which are discussed in the present study, resulting in somewhat simplified descriptions.

[549] Warntjes, *Munich Computus*, 341-353. Other glossaries and explanations of computistical terms and are available in Grotefend, *Taschenbusch der Zeitrechnung des deutschen Mittelalters und der Neuzeit*, esp. 1-11; Springsfeld, *Einfluß*, 35-38; Faith Wallis, *Bede: The Reckoning of Time*, vol. 29, Translated Texts for Historians (Liverpool: Liverpool University Press, 1999), 427-429.

Structure and use

The structure of this glossary is based on the following principles. All relevant English technical terms, their synonyms, and – if relevant – their Latin equivalents, are listed in alphabetical order. However, most entries provide a cross reference to another entry, for the explanations and definitions are usually elaborated in the context of thematical groups. As a result, the following glossary can be read in an alphabetical and a thematical way.

Concepts as parameters

To find classes and objects in Pal. lat. 485 and the regional codex units using particular computistical concepts as parameters, see the digital tool which I've created especially for this purpose: http://computus.lat/objects/params.

---

age of the Moon: see lunar age.

***annus*:** see year.

Ascension Day: see moveable feasts.

approximations: see computus.

autumnal equinox: see equinox.

bissextile day: see day.

bissextile lunar year: see year → lunar.

bissextile solar year: see year → solar.

calendar: see Julian solar calendar.

calendrical lunar month: see month → lunar.

calendar science: see computus.

common lunar year: see year → lunar.

common solar year: see year → solar.

computus (calendar science, reckoning of time): Computus is the medieval body of knowledge or science of Christian time reckoning, dealing with the creation of calendars, the calculation of the dates of liturgical feasts, and the unfolding of salvation-history. A work, section, or manuscript concerning medieval calendar science is sometimes named a computus.

- **approximations:** The medieval reckoning of time was, in essence, a system of arithmetical approximations, aimed to correspond with astronomical reality. By definition, approximations differ from more precise numbers. In practice, the resulting deviations increase whenever approximations are used to predict astronomical data in advance for extended periods of time. Moreover, calculations with fractions and irrational numbers posed difficulties for the scholars of medieval computus. Therefore, rational approximations (29,5306 ≈ 29,5) or even integer approximations (29,5 ≈

alternations of 29 and 30) were preferred, rather than the use of precise numbers. Yet, medieval scholars were also aware that the excess should be accounted for using all sorts of computistical devices, compensating for deviations between the performed calculations and astronomical reality. The most fundamental approximations used by medieval computists concern the lengths of the solar year (365,2422 days ≈ 365,25 days) and the synodic lunar month (29,5306 days ≈ 29,5 days).

- **Easter reckoning (Paschal reckoning):** In early medieval calendar science, different Easter reckonings were followed in the Carolingian empire.
    - **Dionysian:** The Dionysian Easter reckoning was a Latin translation of the Alexandrian system, which was composed in Greek, by Dionysius Exiguus in AD 525. Dionysius' translation aimed to make the Alexandrian reckoning of time available in the Latin West. The Dionysian Paschal reckoning was based on a regularized 19-year lunar cycle, known as the *cyclus decemnovenalis.* During the eighth century, the Dionysian reckoning of time became the dominant computistical traditions in the Carolingian empire.

        In the Dionysian Easter reckoning the limits for the age of the Moon of Easter Sunday were *luna* 15 to 21 inclusively. The acceptable Julian calendar dates for Easter ranged from 22 March to 25 April, while the earliest date for the Easter full Moon was the vernal equinox of 21 March. The original Alexandrian Easter table consisted of 95-years (19*5=95) and would eventually be extended to an Easter cycle of 532-years (19*28=532). Dionysius defined each year by the year AD.
    - **Victorian:** The Victorian Easter reckoning, devised by Victorius of Aquitaine in AD 457, was based on a 19-year lunar cycle, and consisted of a full Easter

cycle of 532 years. During the Council of Orléans in AD 541, the Victorian reckoning of time became the established tradition in the Frankish kingdom.

In the Victorian Easter reckoning, the limits for the age of the Moon on Easter Sunday were *luna* 16 to 22 inclusively. The Julian calendar limits for an acceptable Easter date ranged from 22 March to 24 April inclusively, while the Easter full Moon was allowed to fall as early as 20 March, one day before the vernal equinox. In years with *luna* 22 on Easter Sunday, Victorius left the choice for the right date of Easter to the pope, noting two Julian calendar dates for Easter Sunday by suggesting the 'Greek' alternative *luna* 15 to the 'Roman' *luna* 22. Victorius defined each year by the names of two Roman consuls appointed for those years and by the lunar and weekday data of 1 January, and consecutively numbering the years from the first year, the year of the passion of Christ.

- **parameters:** Like mathematical formulas, computations performed in the context of medieval calendar science involved a range of parameters, which determine the output of a calculation. Common examples of such parameters are the year AD, the concurrents, solar regulars, epacts, or lunar regulars. On a more general level, a valid date for Easter depended on three fundamental parameters, for Easter was celebrated on the first Sunday after the first full Moon after the vernal equinox. Hence, the calculation of a date for Easter amounted to a detailed coordination of the lunar cycle, the solar cycle, and the weekday cycle.

concurrents: The concurrents can be defined as a list of Roman numerals, representing the weekday on March 24, which was first introduced as a column in Dionysian Easter tables.

Because the weekday data recurs every 28 years, the concurrents are often listed separately for every year of the 28-year solar cycle.

The concurrents can be used in three different computations. Used in calculations with the solar regulars, the concurrents can be used to compute the weekday of the Kalends of any month of the Julian solar calendar for any year of the 28-year solar cycle. Used in calculations with the *regulares minores* or the *regulares pasche*, the concurrents can be used to compute the weekday of the Easter full Moon.

In general, the weekday of the Kalends of any month in the Julian solar calendar can be calculated by adding the concurrent of that particular year in the 28-year solar cycle to the solar regular of the corresponding month. Because there are no more than 7 weekdays, a modulo operation has to be performed. In other words, find the remainder after division of the result by 7. The remainder represents the weekday of the Kalends of the particular month: 1 = Sunday; 2 = Monday; 3 = Tuesday; 4 = Wednesday; 5 = Thursday; 6 = Friday; 7 = Saturday.

counting: In general, Roman computists counted and calculated inclusively. However, some calculations were performed by counting and calculating exclusively, like we are used to do in modern times.

- **inclusive and exclusive:** The difference between inclusive and exclusive counting is best understood using the difference between cardinal and ordinal numbers. Counting from 1–3, we produce the following array of cardinal numbers: 1, 2, and 3. Which of these numbers is the second ordinal number after the cardinal number 1? Counting inclusively – including 1 as you count – the 1st number after 1 is 1 itself, whereas the 2nd number is 2. Counting exclusively – excluding 1 as you count – the 1st number after 1 is 2, whereas the 2nd number after the number 1 is 3. In other words, the

difference between inclusive and exclusive counting comes down to whether you consider 1 to be 1st (inclusive) or the 0st (exclusive) number in an array of 1, 2 and 3.

As a result, the 1st day after Sunday is Monday in exclusive reckonings of time, whereas Monday is the 2nd day after Sunday in inclusive reckonings of time. Moreover, using the marker-days of the Julian solar days, the 2nd day before the Kalends of February is 31 January inclusively or 30 January exclusively.

cycle: Cycles of a particular number of years, making full use of the recurrence of solar and/or lunar data, were the most important arithmetical devices constructed by early medieval computists.

- ***cyclus decemnovenalis*:** As in most other computistical traditions, the point of departure of the Dionysian reckoning of time was a 19-year lunar cycle. To be specific, this *cyclus decemnovenalis* was a regularized lunar cycle, for it was set to a specific order and beginning, namely the equivalent of epact 30 on 22 March in the year BC 1 and every 19th year thereafter. Note, however, that Carolingian computists began the solar year on 1 January, due to their use of the Julian solar calendar. As a consequence, the beginning of the *cyclus decemnovenalis* was shifted to a calendar date approximately eight months later than Dionysius originally envisaged, which resulted in differing computistical practices.
    - **embolismic lunar months (embolisms) and the *saltus lunae* (leap of the moon):** The correspondence of the computed *cyclus decemnovenalis* with the astronomical lunar months was maintained using several computistical devices, known as embolismic lunars months and the *saltus lunae*. The necessity of these devices derived from the deviating lengths of the solar year (365,25 days) and the lunar year (354,25 days), and the difference

between the employed approximate length of the synodic lunar month (29,5 days) and its actual length (29,5306 days). After a cycle of 19 years, the effect of these deviations increased to a difference of 209 days. On the one hand, 19 solar years of the Julian solar calendar consisted of 6939,75 days. On the other hand, 19 lunar years of 354,25 days consisted of only 6730,75 days.

To compensate for the difference of 209 days, 7 embolismic lunar months of 30 days were implemented during the 3rd, 6th, 8th, 11th, 14th, 17th, and 19th year of the *cyclus decemnovenalis*, resulting in a cycle of 6940,75 days. Note that this system of embolismic lunar months provided a single day too many compared to 19 solar years of a total of 6939,75 days. Therefore, one day was subtracted during the course of this cycle: the so-called *saltus lunae* or leap of the Moon. During the Carolingian period, the subtraction of the *saltus* lunae was generally accomplished by reducing a full lunar month to a hollow lunar month during the final year of the *cyclus decemnovenalis* in July or November. Together, the implementation of seven embolismic lunar months and the subtraction of the leap of the Moon resulted in a correct coordination of the solar cycle and the lunar cycle (6730,75 + 7 * 30 - 1= 6939,75)

- **Easter:** The Easter cycle is a luni-solar cycle, which provides a recurring cycle of weekdays and lunar dates on any given Julian calendar date, including the dates for Easter. During the Carolingian era, a 532-year Easter cycle was generally used, combining the *cyclus decemnovenalis* with the 28-year solar cycle (19*28=532).
- **lunar:** Based on the notion of synodic lunar months, lunar cycles can be defined as a period in which a sequence of lunar ages recurs, corresponding to any Julian

calendar date. Carolingian computists used a regularized lunar cycle, known as the *cyclus decemnovenalis*.

- **luni-solar:** A luni-solar cycle can be defined as a period in which both the weekdays, the solar data, and the lunar data recur in the same order, corresponding to any given Julian calendar date. Carolingian computists generally used a 532-year luni-solar cycle, also known as an Easter cycle.
- **solar:** A solar cycle can be defined as a period in which the same sequence of weekdays recurs on any given Julian calendar date. In practice, this means that a solar cycle should accommodate the weekday increment of both common years (365=52*7+1) and bissextile years (366=52*7+2). Medieval computists used a solar cycle with a length of 28 years (7*4=28).
- **weekday:** The weekday cycle can be defined as a period of 7 weekdays, running from Sunday to Saturday.

***cyclus decemnovenalis*:** see cycle.

day (*dies)*: A day is usually defined as a period of 24 hours. In some contexts, the notion of a day refers to the period between sunrise and sunset.

- **bissextile (*dies bissextus,* leap day):** Carolingian computists used a solar and a lunar bissextile day.
    - **solar:** The length of a common solar year (365 days) differs from the approximate length of the solar year (365,25 days). To compensate for this deviation, a sum of four annual quarter-days, known as the bissextile day, is implemented in every fourth year of the Julian solar calendar. Note that Carolingian computists intercalated the bissextile day by doubling 24

February (the sixth day before the Kalends of March, therefore: *bis sextus*), rather than by adding a 29th day to the end of February.

- **lunar:** One of the main achievements in seventh-century calendar science was the realization that the bissextile day should also be applied to the lunar year, for the solar bissextile day extends the length of the calendrical lunar month ending in February. By the eight century, computists adhering to the Dionysian reckoning implemented a lunar bissextile at the end of the February lunation, turning this hollow lunation into a full one.

- **weekdays (*feria*, days of the week):** In medieval calendar science, the names of weekdays were defined by counting inclusively from Sunday to Saturday, resulting in the following cycle: *dominica* or *feria prima* (Sunday); *feria secunda* (Monday); *feria tertia* (Tuesday); *feria quarta* (Wednesday); *feria sexta* (Thursday); and *sabbatum* or *feria septima* (Saturday).
- **marker-days:** see Julian solar calendar.

dies: see day.

Easter: see moveable feasts.

Easter cycle: see cycle.

Easter full Moon: see moveable feasts → terms → Easter term.

Easter new Moon: see moveable feasts → Easter.

Easter parameters: see computus → parameters.

Easter reckoning: see computus.

Easter table: see moveable feasts → Easter.

Easter term: see moveable feasts → terms.

embolism: see cycle → *cyclus decemnovenalis*.

embolismic lunar month: see cycle → *cyclus decemnovenalis.*

embolismic lunar year: see year → lunar.

epacts (*epactae*): The epacts can be defined as a list of Roman numerals, representing the age of the Moon on March 22; the first possible Julian calendar date for Easter, according to the Dionysian and Victorian reckoning of time. The epacts are listed for every year of the *cyclus decemnovenalis*.

The epacts can be used in two different computations. Used in calculations with the lunar regulars, epacts provide the age of the Moon on the Kalends for each month of the Julian solar calendar for any year of the *cyclus decemnovenalis*. Used in calculations with the *regulares maiores*, the epacts can be used to calculate the day of the month of the Easter full Moon.

In general, the age of the Moon on the Kalends of any month in the Julian solar calendar can be calculated by adding the epact of that particular year in the *cyclus decemnovenalis* to the lunar regular of the corresponding month. Because the lunar age can be no more than 30,

perform a modulo operation. In other words, find the remainder after division of the result by 30. The remainder is the lunar age on the Kalends of that particular month.

equinox: The equinox can be defined as the day on which the Sun is positioned directly above the equator. As a result, day and night have an equal length on this particular day. The equinox occurs twice every solar year: the vernal equinox or spring equinox and the autumnal equinox. The Dionysian reckoning of time used 21 March as the date for the vernal equinox, which was essential for the calculation of a date for Easter.

exclusive counting: see counting.

***feria*:** see day → weekdays.

full lunar month: see month → lunar.

hollow lunar month: see month → lunar.

Holy Thursday: see moveable feasts → Ascension Day.

Ides: see Julian solar calendar → marker-days.

inclusive counting: see counting.

***initium quadragesimae*:** see moveable feasts.

Julian solar calendar: The Julian solar calendar is structured according to the length of a solar year. Each of the twelve solar months in the Julian solar calendar had three marker-days.[550]

- **marker-days:**
    - **Ides:** The Ides usually marks the 13th day of a solar month. There are four exceptions to this rule, for the Nones is placed on the 15th day in March, May, July, and October. The days preceding the Ides inclusively count backwards from this marker-day. Hence, *2 Ides* is the last day before the Ides, *3 Ides* is the second to last day before the Ides, et cetera.
    - **Kalends:** The Kalends refers to the first day of each solar month. The days preceding the Kalends inclusively count backwards from this marker-day. Hence, *2 Kalends* is the last day before the Kalends, *3 Kalends* is the second to last day before the Kalends, et cetera. Note that the days preceding the Kalends belong to the previous solar month. For instance, *2 Kalends* of February is the equivalent of 31 January.
    - **Nones:** The Nones marks the ninth day before the Ides in every solar month. Because the Ides is set on either the 13th or the 15th day, the Nones is placed on the 5th or the 7th day of a solar month. The days preceding the Nones inclusively count backwards from this marker-day. Hence, *2 Nones* is the last day before the Nones, *3 Nones* is the second to last day before the Nones, et cetera.

Kalends: see Julian solar calendar → marker-days.

[550] For the structural elements of Julian solar calendars in the regional codex units, see appendix 4.

leap day: see day → bissextile.

leap of the Moon: see cycle → *cyclus decemnovenalis*.

leap year: see year → solar → bissextile.

Lent: see moveable feasts → Quadragesima → period.

***litterae punctatae*:** The *litterae punctatae* are a computistical device used to establish the age of the Moon for any Julian calendar date. Originally, the table of *litterae punctatae* was created using repetitions of three alphabets (A-U, A.-U., and .A-.T), comprising one full and one hollow lunar month, and therefore 59 days. The letters of the first alphabet had no distinguishing mark, whereas the letters of the second were followed by a dot, and the letters of the third alphabet were preceded by a dot. The columns of the table corresponded to the years of the *cyclus decemnovenalis*. An abridged table circulated in the Carolingian period, providing only the letters that correspond to the first day of all hollow lunar months and full lunar months for each year of the *cyclus decemnovenalis*. Both the complete and the abridged table were intended to be used simultaneously with a column in a Julian solar calendar, which lists the *litterae punctatae*.[551]

lunar age (age of the Moon): The lunar age of a day or date in the Julian solar calendar is represented by a Roman numeral and refers to the day of the lunar month (*luna 1–luna 29* or *luna 1–luna 30,* respectively for hollow and hull lunations).

[551] See appendix 4.

lunar bissextile day: see day → bissextile.

lunar capitals: The lunar capitals are a computistical device used to establish the course of the Moon through the Zodiac. The table of this cycle, known as the *pagina regularis,* circulated widely during the Carolingian period. In the *pagina regularis*, alphabetical series of capital letters run from A–O for each year of the *cyclus decemnovenalis*, corresponding to the 12 months of the Julian solar calendar, and the 12 constellations of the Zodiac. The table with the lunar letters was intended to be used conjointly with a column in Julian solar calendars, which lists the lunar capitals.[552]

lunar cycle: see cycle.

lunar month: see month.

lunar regulars: regulars.

lunar year: see year.

luni-solar cycle: see cycle.

***mensis*:** see month.

month (*mensis*): In medieval calendar science, the term month was defined in different ways, depending on the context in which this notion was used.

[552] See appendix 4.

- **lunar (lunation):**
    - **calendrical:** Medieval compustists used a system of calendrical lunar months or lunations with differing lengths. In practice, an alternation of one full lunation (30 days) and one hollow (29 days) equals a sequence of two synodic lunar months of approximately 29,5 days. The names of the calendrical lunar months were based on the solar months of the Julian solar calendar in which they ended.
    - **embolismic:** see cycle → *cyclus decemnovennalis*.
    - **full:** A full calendrical lunar month has a length of 30 days.
    - **hollow:** A hollow calendrical lunar month has a length of 29 days.
    - **sidereal:** A sidereal lunar month encompasses the period of the course of the Moon through the Zodiac, with an approximate length of 27,32 days.
    - **synodic:** A synodic lunar month encompasses the period from one new Moon to the next, with an approximate length of 29,53 days.
- **solar:** The Julian solar calendar divides the solar year into 12 solar months, which have lengths ranging from 28–31 days. The solar months in the Julian solar calendar are January, February, March, April, May, June, July, August, September, October, November, and December.

moveable feasts:

- **Ascension Day (Holy Thursday):** The Thursday celebrating the Ascension of Jesus Christ, 39 days after the date of Easter Sunday and 10 days before the date of Pentecost.
    - ***Rogationes*:** The 3 days before Ascension Day.

- **Easter (*Pascha*):** Easter can be defined as the liturgical feast commemorating the passion and resurrection of Jesus Christ. According to the Dionysian reckoning of time, Easter is celebrated on the first Sunday after the first full Moon after the vernal equinox. Consequentially, computations of the date for Easter involved a detailed coordination of the weekday cycle, lunar cycle, and solar cycle.
    - **new Moon (*luna 1*):** The 1st day of the synodic lunar month of Easter.
    - **full Moon (*luna 14*):** see moveable feasts → terms → Easter term.
    - **parameters:** see computus → parameters.
    - **table:** An Easter table can be defined as a list consisting of, at least, the essential data for Easter Sunday, namely the Julian calendar date for the Paschal feast and the lunar age on that day. In general, Easter tables contained far more data.[553]
    - **Sunday:** see moveable feasts → Sundays.
    - **term:** see moveable feasts → terms.
- **Quadragesima:**
    - **period (Lent):** The Christian period of fasting prior to Easter, beginning on the Sunday of Quadragesima.
    - **Sunday (*initium quadragesimae*):** see moveable feasts → Sundays.
    - **term:** see moveable feasts → Terms.
- **Sundays (*dominica*):** A series of important Sundays in the Christian liturgical calendar depended on the date for Easter.
    - ***Septuagesima*:** The 9th Sunday before Easter Sunday.
    - ***Sexagesima*:** The 8th Sunday before Easter Sunday.

[553] For the structural elements of Easter tables in the regional codex units, see appendix 8.

- ***Quadragesima*:** The 6th Sunday before Easter Sunday, marking the beginning of the Quadragesimal period.
- ***Quinquagesima*:** The 7th Sunday before Easter Sunday.
- **Pentecost:** The 10th day after the date of Ascension Day and 7th Sunday after Easter Sunday, celebrating the descent of the Holy Spirit upon the apostles and other followers of Jesus Christ.

– **terms (*termini*):** To calculate the date of the moveable feasts, tables with the terms for moveable feasts were used, providing Julian calendar dates for each year of the *cyclus decemnovenalis*.

- **Easter (*terminus paschalis*, Paschal term, Easter full Moon, *luna 14*):** The Easter term refers to the Julian calendar date of the Easter full Moon, which is also known as *luna 14* of the syndonical lunar months in which Easter is celebrated, because the lunar age on this day is 14. Easter is celebrated on the 1st Sunday after the Easter term. The table of the Easter term provides a list of Easter terms for each year of the *cyclus decemnovenalis*.
- **Quadragesimal (*terminum quadragesimae, luna 2*):** The Quadragesimal term refers to the Julian calendar date for the Quadragesimal lunar day with the lunar age 2, 42 days prior to the Easter term. The Sunday of Quadragesima is the 1st Sunday after the Quadragesimal term. The table of the Quadragesimal term provides a list of Quadragesimal terms for each year of the *cyclus decemnovenalis*.
- **Pentecostal (*terminum pentecosten*, *luna 4*):** The Pentecostal term refers to the Julian calendar date for the Pentecostal lunar day with the lunar age 4, 49 days after the Easter term. The Sunday of Pentecost is the 1st Sunday

after the Pentecostal term. The table of the Pentecostal term provides a list of Pentecostal terms for each year of the *cyclus decemnovenalis*.

- **Rogational (*terminum rogationes, luna 20*):** The Rogational term refers to the Julian calendar date for the Rogational lunar day with the lunar age 20, 35 days after the Easter term. The Thursday of Ascension is the 1st Thursday after the Rogational term. The table of the Rogational term provides a list of Rogational terms for each year of the *cyclus decemnovenalis*.

Nones: see Julian solar calendar → marker-days.

Numbers: Numbers are used to count, calculate, and measure.

- **integer:** An integer can be defined as a whole number, which can be written without a fractional component, e.g. 1, 2 and 3.
- **irrational:** An irrational number cannot be described using an integer component and integer fractional components, e.g. 29,5306.
- **fractional:** A fractional number can be written using a simple division of integer components, e.g. ½ for 0,5 and ¼ for 0,25.
- **rational:** A rational number can be defined as a number which can be written using an integer component and an integer fractional component, e.g. ½ for 0,5; ¼ for 0,25; and 1 ½ for 1,5.

***Pascha*:** see moveable feasts → Easter.

parameters: see computus.

Paschal reckoning: see computus → Easter reckoning.

Paschal term: see moveable feasts → terms → Easter.

Pentecost: see moveable feasts → Sundays.

Pentecostal term: see moveable feasts → terms.

Quadragesima: see moveable feasts.

Quadragesimal period: see moveable feasts → Quadragesima.

Quadragesimal Sunday: see moveable feasts → Sundays.

Quadragesimal term: see moveable feasts → terms.

Quinquagesimal Sunday: see moveable feasts → Sundays.

regulars (*regulares*): The regulars are computistical devices used in calculations of the age of the Moon, the weekday, the Julian solar date for Easter full Moon, and the date of Easter.

- **Easter (*pasche*):** The Easter regulars can be defined as a list of Roman numerals for each year of the *cyclus decemnovenalis*. The *regulares pasche* indicate the difference of weekdays between 24 March and the day of the Easter full Moon for every year of the *cyclus decemnovenalis*. Used in calculations with the

concurrents, the Easter regulars can be used to calculate the weekday of the Easter full Moon.

To calculate the weekday of the Easter full Moon, add the Easter regular of a particular year in the *cyclus decemnovenalis* to the concurrent of the corresponding year in the 28-year solar cycle. Because there are no more than 7 weekdays, perform a modulo operation. In other words, find the remainder after division of the result by 7. The remainder represents the weekday of the Easter full Moon: 1 = Sunday; 2 = Monday; 3 = Tuesday; 4 = Wednesday; 5 = Thursday; 6 = Friday; 7 = Saturday.

- **lunar (*lunares*):** The lunar regulars can be defined as a list of Roman numerals for each month of the Julian solar calendar. Used in calculations with the epacts, the lunar regulars can be used to compute the age of the Moon on the Kalends of any month of the Julian solar calendar for any year of the *cyclus decemnovenalis*. The Roman and Egyptian renditions of the lunar regulars have the same Roman numerals for January–August.
    - **Egyptian:** The Egyptian lunar regulars run from September–August. According to the Egyptian rendition of the *regulares lunares*, the lunar regular for September and October is 5. Moreover, the Egyptian lunar regular for November and December is 7.
    - **Roman:** The Roman lunar regulars run from January–December. According to the Roman rendition of the *regulares lunares*, the lunar regular for September and October is 16. Moreover, the Roman lunar regular for November and December is 18.
- **major (*maiores*):** The *regulares maiores* are used to calculate the day of the month of the Easter full Moon, using the epact of the corresponding year in the

cyclus decemnovenalis. The Roman numeral of the *regulares maiores* depends on the month of the occurrence of the Easter full Moon, namely 26 for March and 35 for April.

To calculate the day of the month of the Easter full Moon, subtract the epact of a particular year of the *cyclus decemnovenalis* from the *regulares maiores* of the corresponding year. The remaining number is the number of the day of the month. Note that the subtraction is calculated exclusively, rather than inclusively.

- **minor (*minores*):** The *regulares minores* are used to calculate the weekday for the date of the Easter full Moon (see regulars → Easter), using the day of the month of the Easter full Moon (see regulars → major) and the concurrent of the corresponding year in the 28-year solar cycle. The Roman numeral of the *regulares minores* depends on the month of the occurrence of the Easter full Moon, namely 4 for March and 7 for April.

  To calculate the weekday of the Easter full Moon, add the *regulares minores* to the *regulares maiores*. Subsequently, add the concurrent of the corresponding year of the 28-year solar cycle. Because there are no more than 7 weekdays, perform a modulo operation. In other words, find the remainder after division of the result by 7. The remainder represents the weekday of the Kalends of the particular month: 1 = Sunday; 2 = Monday; 3 = Tuesday; 4 = Wednesday; 5 = Thursday; 6 = Friday; 7 = Saturday.
- ***pasche*:** see regulars → Easter.
- **solar (*solares*):** The solar regulars can be defined as a list of Roman numerals for each month of the Julian solar calendar. Used in calculations with the concurrents, the solar regulars can be used to compute the weekday of the Kalends of any month of the Julian solar calendar for any year of the 28-year solar cycle. The

Roman and Egyptian renditions of the solar regulars have the same Roman numerals for March–December.

- **Egyptian:** The Egyptian solar regulars run from March–February. According to the Egyptian rendition of the *regulares solares*, the solar regulars for January and February are 3 and 6 respectively.
- **Roman:** The Roman solar regulars run from January–December. According to the Roman rendition of the *regulares solares*, the solar regulars for January and February are 2 and 5 respectively.

Rogationes: see moveable feasts → Ascension Day.

Rogational term: see moveable feasts → terms.

Roman numerals: During the Carolingian era**,** the numeric system of Roman numerals was employed to represent numbers. Numbers in this system are represented by combinations of letters used in the Latin alphabet: I = 1; V = 5; X = 10; L = 50; C = 100; D = 500; and M = 1000.

***saltus lunae*:** see cycle → *cyclus decemnovenalis*.

Septuagesimal Sunday: see moveable feasts → Sundays.

Sexagesimal Sunday: see moveable feasts → Sundays.

sidereal lunar month: see month → lunar.

solar bissextile day: see day → bissextile.

solar cycle: see cycle → solar.

solar regulars: see regulars.

solar year: see year.

solstice: The solstice can be defined as the day on which the Sun reaches its most northerly or southerly positions relative to the celestial equator and the celestial sphere. As a result, the date of the summer solstice occurs on the longest day of the solar year, whereas the winter solstice occurs on the shortest day of the solar year. During the Carolingian period, the solstices were associated with the Julian calendar dates 20 June and 21 December.

spring equinox: see equinox.

synodic lunar month: see month → lunar.

***terminum pentecosten*:** see moveable feasts → terms.

***terminum quadragesimae*:** see moveable feasts → terms.

***terminum rogationes*:** see moveable feasts → terms.

***terminus paschalis*:** see moveable feasts → terms.

weekdays: see day.

vernal equinox: see equinox.

year (*annus*): Medieval calendar science employed two definitions of the year, which were modelled on the course of the Sun and the Moon.

- **solar:** A (sidereal) solar year can be defined as the course of the Sun through the twelve constellations of the Zodiac or the time it takes the earth to make one revolution around the Sun. A solar year has a length of approximately 365,25 days. In practice, the Julian solar calendar employs a combination of common and bissextile years.
    - **common:** The common solar year has a length of 365 days.
    - **bissextile:** The bissextile solar year has a length of 366 days, due to the implementation of the bissextile day. Every fourth solar year of the Julian solar calendar is a bissextile year.
- **lunar:** The lunar year was modelled on the solar year.
    - **common (*communis*):** A common lunar year consists of 12 lunar months plus an annual bissextile increment of a quarter-day. Since a synodic lunar month was calculated as 29,5 days, a common lunar year of 12 lunar months consisted of 354,25 days. Every common solar year consisted of 6 full lunar months and 6 hollow lunar months.

- **bissextile:** In a bissextile lunar year, the lunar month ending in February has an extra day. As a result, the lunar year is one day longer as well. See day → bissextile.
- **embolismic (*embolismus*):** In order to compensate for the 11-day difference between the length of a common solar year and a common lunar year, the Dionysian reckoning of time intercalated seven embolismic lunar months, resulting in seven embolismic lunar years of 13 lunar months, each equalling a length of 384,25 days. See cycle → *cyclus decemnovenalis*.

Zodiac: The Zodiac is an area of the celestial sphere in which the Sun and Moon appear to move during the course of the solar year. The Zodiac is divided into 12 signs or constellations: Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricorn, Aquarius, and Pisces.

Appendix 11. Bede's placement of the *saltus lunae*

In chapter 42 of DTR, Bede argues for a placement of the leap of the Moon in the final year of the *cyclus decemnovenalis*. Although he ambiguously mentions a most natural date for the *saltus lunae* on the day of the vernal equinox, as well as two conventional Julian calendar dates in November according to the Romans and July according to the Egyptians, no rule for the precise and preferred placement of the *saltus lunae* is elaborated by Bede.

In fact, chapter 42 of DTR can be read as an implicit description of three precise dates, for Bede also mentions that the leap of the Moon is implemented by reducing a full lunar month (30 days) to a hollow lunar month (29 days). In other words, the subtraction of the *saltus lunae* comes down to skipping the final day of a full calendrical lunar month (*luna XXX*), by directly moving from *luna XXVIIII* to *luna I*.[554] By implication, Bede implicitly mentions three placements, namely the most natural date of 21–22 March and the conventional Julian calendar dates of 24–25 November and 29–30 July.

Note that historians and medieval scholars tend to refer to the placements for the *saltus lunae* using ambiguous single dates (i.e. 24 November or 25 November). In my view, the placement of the *saltus lunae* is best explained using a pair of Julian calendar dates, for the leap of the Moon is subtracted by leaping from the lunar age on the first date (*luna XXVIIII*) to the age of the Moon on the second date (*luna I*).[555]

Faith Wallis argues that Bede refused addressing a precise rule for positioning the *saltus lunae*, for Dionysius Exiguus was silent on the matter as well. To exemplify the resulting computistical confusion, Wallis refers to the tract pseudo-Alcuin, *De saltu lunae*, in which several possibilities are listed: 24–25 November; 21–22 March, 25–26 September; and

[554] DTR 42. See also Springsfeld, *Einfluß*, 138-142.
[555] 24 November: Warntjes, *Munich Computus*, 284-285, notes to lines 97–110. 25 November: Stevens, "Ars", 34.

16–17 April.[556] In contrast, Immo Warntjes suggests that a placement of the *saltus lunae* on 24–25 November became popular from the eight century and onwards. Because Bede usually implies a leap of the Moon in November, Warntjes argues that Bede used a 24–25 November placement.[557]

[556] *Reckoning*, 326-328, esp. 327 and fn. 154. For an analysis of *De saltu lunae*, see Springsfeld, *Einfluß*, 64-79 and 147-156.

[557] Warntjes, *Munich Computus*, 284-285, notes to lines 97–110. Warntjes provides numerous examples of Irish and Frankish computistical works mentioning or implying a 24–25 November placement. See DTR 20, 42, 46.

Appendix 12. Regional exchanges of computus

Tracing the circulation of regional codicological units reveals a set of exchanges between regional intellectual centres.[558] Based on the provenance of some of the regional codicological units, computistical material seems to have circulated between Lorsch, Prüm, and Trier.[559] Meanwhile, computus texts and computistical units were disseminated from Worms to Weißenburg.[560]

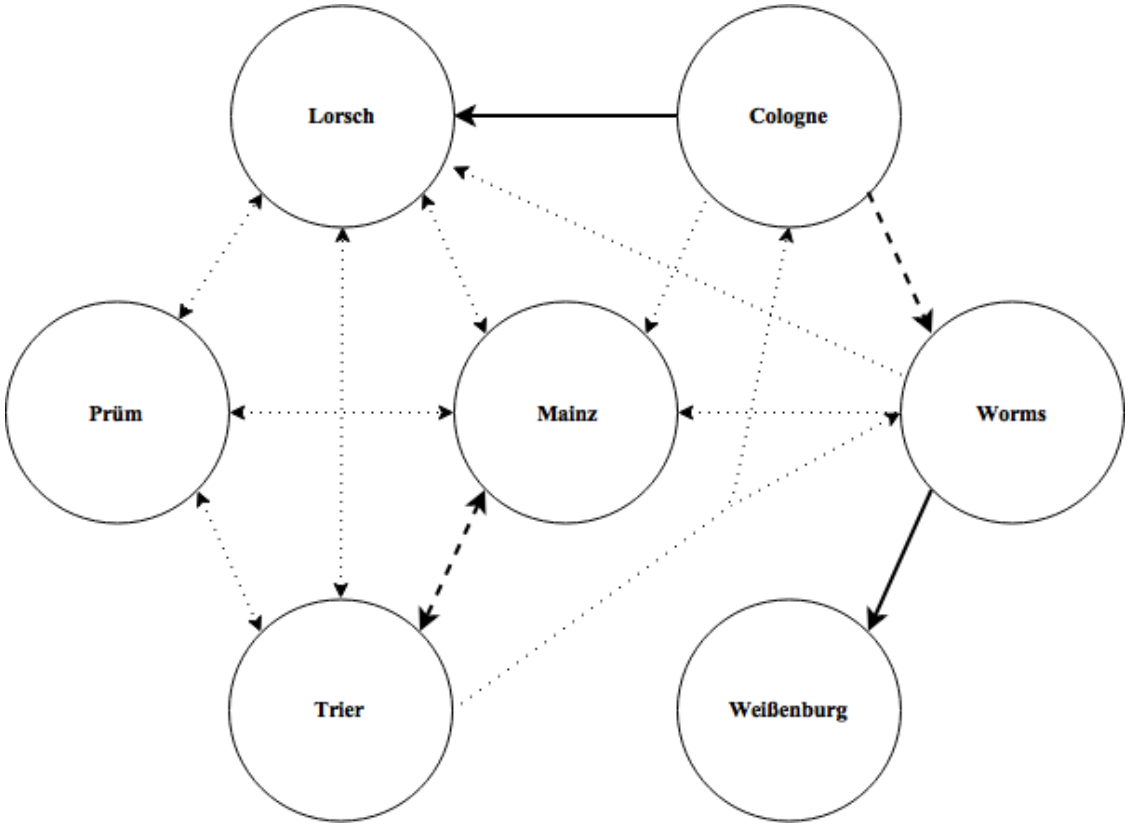
Further transmissions of computus can be deduced by focussing on particular objects and clusters, which occur in more than one of the regional manuscripts, such as calendars with the same format, Easter tables with the same arrangement and range of years, and identical combinations of computistical works. Firstly, an important connection is implied by similarities between manuscripts from the cathedral of St. Peter in Cologne and the abbey of St. Nazarius in Lorsch.[561] Secondly, the only extant copies of the complete *Computus rhenanus* occur in two of the regional codex units, possibly bearing witness to exchanges of computus between the cathedrals of St. Peter in Worms and Cologne.[562] Thirdly, several clusters and objects within codex units from Mainz and Trier are identical, such as their calendars and Easter tables.[563] Fourthly, identical clusters from the *Computus rhenanus* were copied into two codex units from Lorsch and Mainz. [564] Thus, this cluster presumably arrived in Lorsch and/or Mainz from either Cologne or Worms, and may thereafter have been exchanged between Lorsch and Mainz. Fifthly, the structural elements of the calendars within codex units from Prüm and Mainz are identical, suggesting a connection between these

[558] See pp. 90-91, pp. 96-99, and appendices 3 and 5 for overviews of overlapping contents.
[559] MS/7 I and MS/37, see pp. 90-91.
[560] MS/37 and MS/247, see pp. 90-91.
[561] Especially MS4 and MS/89, and more ambiguously MS/1, MS/4, and MS/89. See pp. 96-99, 100-101, and 128-130.
[562] MS/89 and MS/247, see pp. 100 and 129-130.
[563] MS/2 and MS/3 I, see pp. 96-99 and appendices 4 and 8.
[564] MS/1 and MS/3 II, see pp. 128-130.

centres.[565] Finally, it should be kept in mind that Warntjes suggests that the *Computus rhenanus* may have been created in Trier or Cologne, suggesting the existence of exchanges from Trier towards Cologne and Worms and/or Cologne to Worms.[566]

As a result, a network of exchanges of computistical material emerges, displayed in the following figure. The arrows in the figure designate the supposed direction of exchanges. Whenever the direction is unknown, the arrows point in both directions. Solid lines represent connections which have a high degree of certainty. Dashed lines represent relationships that are reasonably certain, whereas dotter connections are plausible, but doubtful.

Figure 1. Exchanges of computus within the intellectual network of Lorsch[567]



[565] MS/3 II and MS/37, see pp. 128-130 and appendix 4.
[566] See pp. 128-130.
[567] For a map of the intellectual network of Lorsch, including the places in this figure, see http://computus.lat/visualize/maps/lorsch-intellectual-network.

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