Early Dutch Interest in Newtonian Mathematics

Adriaen Verwer (1654-1717) and Newton's usefulness

Emma Mojet
3653935
MSc History and Philosophy of Science
Research Thesis
July 2016

Supervisor: Dr. Dirk van Miert
Second reader: Prof. Dr. Arnoud Visser

"En wil iemand de waerheid van de Ovaelse draeyingen breeder weten, hij herkaeuwe maer rijpelijk de voornaemsten inhoud van 't Latijnse boek des gemelten Isaak Newton, geheten *Wiskunstige gronden der Natuerkennisse*."

Adriaen Verwer (1698)

Acknowledgements

This thesis is the result of a year's work which was not uneventful. Hence many people deserve an acknowledgement now that my work is completed.

First and above all I would like to acknowledge my supervisor Dirk van Miert. The amount of energy and time which he put into supervising me is indescribable. Dirk commented in such detail on even my crudest drafts, and even though at the time I might have cursed this or found it intimidating, now I can only count my blessings. His unbelievable expertise and knowledge were extremely helpful, especially when transcribing Verwer's handwriting. I would not have learnt half as much from working on this project if it had not been for him. I also want to acknowledge my second reader Arnoud Visser. Arnoud directed me towards Verwer's annotations some 3 years ago and since then the story of the Dutch reception of Newton has stuck with me and this is the result.

I would also like to recognise the influence which the members of the Descartes Centre have had on the finalisation of my thesis research. Especially those who reside on the fourth floor of the Buys Ballotbuilding – David Baneke, Daan Wegener, Bert Theunissen, Dennis Dieks, Noortje Jacobs, Ivan Flis, Steven van der Laan, Jesper Oldenburger, Hieke Huistra, and any occasional visitors – with whom I had such inspiring, motivating and empowering talks around the coffee table.

Additionally, I thank my dear family and friends for their support and love. My wonderful sister Maria deserves a special mention for her positivism and happiness, and for letting me borrow her laptop when mine had had enough. A great big thank you also to my great basketball teammates and coach, our 'Team Chocomel' definitely helped me through the year. I want to thank my fellow board members for their patience with me during our meetings this year. Being allowed to answer all questions from my basketball friends about this thesis project enabled me to look at my work from multiple perspectives I had never thought of myself and this was most welcome.

Lastly, and perhaps most importantly, I acknowledge my amazing fellow students and friends Marte Bügel, Sjang ten Hagen, Hein Brookhuis, Clemens van den Berg and Linsey Groot. Editing and commenting on each other's research together has taught me more than all the courses I had ever taken. Their unwavering enthusiasm for my project was very motivating and inspiring even when the research seemed more like a cloud of thunder than to reside on cloud nine. Whenever my view was clouded with details, or when I had my head in the clouds dreaming about more primary sources, they were always there to support and guide me. Throughout this year, they were my silver lining.

Prologue

Most stories on Newton in the Netherlands start in 1715 when Herman Boerhaave (1668-1738) called Newton "the miracle of our time" and when Willem Jacob 's Gravesande (1688-1742) travelled to London to visit the Royal Society.[1] This story does not. Most research focuses on the popularisation of Newton's physics by academics such as 's Gravesande and Petrus van Musschenbroek (1692-1761) and the experiments and demonstrations as a result of this popularisation.[2] This research does not. Most studies start seeing Newton's role in the attack on Spinozism after Bernard Nieuwentijt's (1654-1718) work was published in 1715.[3] This study does not. Here the protagonist is the Mennonite merchant Adriaen Pieterszoon Verwer (1654-1717), who had an interest in mathematics and, already in the early 1690s, saw that there was more to Newton than many of his contemporaries thought.

There are three ways which enable the study of Verwer's reception of Newton. Verwer obtained a copy of the first edition of the *Philosophiae Naturalis Principia Mathematica* in 1687 and studied it in detail. During his studies, Verwer annotated his book, adding derivations, comments and references to comparable books or ancient sources.[4] These annotations can provide us with information on how Verwer read his Newton.[5] They show us what Verwer thought was interesting, the connections he made with other books, and which parts troubled him. Second, Verwer appropriated his newly gained Newtonian knowledge for his own work. Verwer published several books on the topics of religion, philosophy, linguistics and maritime law. A third method of discussing Verwer's study of Newtonian thought is through the analysis of Verwer's correspondence with other thinkers and acquaintances who were also interested mathematics. Verwer's network included people of various backgrounds such as scholars of linguistics, church ministers, and book sellers, and

---

[1] As is told in a very fine way in: Jorink & Maas (eds.) (2012), Vermij (2002), Van Bunge (ed.) (2003) and Van der Wall (2004). With the notable exception of: Vermij (2003).

[2] See footnote 1.

[3] Studies such as in footnote 1 and Vermij (1991), Bots (1972), and Van Bunge (2001). Again with some notable exceptions: Klijnsmit in: Noordegraaf & Zemel (eds.) (1991) 9-20, which is especially interesting in combination with Jongeneelen in: Van Bunge & Klever (eds.) 15-21.

[4] Comments include the likes of "argument for the existence of God". The references to other authors are both contemporary, such as to David Gregory's *Astronomiae Physicae et Geometricae Elementa* and Isaac Barrow's lectures on geometry, as well as ancient, for example to Euclid.

[5] Verwer's book has been digitalised by Annotated Book Online: http://abo.annotatedbooksonline.com/. More on the annotations and the context of the *Principia* in The Netherlands can be found in Jaski (2013) .

crossed both geographical and religious borders. This wide ranging circle of friends lead to many discussions which in turn had their influence on Verwer's own thinking.[6]

All this combined makes Adriaen Verwer an extremely intriguing person to research while considering the bigger picture of Newtonian reception in the Dutch Republic.

---

[6] Verwer mentions this himself in his preface to *'t Mom-aensicht* (1684) page xix.

Introduction

Research Rationale and Status Quaestionis

The historiography on Sir Isaac Newton and his legacy is immense. The amount of popular and scholarly literature on Newton himself, his contributions in mathematics and physics, or any of his activities is inconceivable. The consequence of such a legacy is that an introduction of Isaac Newton becomes unnecessary. Yet, this thesis looks into a niche of Newtonian research which has still been left relatively dark. In this research we look not only at Newton's mathematics or physics but also at a Newtonian philosophy in a general sense. As a working definition of Newton's philosophy we borrow Rienk Vermij's: Newtonian philosophy is not just an explanation of the mechanics of planetary motion or free fall, but also a demonstration of God's hand in nature. This entails a whole complex of ideas which are not necessarily connected to mathematics but also to philosophy, theology or the broader term 'natural philosophy'.[7] The use of terms such as 'mathematics', 'philosophy' or 'theology' is problematic. Modern definitions of these classifications simply do not apply for describing the early modern versions. In this thesis we will attempt to apply the terms as correctly as possible, without being unnecessarily vague. The use of the term natural philosophy is by far the safest option, since it is an actors' category and it encompasses the combination of philosophy and natural science which we require. Newtonian philosophy also fits neatly into the scheme of natural philosophy. The definition of this Newtonian philosophy is best understood within a broader intellectual setting.[8]

When discussing Newton and his philosophy in a broader context like we aim to, it would be erroneous not to mention Margaret Jacob's ground-breaking thesis arguing the importance of this approach. Jacob claims that social and political issues played a vital role in the formulation and acceptance of the new Newtonian science.[9] Therefore she pleads for Newton scholarship to discuss Newtonian ideology within the context of the English Revolution. The English – or Glorious – Revolution of 1688 was prompted by the abolishment of James II's rule and the establishment of a constitutional monarchy under William and Mary. This change in monarchy was accompanied by a change in state religion: under James II, Catholicism had been the predominant faith, while William

---

[7] Vermij (2003), page 183.
[8] Delgado Moreira in Ducheyne (2009), page 10.
[9] Jacob (1967), page 19.

and Mary replaced this by Protestantism. Jacob connects the triumph of Newtonianism to its promotion by the latitudinarian community, who were less strict in matters of doctrine, liturgical practice and ecclesiastical organisation. Latitudinarians were keen to promote Newtonianism because it functioned as a foundation for a social ideology which Jacob describes as serving a twofold purpose. The ideology would both secure and legitimise church and state against threats posed by radicals, religious enthusiasts and atheists and it would also reform the established order.[10] Jacob's argument then states that because of this sense of purpose, a linkage was forged between latitudinarianism and early Newtonianism.[11]

Jacob's proposal to study Newtonianism within a social, religious and political context has been picked up by many Newton scholars. Her claim that Newtonianism can be linked with latitudinarianism, however, has been heavily debated. Anita Guerrini, Simon Schaffer and John Friesen each problematize this claim. Guerrini argues that "Newtonianism" is a problematic term to start with. She shows that followers of Newton cannot be confined to a specific political party or religious frame of mind. It is therefore difficult, or maybe even impossible, to define a "Newtonian ideology" Guerrini claims. She argues this using the example of a group of Scottish Newtonians who are themselves very dissimilar to Jacob's latitudinarian Newtonians.[12] Schaffer discusses the case of Scotsman Archibald Pitcairne (1652-1713), who was an early Newtonian and interested in Newtonian medicine, but a fervent Jacobite. Schaffer argues, in the case of Pitcairne, for a link between Jacobite politics and Newton's *Principia*.[13] Friesen's response to Jacob is similar to Guerrini's and Schaffer's. Friesen discusses the predominantly Scottish roots of these Tory Newtonians who were supporters of the deposed James II. He manages this by placing them within the turbulent Scottish political context around that time, in a same way as Jacob does.[14] Friesen concludes that the Scottish Newtonians, who were primarily Episcopalian, can be considered as English Latitudinarians when it comes to matters of religious dogmatism. In a political context, however, they were polar opposites.[15] In this way, Friesen nuances both Jacob's and Guerrini's claims. Even though the Newtonians should not necessarily be seen as one coherent group, there are definitely ties between Newtonians and their religious views. Therefore, studying Newtonianism within a social, political and especially religious

---

[10] Jacob (1976), page 24.

[11] Jacob (1976), page 17.

[12] Guerrini (1986), pages 288-9.

[13] Schaffer (1989) "The Glorious Revolution of medicine in Britain and the Netherlands", discussed by Friesen (2003) page 1.

[14] Friesen (2003), page 1.

[15] Friesen (2003), page 5.

context can lead to more insight into the popularisation of Newton's natural philosophy. And this is indeed also the case when we consider the Dutch Republic.[16]

Just like any text on Newtonianism inevitably mentions Jacob, so too should any work on the Dutch Republic mention Jonathan Israel. Israel argues that the roots of what he calls 'the Radical Enlightenment', on which Israel claims that modern society as we know it today was founded, can be found in the Dutch Republic.[17] Klaas van Berkel argues for a similar claim when he calls the Dutch Republic a laboratory for science.[18] The Dutch Republic was a place where many different people lived and worked close together. Furthermore, in the seventeenth century, the academic centres were Amsterdam, Leiden and Utrecht where new institutions of higher education were established. Because of this mixture of people, ideas, and goods, the innovative atmosphere of the newly established schools and the religious pluriformity, the Dutch Republic was a vibrant place to be for any academic. Moreover, the idea that through the study of nature, one could study God was becoming increasingly common in the scholarly culture of this Dutch Republic.[19] These scholars believed that next to the Bible, God had written a second book: the Book of Nature. It was possible to come closer to God by studying either of these books, reading the Bible or the Book of Nature.[20] On this intellectual and cultural stage we then introduce Newtonianism.

In a way, Newtonianism would seem like a logical step: after Aristotelianism had been discarded by the sceptical doubt of Cartesianism, Newtonianism now dictated how the Book of Nature was meant to be studied.[21] However, Eric Jorink and Huib Zuidervaart argue that in the context of the Dutch Republic as described above, Newtonianism is a problematic term. Newtonianism cannot be seen as a complete and coherent system to be implemented in any society. Jorink and Zuidervaart describe it as a philosophical construction, created for and adapted to specific local problems and circumstances.[22] It is interesting to compare this to the French context which JB Shank describes.[23] Shank argues how Newtonianism in France was constructed through the works Voltaire and Maupertuis. Shank studies the origins of this Newtonianism in French culture and intellectual society in order to understand the strong connection which later philosophers made

---

[16] Van der Wall (2004) argues that the Dutch intellectual market where Newtonianism landed was very diverse with various denominational backgrounds.

[17] Israel (2001).

[18] Van Berkel (2010).

[19] Jorink (2010).

[20] Jorink (2010).

[21] Jorink & Zuidervaart (2012), page 14 and Van de Bilt (2009), page 46.

[22] Jorink and Zuidervaart (2012), page 14 and Jorink (2007), page 23.

[23] Shank (2008).

between Newton's philosophy and the Enlightenment.[24] Shank's focus is mainly on the *Académie des Sciences*. His arguments contain many factors which are specific for French seventeenth-century culture, for example the fact that France was Catholic. Even though a comparison between France and the Dutch Republic would be interesting, such factors show that to study Newton in a Dutch context, we cannot simply copy what has been said about Newtonianism in different contexts. Instead, we should look at Newtonianism afresh. Jorink and Zuidervaart agree with Jacob that this should be done in light of philosophical and theological developments of the late seventeenth century.[25]

Newton's real triumph in the Dutch Republic and afterwards on the continent can be said to have started with the second edition of the *Principia*.[26] The second edition was published in 1713 in Cambridge, after which pirated editions were printed in Amsterdam in 1714 and 1723 by a cooperation of booksellers. The first edition had not sold very well: of the 12 copies which Leiden bookseller Pieter van der Aa had imported in 1687 to sell in the Dutch Republic and at the Frankfurt book market, 7 were returned 2 years later because he had failed to get rid of them.[27] This implies that the reception of Newton's work was not immediate. Newton's popularity at the time of his first edition of the *Principia* was not as widespread as we might expect when we consider the contents of the *Principia* and the changes it brought to early modern natural philosophy. Traditionally, scholars characterised the arrival of Newton's philosophy as a rupture between Cartesianism and Newtonianism thanks to Willem Jacob 's Gravesande (1688-1742). 's Gravesande was responsible for making the theoretical *Principia* more practical and giving it more priority in the university curriculum.[28] 's Gravesande demonstrated and actively engaged with Newton's laws using instruments which he designed and built together with Petrus van Musschenbroek (1692-1761). In this way, Newtonian science became more popular, according to the traditional story.[29]

Contrary to this, recent scholarship advocates a more gradual evolution of ideas.[30] We now see a distinction between the reception of Newton's *Principia* after the second edition (1713) and the earlier reception surrounding the first edition (1687). A comparable case can be found in Shank's research of the French reception of Newton's philosophy. Shank first describes a reception in which

---

[24] Shank (2008), pages 10-11 and 14-15.

[25] Jorink and Zuidervaart (2012), page 14.

[26] Jorink and Zuidervaart (2012), page 27.

[27] Jorink and Zuidervaart (2012).

[28] Vermij (2002), page 201.

[29] This argument is further worked out in "Theorising, Practising, and Amusing: How Newton, 's Gravesande, and Desaguliers present the laws of motion to the public" (2015), written for the History and Philosophy of Science master course "Science and the Public".

[30] Krop (2003), page 173. The scholarship alluded to here is also mentioned in the *Prologue*, but most notably Vermij (2003) and Jorink & Maas (eds.) (2012) are meant.

French scholars accepted and respected Newton for his mathematics, but did not welcome Newton's statements pertaining to natural philosophy. These scholars made a clear distinction between Newtonian mathematics and Newtonian natural philosophy.[31] In this we recognise Christiaan Huygens' (1629-1695) reaction to the first edition of the *Principia*.[32] Shank argues that a second reception can be distinguished when Maupertuis and Voltaire actively work on combining these two Newtonianisms again, followed by what Shank calls "the Newtonian Wars".[33] Shank focuses on institutional and cultural developments which led to this second reception, studying academics who were active in the *Académie des Sciences*.[34] Returning to the Dutch Republic, we see that Jorink and Zuidervaart explain the rise in Newton's popularity – from no interest at all in 1687 to a well selling pirated edition in 1714 – by attributing it to a coordinated action by a group of popularisers.

Among these popularisers, Jorink and Zuidervaart list 's Gravesande, but also Jean Le Clerc (1657-1736) and possibly Bernard Nieuwentijt (1654-1718). These men were involved in a popularisation movement, which was active from the 1680s onwards.[35] Vermij also deals with this group of popularisers and their connections. He calls them "the Amsterdam mathematical amateurs" and lists Adriaen Verwer, Lambert ten Kate, Bernard Nieuwentijt, Joannes Makreel, Abraham de Graaf, and Burchardus de Volder as members.[36] This group did not learn of Newtonian philosophy through academic teaching, but by means of informal contacts.[37] It is far from evident how one should characterise this group. It is not even clear whether they studied together, or saw themselves as a group. Maybe a better term would be 'network'. The religious backgrounds of the members was varied, just like their political views. They had various contacts with foreign scholars – such as David Greogry, Archibald Pitcairne, George Cheyne, and Ehrenfried Walter von Tschirnhaus – and were active in various fields of study.[38] It is in this network that we find the topic of our research.

Vermij argues that what held the group together was a battle against "the challenge of Spinozism".[39] The Dutch philosopher Benedictus (Baruch) de Spinoza (1632-1677 posed a threat to this group of pious mathematical amateurs. For orthodox philosophers and theologians, Spinoza was

---

[31] Shank uses the phrases 'Newtonian physics' and 'Newtonian science'. In our eyes, however, this term fails to do justice to the early modern practice which Shank implies and therefore, we have decided not to copy this. Shank (2008), page 10

[32] Cohen (1983), page 79. Huygens wrote in 1687 that he admired Newton's mathematics but could not agree on his ideas of gravitation since Newton was unable to give a source for this force. We suggest to call the reception of Newton's mathematics and not his physics a "Huygian reception".

[33] Shank (2008), pages 29-30,

[34] Shank (2008), page 38 and further.

[35] Jorink and Zuidervaart (2012), page 31.

[36] Vermij (2003).

[37] Vermij (2003), page 186.

[38] Vermij (2003), page 189.

[39] Vermij (2003), page 189.

their worst nightmare: Spinoza drew a set of logical conclusions from Descartes' philosophy. The debates concerning Cartesian philosophy were only in the very recent past when Spinoza's *Tractatus Theologico-Politicus* was published. Here Spinoza continued with the reasoning which Descartes had started and stated that even God was bound by his own laws, leaving no room for miracles and God who was passive in the proceedings of the universe. Spinoza equated God to Nature (Deus sive Natura) and claimed this on the basis of absolute mathematical certainty.[40] It was this combination, argue Vermij, Jorink and Zuidervaart, that was seen as extremely dangerous by the mathematical amateurs. The group were looking for a mathematical foundation of religious truth and Spinoza's use of a similar methodology was a threat to their work.[41] Their solution was to emphasise the difference between what Spinoza was doing and their goal. In order to make such a distinction, natural philosophy and theology were combined to create a new area of focus: physico-theology.[42] Physico-theology can be described as a theology which is constructed on concepts from experimental science which is in its turn done with explicit theological preoccupations.[43] If we recall the definition of Newtonian philosophy which we stated at the start of this chapter – namely that Newtonian philosophy is not just an explanation of the mechanics of planetary motion or free fall, but also a demonstration of God's hand in nature – we see that Newton's work can easily be connected to physico-theology.[44]

Jorink and Zuidervaart claim that by using the idea of physico-theology, the mathematical amateurs attempted to make a distinction between Spinoza's pure mathematics and true scientific method.[45] Mathematics should be tested by experience, only then can it say something about reality. When the mathematical amateurs read Newton, they found a scholar who was doing exactly this. In their eyes, Newton saved the mechanical way of reasoning from the Cartesian and Spinozist spell of atheism.[46] Newton's mathematics was seen as a better method or more proper reasoning than Spinoza's and could thereby be used to refute the threat of Spinozist atheism.[47] A better mathematical method is not the same as better mathematics. Jan Noordegraaf uses the term 'better mathematics', but here we need to note that this is not the same as 'more correct' mathematics.[48] Through the eyes of his followers, Newton was 'better' because the Newtonian method of testing mathematics through experience was deemed more proper. Therefore, better mathematics might

---

[40] Vermij (2003), page 190 and Jorink and Zuidervaart (2012) page 19.

[41] Vermij (2002), page 355.

[42] Bots (1972), page 14 and Vermij (2003) page 194-6.

[43] Bots (1972), page 2.

[44] Van der Wall (2004). Newton himself also worked in this field, though his work was unpublished.

[45] Vermij (2003) page 194-6.

[46] Jorink and Zuidervaart (2012), page 26.

[47] Vermij is quoted from unpublished work by Noordegraaf (2004).

[48] Noordegraaf (2004), page 4.

not be the right wording: a different mathematical method was needed and the mathematical amateurs found it in Newton's *Principia*. This leads Jorink and Zuidervaart to state that "Newton became so successful not because he was right, but because he was useful."[49] This claim seems logical, considering the anti-Spinozist sentiments and the contents of the *Principia*. When studied with such preoccupations, it can be understood that Newton's *Principia* was wholeheartedly welcomed. However, explicit examples and detailed studies into these arguments have not been published. This research attempts to amend this deficit and possibly provide new insights of these statements by considering the case of Adriaen Pieterszoon Verwer (1654-1717).

Adriaen Verwer was an important participant of the group of mathematical amateurs and seems to have fulfilled a pivotal role in the informal intellectual life of Amsterdam.[50] Through Verwer the group upheld contacts with the British island: Verwer was in touch with the Scottish Newtonian David Gregory (1659-1708) while Gregory was at Oxford and close to Newton himself.[51] Verwer makes a fruitful case study to research Jorink and Zuidervaart's claim because of the abundant source material which is available. Verwer published several books on philosophy, religion, linguistics and maritime law. Furthermore, a unique source of Verwer's study of Newton is available online. Verwer annotated his copy of the first edition of Newton's *Principia*, and this copy is still extant. Using the annotations, we can read Verwer's personal notes while studying Newton. These annotations have not been studied in detail before, making this an exciting primary source. Furthermore, Verwer's contact with Gregory can be read through two letters from Verwer to Gregory, one of which is still unpublished. This combination of publications, annotations, and correspondence makes Verwer a compelling research subject. As for secondary literature, Verwer is known for his contributions to linguistics and is therefore mostly studied by linguists without much mention of his natural philosophical interests.[52] In this research, we add to the scholarship by looking at Verwer's mathematics and theology within the context of Newtonian physico-theology.

Research Question and Research Structure
This brings us to our research question. In the above we have seen how the anti-Spinozist reading of Newton is believed to be the driving force behind the popularisation of Newton's *Principia* in the Dutch Republic. Jorink and Zuidervaart call this Newton's "usefulness".[53] To investigate this idea of

---

[49] Jorink and Zuidervaart (2012), page 26.
[50] Vermij (2003), page 187.
[51] Vermij (1991), page 17.
[52] Such as Jongeneelen, Van Driel, Van de Bilt and Noordegraaf.
[53] Jorink and Zuidervaart (2012), page 26.

how Newton could be useful, we look at Adriaen Verwer's work and correspondence. In doing this, we attempt to answer the following research question:

Wherein lay the usefulness of Newtonian mathematics for Verwer?

Within this question lies the assumption that Verwer did indeed find Newton useful. Perhaps a discussion of Verwer's interest in Newton would be more neutral, since it merely implies that Verwer felt some need to study Newton without attaching quite as much value to it. However, the fact that Verwer was indeed interested in Newton is easily established – he says so himself – whereas the question remains as to the reason and nature for this interest in Newton.[54] Calling Verwer's interest "usefulness" is a reference to Jorink and Zuidervaart's statement on the popularisation of Newton's *Principia*. With this reference we recall the bigger picture which Jorink and Zuidervaart allude to as well: the Amsterdam mathematical amateurs, the anti-Spinozist sentiments with which Newton was studied and the context of the Dutch Republic. In this way, we place this research in the broader framework of studying the reception of Newton in the Dutch Republic.

In order to come to an answer for this question we structure our research as follows. Starting with a thorough introduction of our main character Adriaen Verwer in chapter 1, the main body of the research will be ordered chronologically. From Verwer's 1683 publication of an explicit anti-Spinozist treatise *'t Mom-aensicht der Atheistery afgerukt*, we learn what Verwer's goal and methodology were in chapter 2. Verwer coins an empirical epistemology which deserves special attention because he did so before studying Newton. In 1691, correspondence between Verwer and Gregory was established. Chapter 3 discusses this correspondence in which we see Verwer's mathematical study. Verwer talking to Gregory about his mathematical study is fruitful in understanding Verwer's interest in Newton. We look at Verwer's mathematics in more detail when we discuss his annotations in the *Principia* in chapter 4. In 1687, Verwer attained a copy of the *Principia*. Studying Verwer's marginalia, we obtain direct insight into what Verwer found interesting in Newton and what he was focussing on. In addition to this we also learn how Verwer positioned Newton within a broader scholarly context. Verwer referred to many scholars while reading the *Princpia* and this tells us more of how Verwer read Newton.

Moreover, Verwer also mentions more philosophical and theological connections which he finds in Newton and these are of particular importance to our research. The connections Verwer highlights are elaborated on in his 1697 publication of the *Inleiding tot de Christelyke Gods-geleertheid*, our fifth chapter. Here many of Verwer's arguments come together as Verwer discusses his view on

---

[54] Verwer to Gregory (1703), in Rigaud (1841) pages 248-253.

religion and theology. In this religious work, Verwer assigns a pivotal role to Newton and Newtonian mathematics, hence an important step in answering our research question. Before summing up what we have learnt from these different sources, we quickly look into Verwer's 'other' interests, linguistics and maritime law in chapter 6. These topics are part of Verwer's legacy and can teach us more about what Verwer's background was while studying Newtonian mathematics. More interestingly, however, we also see Verwer using Newtonian mathematics in his study of the Dutch language. This leads us to argue that Verwer found uses for Newton in more contexts than purely mathematical. With all this covered, we then come to conclude our research into Verwer's interest in Newtonian mathematics and what this says of Newton's reception in the Dutch Republic.

1. *Adriaen Pieterszoon Verwer* (1654-1717)

To answer the research question of Newton's usefulness for Verwer, we first need to look at Verwer himself. We shall not only look at the biographical details, but also consider what this background meant for Verwer and his further endeavours.

Rotterdam years

Adriaen Pieterszoon Verwer was born in 1654 in Rotterdam. His father, Pieter Adriaenszoon Verwer (birth and death dates unknown), was an Mennonite deacon and part of the Waterlandic Mennonite community of Rotterdam.[55] Pieter Verwer participated in a group of men who considered themselves "Erasmian". The participants of this group were inspired by Biblical humanism propagated by Erasmus (ca. 1467-1536).[56] Their goal was to build bridges between different religious groups as one community, where tolerance was important, instead of the many different religious debates and strives that were so prevalent at the time. This network was widespread and consisted of people who were interested in theology, philosophy, politics and literature. The composition of the group varied and its participants had many different backgrounds, ranging from painters and book sellers to ministers and regents. The group had connections with thinkers and scholars like Pierre Bayle, Jean Le Clerc, and John Locke. [57] Through this network, Pieter Verwer became involved in debates surrounding the presumed Spinozist Jacob Ostens. These debates started the reception of Spinoza's philosophy in Rotterdam.[58] Adriaen Verwer was adopted by this circle and this would prove to be an important part of his education. In Rotterdam, Verwer worked for and learned from the merchant Willem Pedy (ca 1636-1710). Because of this experience, Verwer was schooled in law, especially maritime law, on which he would later publish some internationally renowned work. However, Pedy was not the only person who had an impact on Verwer's thinking.

Joachim Oudaen (1628-1692), a friend of his father, played an influential role in Verwer's upbringing. Oudaen was a figure of authority in the Rotterdam literary and religious circles of the last decades of the 17th century and was a mentor to several students, including David van Hoogstraten

---

[55] Van de Bilt (2009).
[56] Van de Bilt (2009), page 30.
[57] Van de Bilt (2009).
[58] Van Bunge & Klever (1996) & Van de Bilt & Noordegraaf (2001).

(1658-1724) with whom Verwer stayed in touch.[59] Born in Rijnsburg in 1628, Oudaen was a remonstrant poet and writer who considered free thinking and free speaking to be important values. He moved to Rotterdam where he became a wealthy pottery shop owner. In Rotterdam, Oudaen joined the Waterlandic Mennonite society because of their liberal philosophy. The Waterlandic community met every week for so-called colleges, just like the Remonstrant Collegiants. Oudaen worked towards merging these groups, but he did not manage to accomplish this. The main philosophy of the colleges was tolerance, but the different colleges each tried to claim the right of being the most tolerant which in itself led to rivalry.[60] Oudaen never really interfered with such rivalries. As for his own religious views, Oudaen was opposed to the dogma of the Trinity and seems to have been a Socinian: following the Italian theologian Fausto Sozzini (1539-1604), he regarded Christ as a man who became God instead of a God in human form. Despite his heterodox Christian beliefs, Oudaen was an adversary of Cartesian and Spinozian rational thinking as his hymns and psalms which he wrote show.[61]

It is of course not possible to say to what extent these views were of influence on Adriaen Verwer, even though Verwer occasionally indicated that the studies which he enjoyed in his youth had inspired him.[62] Nevertheless, a poem by Oudaen, printed on the first pages of Verwer's anti-Spinoza treatise *'t Mom-aensicht* gives a clear insight into the kind of warning which Oudaen gave against Spinoza and his followers. Oudaen rhymes that he is happy that someone has finally succeeded in writing a work which counters Spinozist philosophy.[63] The poem indicates that Oudaen and Verwer were on the same page when it comes to anti-Spinozist thinking.[64] The fact that these two men were involved in the same circle of thinkers, that they agreed in their anti-Spinozism, and that they maintained a correspondence until Oudaen passed away, leads us to believe that Verwer was influenced by Oudaen's teachings.

Move to Amsterdam

Verwer moved to Amsterdam in 1680 to pursue his career as a merchant.[65] With a background in literary studies, religion and law gained from his father's Mennonite contacts and through self-study, Verwer continued his involvement in philosophical and mathematical discussions in Amsterdam. He

---

[59] Verwer to Van Hoogstraten (1711), Leiden University (PAP15).

[60] Van de Bilt (2009), page 30.

[61] Entry "Oudaen, Joachim" in: *Biografisch Lexicon voor de Geschiedenis van het Nederlands Protestantisme*, Part 4 (1998), page 355-357.

[62] Verwer (1683) page xix.

[63] In chapter 2 we will revisit Oudaen's poem in more detail.

[64] Verwer (1683).

[65] Verwer mentions his moving to Amsterdam in the preface of *'t Mom-aensicht* saying that he moved "om den koophandel" on page xiv.

met many of the people whom we called "the Amsterdam mathematical amateurs" in the Introduction and thus his network was extended.[66]

In 1688, Verwer married Hester Pellewijk (1659-1723) with whom he got three children, Elisabeth (born 1691), Joanna (born 1694) and Pieter (1696-1757). Verwer and his wife were baptised at the Mennonite society "Lam en Toren" in 1689.[67] In the same year, Verwer became a "poorter" of Amsterdam.[68] This meant he gained special rights and privileges. For example, Verwer did not have to pay any toll in Holland and he was allowed to trade and be appointed for a governmental body. Verwer was an active participant of the Amsterdam society, commercial, religious and intellectual.

It was during this time that Verwer and his acquaintances learned of the publication of Newton's book *Principia*. One of Verwer's friends, Jean Le Clerc published an anonymous review of the *Principia* in his journal *Bibliothèque universelle et historique* in 1688.[69] Verwer owned a copy of the book, proven by the "ex libris" in his hand. During the same time, in 1691, he established a correspondence with the Scottish mathematician David Gregory (1659-1708).[70] These first letters have unfortunately not survived, but Verwer's reply to one of Gregory's letters is still extant. In a relatively long letter, Verwer discussed a number of mathematical difficulties which he had encountered while studying together with one of his acquaintances Jan Makreel (born ca 1653). Verwer also discussed his own philosophical interpretation of the study of mathematics and his attempts to connect mathematics with other kinds of knowledge. Additionally, Verwer brought Gregory up to date with the latest news from the Dutch Republic. We will look at this letter in detail in chapter 3. David Gregory visited the Dutch Republic in the summer of 1693. He bought books in Amsterdam from Jean Le Clerc and met with Christiaan Huygens and Burchardus de Volder.[71] It seems only logical that he met Verwer as well. It is not known how much contact Gregory and Verwer had during this period.

Verwer became a deacon for the Mennonite community in 1697. This implied that he was in charge of the financial matters of the community. While he was fulfilling this task, he published a work entitled *Inleiding tot de Christelyke Gods-geleertheid* (1698). Verwer explained that the *Inleiding* was based on his notes made over a couple of years, but possibly his closer contact with the

---

[66] Vermij (2003).

[67] This church community was the result of a 1668 merging of the Waterlandic community at Toren and the Mennonite society at Lam. Verwer was the deacon of Lam en Toren from 1697-1702. Van de Bilt & Noordegraaf (2001).

[68] "Handleiding Poorters 1531-1652" *Gemeente Amsterdam Stadsarchief:* https://archief.amsterdam/indexen/poorters_1531-1652/handleiding/index.nl.html#4QVJ

[69] Jorink and Zuidervaart (2012). It is understood that this review was written by Locke.

[70] Vermij (2003).

[71] Vermij (2003) page 186, Mijers (2012) pages 73 & 140.

religious community inspired him to write these notes up into a book.[72] There is little doubt that his experiences with Newton's text also played a role while writing. After publishing the *Inleiding*, he gave two copies to their mutual acquaintance, the Scottish law student Guilelmus Moncrief (born ca 1661), hoping that Moncrief would give one to Newton himself and one to the Scottish philosopher and historian Gilbert Burnet (1643-1715) who spoke Dutch.[73] Verwer wrote to Gregory to tell him about the publication of the *Inleiding*. This letter dates from 1703. Since Gregory did not speak Dutch, Verwer was forced to translate the main arguments of the *Inleiding*.[74] The letter also shows that the two remained in touch. In the letter, Verwer gave a number of updates on their mutual acquaintances. In addition to this, Verwer mentioned that he used all his spare time to study Newton's work and that he was most intrigued by it.[75] Verwer's fascination of Newton's mathematics resounded in his theological argument of the *Inleiding*.

In this research, we focus on Verwer's mathematics and natural philosophy. However, Verwer was most known for his work in linguistics and maritime law. In 1707, Verwer published the *Linguae Belgicae Idea Grammatica, Poetica, Rhetorica,* in which Verwer paves the way for an empirical study of the Dutch language. Verwer and his friend and student Lambert ten Kate are seen as the founders of a Newtonian study of the Dutch language.[76] In 1711, Verwer's *Nederlants See-Rechten; Avaryen; en Bodemeryen* saw the light. This work was a compilation of Verwer's studies in maritime law. Verwer was internationally renowned for his knowledge of maritime jurisdiction and was consulted by the editors of the French *Grande Ordonnance de la Marine* in 1681.[77] To this scholarship on Verwer, we want to add our research on Verwer's natural philosophy.

Adriaen Verwer died in 1717 and was buried in the Oude Kerk in Amsterdam.[78]

---

[72] Van de Bilt (2009) pages 34-35.

[73] Verwer to Gregory (1703), in Rigaud (1841), pages 248-253 and Van de Bilt (2009), page 35. Guilielmus Moncrief or Moncreif (1661-…) studied law at Leiden in 1689, aged 28 ("Guillielmus Moncreif, Scotus, 28, J." in *Album studiosorum Academiae lugduno batabae MDLXXV-MDCCCLXXV* (1875) column 706).

[74] Verwer lamented this necessity heavily and asked Gregory to find someone in Oxford who did speak Dutch so as to translate Verwer's masterpiece for him. Rigaud (1841).

[75] Rigaud (1841).

[76] Noordegraaf (2002) and (2004).

[77] Hermesdorf (1967).

[78] Van de Bilt (2009).

2. 't Mom-aensicht der Atheistery Afgerukt

Introduction

In 1683, Adriaen Verwer published his anti-Spinoza treatise *'t Mom-aensicht der Atheistery Afgerukt*. In this book, Verwer attacks Benedictus de Spinoza's philosophy of God and religion.[79] We have discussed the background of this polemic in the Introduction: Spinoza was seen as a threat by Verwer and his acquaintances because of Spinoza's allusion to atheism which was based on mathematical reasoning. In *'t Mom -aensicht* we see this threat being spelled out by Verwer. The tone of his argument is already set in the full title of the book: "the mask of atheism ripped off by a dissertation on the natural human order, containing not only an argument on orthodox theses, but mostly a thorough refutation of the contradictory delusional feelings and especially of the complete Ethics of Benedictus de Spinoza."[80] This rhetoric continues in a liminal poem where Joachim Oudaen celebrates the fact that according to him, Verwer had captured the atheist hellhound and stopped it from barking from its three throats.[81] With these strong metaphors, Verwer's argument is introduced.

We know that *'t Mom-aensicht* gained some attention in the late 17th and 18th century. Its arguments were repeated in Bernard Nieuwentijt's *Gronden van Zekerheid* (1720), which was directed against the way followers of Spinoza used mathematics. In Nieuwentijt's refutation, Verwer's arguments resound clearly. Nieuwentijt's logical empiricism to dismantle this Spinozist mathematics seems to be derived from *'t Mom-aensicht*. It is certain that Verwer and Nieuwentijt had contact in the 1690s, therefore such a conclusion is not entirely far-fetched.[82] Furthermore, the epistemology which Verwer constructed in *'t Mom-aensicht*, echoed in Lambert ten Kate's theories of linguistics. Verwer was Ten Kate's teacher and close friend and therefore this influence can be seen directly.[83] Lastly, it was rumoured that the collegian Johannes Bredenburg (1643-1691)

---

[79] *'t Mom-aensicht Der Atheistery Afgerukt door een Verhandeling van den Aengeboren Stand der Menschen, Vervattende niet alleen een Betoogh van de Rechtsinnige Stellinge; maer ook voornamentlijk een Grondige Wederlegging van de tegenstrijdige Waen-gevoelens en in 't bysonder van de geheele Sede-konst Van Benedictus de Spinoza* (1683) from here on abreviated to *'t Mom-aensicht.*

[80] Own translation of footnote 69.

[81] "den Hel-hond vastgelegt, en 't blaffen uyt driekelen bedwongen," Oudaen's poem in Verwer (1683), page xxii.

[82] Vermij (1991), page 17 and 114, also referred to in Jongeneelen (1996), page 16.

[83] As the linguist Jongeneelen describes on page 15.

decidedly threw out his Spinozist views after reading Verwer's *'t Mom-aensicht*.[84] Therefore it is clear that *'t Mom-aensicht* was read by Verwer's contemporaries and that his arguments found a larger public through Nieuwentijt.

According to Verwer, many of the debates in philosophy and religion are based on the difference between what he defines as theories of "dependency" and "independency". Proponents of dependency argue that all physical and real things are directly dependent on a non-physical being called God. Independency adherents, on the contrary, will claim that this dependency does not exist. They believe that the universe acts as a clock: once set in motion, it follows the universal rules as God had designed them without any further divine interference. Verwer's main goal of *'t Mom-aensicht* is to defend the dependency argument against the independents. Verwer in particular targets the "professor" of Independency: Benedictus de Spinoza.[85] His second book is dedicated entirely to refuting Spinoza's philosophy.

Verwer's main argument against Spinoza concerns Spinoza's method of argumentation. To refute this, Verwer first defines an epistemology based on the distinction between real ("wesentlijke") and hypothetical ("onwesentlijke") claims and arguments. This epistemology fits in with how Verwer's environment dealt with the Spinozist threat: Spinoza's claims were seen as being based on hypothetical arguments and therefore had no influence on reality. We shall examine how Verwer utilises this reasoning in the following chapter.

The analysis below first treats Verwer's division between "Dependency" and "Independency". We will see that Verwer makes a distinction between claims which are based on real arguments, and hypothetical claims which have no value for reality. We follow Verwer's argumentation on why Dependency is correct over Independency. This is the basis for Verwer's refutation of Spinoza, which is the topic of the second book of *'t Mom-aensicht*. We designate a number of aspects from Verwer's argumentation. We first discuss Verwer's ideas on the role which mathematics should play in philosophical discourse. Secondly, we turn to Verwer's distinction between real and hypothetical claims which recalls the Newtonian "hypotheses non fingo". This appears to be the basis for Verwer's empiricist epistemology which deserves a detailed discussion. The last point which we single out is on Verwer's refutation of Spinozist philosophy itself.

Dependency and Independency
According to Adriaen Verwer, the start and fundament of many a religious discussion is whether all things physical and real are dependent on some being which is separated from these physical things or not. This being is commonly called God. Verwer gives the two options a name so that he can easily

---

[84] Van de Bilt (2009), page 39.
[85] Verwer (1683), page 6.

refer to them when discussing the debates and arguments. The side which argues that "humankind together with all other things in this world, according to their natural order, depend on something above, which is separated from those things" Verwer defines to be called "Dependentie" (Dependency), while the side which believes that "it is independent of such thing" is "Independentie" (Independency).[86] On the Dependency side, Verwer ranks the Jews, Christians, Muslims and pagan elite. The Independency camp consists of the ancient wisdoms of figures such as Protagoras, Aristotle, and Plato, together with the more modern philosophy of Hobbes and Machiavelli, and their leader Spinoza. In addition to these names, Verwer claims that the people who are traditionally labelled as atheists, or "deniers of God", also belong to this category of Independency.[87] To show that Dependency is concordant with the natural order of humankind and all other things, Verwer discusses the debate on "plaetselijke beweging", *motus localis* or local motion.[88] The discussion evolves around the question of whether the motion belongs to the realm of the physical things or that of the non-physical.

Why Dependency is correct

Verwer announces that he wants to examine the first cause of motion, the *causa primaria*, and that this will necessarily lead to Dependency. This announcement is accompanied by a corpuscular theory: one should realise that "the physical things, which we encounter in real life, have been found to consist of countless number of particles and corpuscles; which, combined, build up such figures and shapes as we see and feel here in real life".[89] These particles determine the structure and form of that which is constructed by them. The things that really exist, Verwer calls them the tangible things, can be influenced by a "certain drift" which is given to them by an external source. This source is the tool, not the cause of the drift. The drift is called local movement and the detaining of this movement is called rest.[90] The cause of movement is Verwer's point for discussion.

To be able to discuss the cause of the movement, Verwer poses five "Algemene Kundigheden" which are in accordance with both Independency and Dependency. These common theses concern the essence of things. The essence of a thing which is tangible, Verwer says, is specific to that thing and cannot be separated from that thing without destroying or changing it. Besides, all

---

[86]"de menschen te gelijk met alle de andere dingen in dese wereld, ingesien in haren naturelijken stand, afhangende sijn van yet hoogers, dat van deselve is onderscheiden" Verwer (1683), page 5. "se van yet sulx onafhangende sijn" Verwer (1683), page 6.

[87] "God-verloochenaars" Verwer (1683), page 6.

[88] Verwer (1683), page xvii.

[89] "de stoffelijke dingen, die wy hier ontmoeten, bevonden warden te bestaen uyt ontelbare stofjes en lichaemtjes; welke, dus of soo te samen gevoegt, sulke gestaltens en gedaentens uyt maken, als wy hier sien en voelen." Verwer (1683), page 7.

[90]Verwer (1683), page 7.

physical bodies are subject to motion and movement or are at rest. The fifth and last thesis is more general and somewhat less tangible: "A thing, which one allows to be true, cannot be denied its existence, even though it might be unknown what its real essence is".[91] This will turn out to be extremely helpful when defining such matters as motion or the soul. From these five theses, Verwer then builds three propositions. He states that local movement does not belong to the realm of physical bodies. Hence, since it is common knowledge that there is such a thing as rest and movement, it must be attributed to something else. This leads Verwer to the corollary that the 'something else' is God and as a scholium he adds that we must conclude not only that there is a God, but also that God does not belong to the realm of physical bodies. Verwer's third proposition is that the physical things are the second (*secundaria*), or instrumental (*insturmentalis*), source of local movement, just as the racket was in the above mentioned example.[92] Here, now, the fifth common thesis comes in to play the primary cause of movement must exist, but since it does not exist in the physical world, we must ascribe it to God. Verwer's conclusion is then that all things must be dependent of one omnipotent, eternal, unstoppable and unchangeable God, since God takes care of the motion of all things.[93] Through this argument, Verwer uses examples based on mechanics to end up with a theological proof. The matters which Verwer discusses are not intricate or complicated, nor is his proof watertight. Yet, the combination between mechanics or natural philosophy and theology, is a returning theme in this research. An extra emphasis here merits this early example of Verwer's interest in natural philosophy.

Wesentlijke and Onwesentlijke concepts

An important part of Verwer's argumentation is a distinction between real concepts and hypothetical principles. Verwer calls them "wesentlijke" versus "onwesentlijke" entities, *entia realia* versus *entia rationis*.[94] Real are those things which have a referent in the real world, something tangible or in Verwer's words: "from which true things one can produce examples, which really exist in the universe".[95] On the other hand, "onwesentlijke" or hypothetical concepts, *gratis assumpta*, can "only be presupposed".[96] This distinction is fundamental in Verwer's argument and he says it is the first lesson of his book. All one needs to do is look at the principles on which an argument is built and

---

[91] The five "Algemene Kundigheden" are listed on pages 8 and 9 of Verwer (1683). The fifth thesis goes: "Een saek, die men anderssins toestaen moet dat'er waerlijk is, en kan, om de onbekentheid van hare wijse hoe se is, niet geloochent werden 'er te sijn".

[92] The propositions, corollary and scholium are displayed on page 11 of Verwer (1683).

[93] Verwer (1683), pages 11, 12 and 13 show these conclusions.

[94] Verwer (1683), page 2.

[95] "van welker waerheden men exempelen kan by brengen, die'er wesentlijk in dit Heel-al sijn" page 3

[96] "alleen by verstand voor-onderstelt worden" Verwer (1683), page 3.

whether they are real or hypothetical entities. That will determine whether it is a good argument or not since only arguments based on real principles can lead to something real. As an example Verwer discusses concepts in mathematics, where the "riffraff of hypotheses" is predominant but mathematical concepts can be real when they are applied to astronomy or mechanics.[97]

This brings Verwer to his second lesson. Real concepts and principles can lead to clear and distinct ideas. One should take care, however, to realise that clear and distinct ideas do not always lead to statements pertaining to reality, for clear and distinct ideas can be based on hypotheses.[98] Furthermore, when building up an argument, Verwer says there are two ways to discuss facts: either after the establishing fact or from the start, *a posteriori* or *a priori*.[99] For concepts which have a real referent, all foundations must be built up *a posteriori*, but if one wanted to say something hypothetical then *a priori* reasoning would be allowed. Verwer admits that sometimes in presenting ones argument it is more logical to write it down as if it were obtained *a priori*. However, this is merely a way of presenting it, not the actual reasoning itself. This second lesson is important to Verwer because he complains that in his century certain people have been playing with these clear and distinct ideas and have claimed that they were enough to say something pertaining real truths. These people are notably Descartes and Spinoza and their disciples. As we will see, this is Verwer's main argument against Spinoza and the Independency: that they build their argument on "onwesentlijke" foundations.

Verwer claims that Spinoza's proofs are all based on assumptions and purely mathematical reasoning. Such reasoning, Verwer argues, can never lead to real knowledge about actual concepts. No value for ethics and reality can be inferred from reasoning that is grounded on hypotheses. This statement recalls Newton's famous "hypotheses non fingo".[100] Newton's distrust of hypotheses was directed against the Cartesian philosophy, and Verwer seems to be reasoning along a similar line to

---

[97] "'t Heeft ons gelust dese voor-beelden by te brengen uyt de Wis-konst, om dat 'er geen wetenschap soo is als dese, waer in dat gespuys van voor-onderstellingen soo door, en weer door elkanderen swiert." Verwer (1683), page 3.

[98] "Allle wesentlijke waerheyd laet toe dat men 'er een klare en onderscheydentlijke bevatting van hebbe: maer *alle klare en onderscheydentlijke bevattingen is geen wesentlijke waerheyd*; om dat men ook klare en onderscheydentlijke bevattingen kan hebben van dingen die op voor-onderstellinge rusten, en daer van afgeleyt werden" Verwer (1683), page 4.

[99] "Dat'er tweederley middel is waer langs wy de saken kennen; Te weten of *van achteren*, (soo men het noemt) of *van voren*. *Van achteren* is, wanneer wy, by voorbeeld, uyt de kennis des gewrochts opklimmen tot de kennis des oorsaeks, en diergelijke. *Van voren*, wanneer wy uyt de kennis des oorsaeks afdalen om te besluyten de hoedanigheyd der gewrochten. Na naturelijk vermogen, waer van wy enkelijk spreken en kennen wy geene wesentlijke grond-saken anders als van achteren: wy seggen *wesentlijke*; want van *voor-onderstelde* saken konnen wy de eygenschappen en gevolgen wel van voren afleyden." Verwer (1683), page 17.

[100] "I feign no hypotheses." More on Newton's view of hypotheses and how he treated them can be found in Ducheynes'discussion of "The General Scholium: Some Notes on Newton's Published and Unpublished Endeavours." [preprint retrieved from: http://philsci-archive.pitt.edu/3461/ on 26-01-2016] .

counter Spinozian arguments. This shows that Verwer was not inspired by Newton to take up this line of argumentation, but was already working with this himself. It also unravels one of the factors which might have struck Verwer while reading Newton: they were quite like minded on this matter. Judging from *'t Mom-aensicht*, Verwer would approve of Newton's style of argumentation in the *Principia* and find extra arguments for his case in it too.

Mathematics and mos geometricus

Several aspects of Verwer's use of mathematics are interesting to examine more closely. It appears Verwer was an accomplished mathematician, since he uses multiple examples from mechanics and mathematics to illustrate his point. When Verwer describes the difference between "onwesentlijke" and "wesentlijke" arguments, he gives the example of how all three angles of a triangle will always add up to 180°, just like two right angles. This, Verwer claims, is based on real arguments since one can measure this in reality.[101]

How, when and where Verwer studied mathematics is unclear. Perhaps his mathematical knowledge was a result of his education which Verwer received from his father's network of acquaintances in Rotterdam or with his own circle of acquaintances in Amsterdam. There are no other mathematical examples or arguments in Verwer's *'t Mom-aensicht*, but the structure of his argumentation is mathematical. As discussed above, Verwer defines a number of "Algemene Kundigheden" which both sides of the debate agree on to hold in all cases and these theses are the basis of his argument. After this, Verwer gives three propositions, each with their own proof, and he closes the argument with a corollary and a scholium. This mathematical way of constructing an otherwise philosophical argument was common in Verwer's time and added a certain amount of authority to the proof. Even though using mathematical methods conveyed a certain authority to the argument, Verwer warns the reader that pure mathematics is something to avoid. He says that in no other discipline of knowledge the difference between "wesentlijke" and "onwesentlijke" is as vague as in mathematics. Concepts like a circle or a plane rest on hypothetical arguments when they are used only in pure mathematics.[102] Pure mathematics which is not applied to real life concepts is considered as hypothetical. However, when there is an actual referent, a link to reality, Verwer

---

[101] "insgelijkx (om een uyt vele te nemen) het betoog in de Meet-konst, dat de drie hoeken eenes driehoeks even soo veel doen als twee reghte; (…), rusten op *wesentlijke* gronden: want de beginselen (…) zijn'er wesentlijk te toonen" Verwer (1683), page 3. Such basic properties of a triangle are from Euclid, *Elements* books 1 to 4.

[102] "Want in de Meet-konst moeten wy de Lijnen en Vlakken voor-onderstellen als onlichamelijk" Verwer (1683), pages 3 and 4.

claims that mathematics can lead to the truth, for example when measuring or weighing items ("in de Weeg-konst").[103]

Verwer makes it clear that as soon as mathematical concepts can be connected to notions which exist in reality, then the mathematics can be applied in arguments to approach truth. This is important in Verwer's refutation of Spinoza's *Ethica, Ordine Geometrico Demonstrata*. As the title suggests, Spinoza's work was ordered in a "geometrical" way. This style of argumentation is called *mos geometricus*: the manner of geometry. This was utilised in many treatises on all kinds of topics. Famous examples are, apart from Spinoza's *Ethics*, the works of Descartes and Leibniz. Traditionally based on the Euclidean style of reasoning built up from axioms to hypotheses, propositions and theorems, this style is easily associated with mathematical proofs. The strength of this style is based upon the idea that mathematical proofs are decisive: when something has been proven using correct mathematics, then there is no way to refute it, apart from attacking it with better mathematics. Paul Weingartner discusses the *mos geometricus* in Descartes and Leibniz, connecting it to rationalism of the seventeenth and eighteenth centuries.[104] The method rests on the idea that there are such things as "first evident principles" which are the source of human knowledge and from which theorems and further knowledge can be derived using logical and mathematical principles of deduction. There is a truth criterion by which these principles can be selected and the principles are built up out of "primitive innate ideas" or concepts. Starting from a complex idea, there are logical and mathematical principles of definition which can reduce such complex ideas to primitive ideas and there are criteria to select the primitive ideas from other ideas.[105] For the *mos geometricus* it is important that statements are arranged in a deductive system of axiomatic character, in which the first evident principles are the axioms and the deducted statements are the theorems.[106] In this sense, *mos geometricus* can be seen as a complete deductive system, and it was used in various fields such as logic, mathematics, physics, jurisprudence, meta-physics, and natural theology.[107] According to Weingartner, these *mos geometricus* principles can be seen as the first normative principles of a general methodology of all sciences.[108]

As Verwer says several times in *'t Mom-aensicht*, he attempts to show that Spinoza's mathematics is misleading since there is no referent to reality. Therefore Spinoza remains in the realm of hypotheticals and his arguments can never say something with value to ethics or reality. Even though Spinoza reasons in a mathematically structure way, Verwer argues that Spinoza will not

---

[103] Verwer (1683), page 4.
[104] Weingartner (1983).
[105] Weingartner (1983), pages 151-152.
[106] Weingartner (1983), page 159.
[107] Weingartner (1983), page 168.
[108] Weingartner (1983), page 171.

reach any truths since he continuously poses hypotheses. An opposite method of reasoning can be found in Newton's work. Newton's *Principia* is also ordered in an axiomatic way: starting with his laws of motion as the axioms, Newton builds his theorems on these laws. As Newton promises in the title of the *Principia*, he focuses on the mathematical principles of how the universe works. In doing so, Newton does not specify how things work or act, but what the mathematical principles are. Newton formulates mathematically descriptive laws, a set of causal conditions for forces and motions, which he deems to be both true and sufficient to explain the phenomena.[109] Here Newton continuously makes a distinction between the mathematical principles to describe the phenomena and the natural philosophy with which to explain the origin of the phenomena.[110] Newton does not formulate hypotheses on the origins of the phenomena, but sticks to descriptive reasoning based on how the phenomena work. It is clear that this is method of reasoning would appeal greatly to Verwer. Newton's main critics, such as Christiaan Huygens, were those scholars who did not accept this operative level of reasoning and asked for knowledge with a conceptual basis, but this is exactly what Verwer seems to be looking for.[111]

Already in 1683, Verwer is decidedly against Spinozist and Cartesian style mathematical reasoning, which depends too much on reasoning and too little on actually phenomena. Hence, Verwer aims to find a different kind of mathematics, or mathematical reasoning which is used in a better way, in order to completely refute Spinoza. Since Spinoza's mathematics is incorrect, Verwer promises that one of his methods to "unmask" Spinoza will be by undoing Spinoza's arguments of their mathematics. By doing this Verwer believes he will be closer to what Spinoza actually means and will be misled less. In the following we look at how Verwer realises this refutation of Spinoza.

Refutation of Spinoza and the Independency

Verwer's motive for writing this book is to present a refutation of the arguments from the "Independency" side. From this "gang"[112], he picks Benedictus de Spinoza as the leader: "and that is why we have chosen this target, to whom all our questions will be directed, and who will figure as centre of our discussion".[113] Verwer promises to translate Spinoza's arguments from Latin to Dutch. By doing so, Verwer believes he will be able to unmask Spinoza for what he really is, namely one of

---

[109] Cohen (1995), page 131-2.
[110] Cohen (1995), page 135.
[111] Cohen (1995), page 143.
[112]"Daer en is neimand onder de ganstche Bende, die soodanig sijn werk gemaekt heeft, van dese opinie op ordentelijke voeten te setten" Verwer (1683), page 50.
[113]"en daerom hebben wy desen uytgekipt om het eigenlijke doelwit te verstrekken, waer op alle den uitstrek onser bedenkingen sal gemikt, ende als in een middelpunt te samen vergadert sijn" Verwer (1683), pages 50 and 51.

the "Independents".[114] In addition to a translation from Latin to Dutch, Verwer also plans on undoing Spinoza's arguments of their geometrical reasoning. When Verwer introduces Spinoza on page xiv of his Preface, he says that Spinoza has led the entire world by the nose in teaching delusional claims.[115] Verwer says that Spinoza accomplished this because in his *Ethica* Spinoza argues using geometry. If one is not used to such reasoning, Verwer claims, then it is logical that one loses a feeling for what is true and what is not. The difference between hypothetical arguments and real claims is much more subtle due to Spinoza's use of geometry.[116] Therefore, to make the material more accessible for his readers, Verwer announces that he will present its contents in the form of theorems which are written out and divided into three topics: on Spinoza's concept of God, on humankind, and on the highest virtue.[117] In the following ten pages Verwer indeed lists the theorems containing the elements on which he believes Spinoza builds up his philosophy, including the Spinozist idea of equating God to Nature (*Substantia*).[118] According to Verwer, an "incurable misunderstanding" arises when one claims that this God or Nature is the same God as the one in Dependency.[119]

---

[114]"Dan vertoonen wy u de Hooft-somme van alles wat hy op dien grond heeft gebouwt, soo als wy't self uyt den Latijnschen Grond-text heb ben getrokken en vertaelt met aenwijsing van Kapittel, en, Vers. In onse vertaling hebben we 'er de doekjes, die 'er in den Grond-text omgewonden sijn, niet omgelaten, maer 'tMom-aensicht vryhartig afgerukt, en 't gene onderbedekte woorden altoos was bewimpelt geworden, in sijn eigentlijke gedaente bloot-geleyt" Verwer (1683), page xix.

[115] "En hierin is het, dat hy de gantsche Weereld heeft by de neus geleidt" Verwer (1683), page xiv.

[116] "'t welk hem des te beter kon gelukken eensdeels om dat hy sijne soo-genaemde Seden-konst door den haspel van een meetkonstige ordre, waer op hy de selve heeft verhandelt, voor een yder en insonderheid voor Duytsche Klerken soodanig door elkanderen heeft gedraeit, dat eenen, die aen diergelijke ordre niet gewend is , het eind van den draed flux uyt de Vingeren slipt ; en anderdeels om dat de meeste menschen soo scherp van opmerking niet en sijn, dat se al schoon verre (soose wanen) in swier van Redenkaveling gevordert , 't naeu-luysterend onderscheid tusschen Voor-onderstelling en grondig Betoog eens weten na te gaen." Verwer (1683), page xiv; "De bysondere stellingen by hem op desen grond gebouwt, staen in sijn nagelaten Schrift, genaemt de Sede-Konst; doch aengesien hy de selve heeft ter neder gestelt langs een ordre, die in de Wis-konst gebruykelijk is; en dat de minste menschen gewoon sijn de dingen daer langs te vatten, soo hebben wy, tot gemak van de lesers en ook van ons selven, haren voornaemsten inhoud in een kort begrip getrokken ende hier vervolgens ingelijft; behoudende, over al de uytdrukkingen van den Schrijver, soo als wy die uyt het Latijn in dese onse Tael na harern eysch hebben moeten vertalen, met aenwijsinge van de plaetsen waer uyt elk genomen is" page 54; and "want door die Wiskunstige ordre heeft het den *Aucteur* seer wijds en sijds van den andere weten te verspreiden, soodanig dat'er om het wêer kort in een te begrijpen, ('t welk nootsakelijk is, wil men 't verstaen, en noch meer als men 't wêerleggen wil) vereyscht wierde een meer als gemeene aendacht en opmerking, ende grooter, als 't den meesten menschen, en verstands- en tijds-halven te pas quam daer toe over te geven." page 63.

[117] "van het AL (by hem *God* genoemt), van den Mensch, en van 't hoogste Goed" Verwer (1683), page 54.

[118]Verwer (1683), pages 54 until and including 63.

[119] "ongeneeeslijk misverstand" Verwer (1683), page 53.

Following this enumeration, Verwer starts his test of the Spinozist argumentation on the grounds of Independency.[120] The main issue, Verwer argues, is that Spinoza is not able to give a proof of Independency but that his arguments are mostly founded on Independency principles. Verwer projects Spinoza's core theorem as the statement that "all things exist as they are at their highest and upmost potential" (Verwer's phrasing of *Natura naturata*).[121] Here Verwer argues, Spinoza bases his argument completely on Independency, while he is unable to prove that things are indeed independent of a being like God. Verwer states that Spinoza thus tries to prove a claim with a claim which is hypothetical in itself.[122] This brings Verwer to the conclusion that Spinoza has founded his work entirely on hypothetical arguments. Moreover, since Verwer himself has proven that Dependency does hold true, it is not possible to prove Independency. "What, then, can one say of the building on which is built on a foundation as such?" Verwer asks his reader. Surely nothing else than that it will collapse immediately when the storms and winds of Dependency come roaring past.[123] The fact that Spinoza's reasoning is based on unprovable Independency, as Verwer argues, also has its consequences for Spinoza's arguments about issues pertaining to reality, like the cause of local motion.[124] Spinoza cannot claim to argue anything which can be applied to reality, since his reasoning is based purely on hypothetical claims.

Ambiguous role of Spinozist philosophy

Considering Verwer's refutation of Spinozist philosophy, some comments can be made. A scholar of the history of linguistics in the Dutch Republic, Gerrit Jongeneelen does this in his suggestively titled "Disguised Spinozism in Adriaen Verwer's *Mom-aensicht*".[125] Jongeneelen's main point is that since Verwer only refutes those Spinozist theses which are atheist and based on autonomous and hypothetical reasoning and adapts the rest of Spinoza's philosophy to Renaissance conceptions of natural law and analogy. There is some disguised Spinozism in Verwer's argument. When it comes

---

[120] "Tweede Hooft-Deel: *Behelsende een toetse van de Redenering of belijdenis van B. de Spinoza wegens de grond der* Independentie" Verwer (1683), page 64.

[121] "dat alle dingen op die wijse als se bestaen, juist bestaen na't hoogste en opperste vermogen dat'er is" Verwer (1683), page 64.

[122] "Nu en kan yet geen bewijs verstrekken van dat gene, waer van het self sijne sekerheid noch eerst ontleenen moet" Verwer (1683), page 64.

[123] "wat valt hier uyt te besluyten van het heele Gebouw, 't welk daer op gesticht is? niet anders, dan dat, soo dra de stormen en winden der *Dependentie* daer met kraght op aen ruysschen, het in een ogenblik ter neder stort" Verwer (1683), page 66.

[124] "En 't is'er soo verre van daen, dat in het tegendeel de Filosofie van Spinoza niet alleen seker alleruiterste beginsel voor-onderstelt, gelijk gemeen is: maer daer-en-boven moet sy noch van armoede, in seker stuk, voor-onderstellen, waer in de Godsgeleertheid ofte de *Dependentie* by Betoog gaet; te weten in de eerste oorsaek der plaetselijke beweging" Verwer (1683), page 78.

[125] Jongeneelen in Van Bunge & Klever (eds.) (1996), pages 15-21.

down to especially politics and metaphysical epistemology, Verwer discards Spinoza's ideas as hypothetical and therefore not related to reality.[126] Instead of on Spinoza, Verwer leans on the Renaissance idea that civil society is based on freedom and equality.[127] According to Jongeneelen, Cartesian and Spinozist ideas preluded a break from the scholastic tradition, since Descartes and Spinoza based their arguments on rationalism and sceptical doubt. From this point of view, Jongeneelen sees Verwer's refutation of Independency as an attempt to re-establish the link between Enlightenment and Renaissance theories of natural law and humanist political thought.[128] This broader context is interesting, but does not hold for our research. Verwer used mathematical arguments in his refutation of Spinoza: by refuting Spinoza with a better mathematical method than Spinoza used himself, Verwer would be successful in his argument. Jongeneelen's claim that Verwer's arguments stem from Renaissance theories then no longer holds.

Verwer appropriated or even judged positively certain Spinozist arguments, while those that are based directly on independency are refuted. Jongeneelen gives the example of Verwer's positive reaction of Spinoza's analysis of the passions.[129] Indeed, Verwer takes up these concepts and sees certain links with Dependency. However, after discussing Spinoza's theory of how passions can be influenced, Verwer has to conclude that Spinoza's ideas are "not applicable to a state of Dependency".[130] Verwer's "positive reaction" is short-lived: the connection between Spinoza's ideas and Independency is too strong and Verwer's attempt to separate them and only appropriate the Dependency arguments succeeds partially. Hence, Jongeneelen's image of a cherry-picking Verwer is not entirely tenable. Nevertheless, Verwer does make a selection of statements which he decides to attack Spinoza on. These are all on autonomous reasoning and hypothetical argumentation. Other elements of Spinozist philosophy are not treated. In that sense, Verwer's selective refutation does come to the fore.

---

[126] Jongeneelen (1996), page 17.

[127] "Dit opsicht dan, waer in de menschen staen tot hare even-menschen, is, in 't kort geseyt, *vryheid* en *evengelijkheid*. Dit opsicht is het, 't welk anders ook genaemt werd *aengeobren* ofte *ingeschapen Recht*; door een selve verbloemde wijse van spreken, als de eeuwige waerheden *ingeschapene denkbeelden* geheten werden: Het uiterste einde, dat in dit opsicht leyd, *behoudenis en handhaving van deselve*; en het middel (anders *deugd*) daer toe leidende, *Regtvaerdigheid*." Verwer (1683), pages 32-33, start of the third chapter "Van het opsicht, waer in de mensch staet tot sijnen even-mensche".

[128] Jongeneelen (1996), page 19.

[129] Jongeneelen (1996), page 19.

[130] "Dese stelling is enkel gegrond op de *Independentie*, ende wel bysonderlijk op die opinie die Spinoza heeft wegens de natuer der *denking*. En daer uit siet men dan, datse niet toepasselijk is tot den staet der *Dependentie*" Verwer (1683), page 84.

Empiricist epistemology

According to Jongeneelen and Igor van de Bilt, Verwer creates an empiricist epistemology which turns out to be most fruitful for eighteenth century linguists and physico-theologians.[131] This empiricist epistemology rests on the basis of distinguishing between hypothetical and real arguments and concepts. Real knowledge according to Verwer is produced with concepts which correspond to things that really exist.[132] Verwer's refutation of Spinoza is an example of the criterion for this epistemology. From here, Jongeneelen demonstrates how this leads to Verwer's semantic epistemology, something we will discuss in more detail later on. Jongeneelen goes into quite some detail on Verwer's linguistics, which is a logical consequence of the fact that Jongeneelen is a scholar of the history of linguistics himself. He mentions, but does not expand on, the link Verwer had with physico-theology and how Verwer's empiricist epistemology is applied there. Our research picks up where Jongeneelen leaves us to look more closely at Verwer's interest in physico-theology.

The emphasis which Verwer puts on distinguishing between real and hypothetical claims, the basis of Verwer's epistemology, can be found to echo in the Newtonian philosophy of "hypotheses non fingo". Furthermore, it is also part of the main argument in Nieuwentijt's *Gronden van Zekerheid*. Since Bernard Nieuwentijt is commonly seen as one of the founding fathers of physico-theology, we see that Verwer was not unique in defining his epistemology as such.[133] Indeed, it fits in with the reception of Newtonian thought in the Dutch Republic as described by Jorink and Zuidervaart.[134] The need to refute Spinozist thought was urgently felt in the religious scholarly community. The main arguments are provided by Verwer in *'t Mom-aensicht*: the all-important distinction between real and hypothetical claims. When studying Newton, Verwer and his colleagues found their prime example of how such distinction could be applied using mathematics in search of the truth about the universe.

---

[131] Van de Bilt (2009), page 41. Jongeneelen (1996), page 21.
[132] Jongeneelen (1996), page 16 and 21.
[133] Vermij, (1988) and (1991).
[134] See also the Introduction.

3. Corresponcence of Adriaen Verwer and David Gregory

Introduction

In August of 1691, Adriaen Verwer wrote a "very long difficult letter to a kindred spirit" which he had found in the Scottish mathematician and Newtonian Dr David Gregory (1659-1708).[135] The topic of the letter is a number of problems which Verwer encountered during his studies of mathematics. He asks Gregory to give his opinion on these problems and is curious to learn more about Gregory's work. It is clear that Verwer considers Gregory an authority on the topic and speaks highly of Gregory's knowledge and opinions. Verwer's letter has not been studied in detail before, which is surprising since it contains many references to Verwer's friends and colleagues which help to contextualise early modern natural philosophy in the Dutch Republic.[136] In this chapter we study the letter, its content and its context. The question we ask ourselves throughout this chapter is what was the reason for and the nature of Verwer's interest in David Gregory and his mathematics? To be able to answer this question we first need to understand in what context this letter was sent. We will examine David Gregory and what he was working on, placing the 1691 letter into this picture and seeing how it fits with Verwer's timeline. Secondly, we research the letter itself, its main topics and the references to friends of Verwer. Verwer's mathematical problems are on methods of finding tangents and describing series and ratios. We look at his exercises and try to place them within the larger picture of seventeenth century mathematics. After we have seen which mathematical topics Verwer worked on when writing Gregory, we can see evidence of this work in Verwer's annotations in the *Principia,* discussed in chapter 4. Furthermore, Verwer is keen to stress the connection between mathematics and all other knowledge. This leads us to chapter 5 and Verwer's work in the *Inleiding tot de Christelyke Gods-geleertheid*, published in 1698.

The 1691 letter is one of two surviving letters between Adriaen Verwer and David Gregory. Unfortunately Gregory's letters sent to Amsterdam have been lost: the two remaining letters were both written by Verwer. The second letter was sent in 1703 and is included in Rigaud's *Correspondence of Scientific Men of the Seventeenth Century*.[137] Judging from the 1691 letter,

---

[135] As described in EMLO catalogue: http://emlo.bodleian.ox.ac.uk/profile/image/acfe10e2-82bc-4948-9442-ae93221a45c4 . The letter itself can be found in the Bodleian Library Oxford, MS Tanner 26 folio 42, 46 and 47.

[136] The letter is mentioned in, amongst others, Vermij (2003), Jorink and Zuidervaart (2012), Van de Bilt (2009), Jaski (2013), and Mijers (2012).

[137] Rigaud (1841) pages 248-253.

Gregory first sent a letter to Verwer which was received in Amsterdam on the 21st of May 1691.[138] According to Vermij, this was the first contact between the two men, but it is almost impossible to consolidate this.[139] We indeed find traces of this earlier contact in the letter at hand. However, Verwer also thanks Gregory for answering a question which he had asked Gregory.[140] This means that there must have been contact between the two men already previous to the letter Vermij refers to. Therefore it is uncertain when the relationship between Verwer and Gregory was established. Nor are we sure about the size of the correspondence between Verwer and Gregory..

David Gregory

Before we analyse the contents of the letter, the recipient requires some introduction. David Gregory was born in Aberdeen in 1659.[141] He was the fourth of what would be a total of 29 children of David Gregorie of Kinairdy. Gregory's uncle, James Gregory (1638-1675) was professor of mathematics at St Andrews and later in Edinburgh and was known for his work on the reflecting telescope and his dispute with Huygens.[142] In 1695, Gregory married Elizabeth Oliphant of Langton and they had 9 children together. Gregory died of sudden illness on the 10th of October 1708 at Greyhound Inn, Maidenhead, Berkshire and was buried in Maidenhead churchyard.[143]

David Gregory started his academic career at Marischal College, University of Aberdeen. After his uncle James died in 1675, he began to study mathematics along with the papers which James had left him. Gregory left Scotland in 1679 to visit several countries on the Continent, including the Netherlands. We find his name, written as "David Gregorie, Scotus" in the matriculation list of Leiden University of 1679, where he studied mathematics.[144] Gregory returned to Scotland in 1681 and lived at Kinairdy where he studied his uncle James' papers. In 1683, at the age of 24, he was appointed to the chair of mathematics at Edinburgh. At the same university, Gregory became friends with the professor of medicine Archibald Pitcairne (1652-1713) and together they became ardent admirers of Isaac Newton.[145] In 1684, Gregory published his *Exercitatio Geometrica de Dimensione Figurarum* which contained little original work, but was mostly based on papers that he

---

[138] "quas [literas] ad xii kalend. Junias ad me dare dignatus es".

[139] Vermij (2003), page 186. "In 1691 Gregory wrote to the Amsterdam Mennonite merchant Adriaan Verwer in order to establish a scientific correspondence. Verwer answered in a long and enthusiastic letter".

[140] Verwer writes: "tu reponis ad meum quaesitum".

[141] This extremely detailed time and place of birth is cited in Lawrence and Molland (1970) on page 144.

[142] Stewart (1980).

[143] Lawrence and Molland (1970).

[144] "David Gregorie Scotus. 22, Mat." page 631 of *Album studiosorum Academiae Lugduno Batavae MDLXXV-MDCCCLXXV*, published in 1875, edited by William N. Du Rieu. Digitally available at HathiTrust: http://catalog.hathitrust.org/Record/100206981 Interestingly, Gregory was actually 20 years old at the time, but apparently pretended to be 22.

[145] Stewart (1980), Jorink & Zuidervaart (2012) and Krop in van Bunge (2003), pages 173-196.

had bequeathed from his uncle James.[146] When Newton's *Principia* was published in 1687, Gregory studied it in detail: he started his *Notae* of the *Principia* in September of 1687.[147]

Gregory's faith and political views are not at all clear or easy to grasp since he was not one to engage publically in political or religious controversies, contrary to his friend Pitcairne.[148] Gregory's Scotland found itself in turbulent times. The Glorious Revolution of 1688-9 which saw the deposition of James II as mentioned in the Introduction, also had its consequences in Scotland. The inauguration of William and Mary meant the abolishment of the Episcopalian rule of Scotland. This had direct consequences for Gregory and Pitcairne. Gregory and Pitcairne were followers of the Episcopalian church, which, up until the Glorious Revolution, had maintained a hierarchical structure of rule, with a King and bishops. When Presbyterianism was re-established as the state religion, this was not to the liking of Gregory and Pitcairne. As Presbyterians rejected the order of the bishops, Gregory and Pitcairne saw this as a disturbance of social order. Furthermore, Presbyterianism, being hard-line Calvinists, was exceedingly dogmatic and hostile towards new learning. This lead Episcopalians to develop a dislike towards Calvinism and dogmatism, and at the same time adopting degrees of latitude in manners of religious doctrine.[149] Because of this tolerant attitude, the Episcopalian intellectual outlook was quite similar to the English Latitudinarians. It should be noted, however, that Episcopalian church is considered High Church and politically this is associated with Tory, while Latitudinarian church is Low Church and Whig. Hence, politically speaking, Episcopalians and Latitudinarians were at different ends of the spectrum. Intellectually speaking, on the other hand, they can be considered to be very close together. As we have discussed in the introductory chapter to this thesis, Jacob established that there was a strong connection between Newtonian philosophy and English Latitudinarianism.[150] From the theological comparison of Latitudinarianism and Episcopalianism, similar arguments for a connection between Episcopalians and Newtonians can be made. Friesen does this for the case of David Gregory and Archibald Pitcairne.

Gregory and Pitcairne found a useful antidote in Newton against religious enthusiasm and sectarian violence. Studying Newtonian natural philosophy was particularly attractive for Gregory and Pitcairne as a means to counter Presbyterian anti-intellectualism.[151] In Newton, Gregory, Pitcairne and their circle saw a way to reintroduce the order which Presbyterian rule was threatening. With Newton's mathematical natural philosophy, a more certain picture of how the universe operated could be drawn. The language of the *Principia* was seen as a discourse of order,

---

[146] Stewart (1980).
[147] Whightman (1957), pages 393-394.
[148] Friesen (2003), page 6.
[149] Friesen (2003), page 5.
[150] Jacob (1976).
[151] Friesen (2003), page 5.

with its mathematical reasoning and geometrical strucutre.[152] Pitcairne and Gregory attributed a lot of value to geometrical demonstrations and aimed to use such methods in Scripture as well.[153] In the early years after the Glorious Revolution, such attitudes were not uncontroversial. Even though Gregory never spoke publically of his anti-Presbyterian sentiments, he was accused of atheism in 1690 by the Visitation Committee whose task it was to judge whether those in high position at the Scottish universities were indeed suitable for the new political and religious regime. Furthermore, he refused to sign the Confession of Faith and so did not submit to the requirements set by the new regime.[154] Gregory was spared from any punishment, but he moved to Oxford the same year.

Gregory was appointed Savilian Professor of Astronomy at Oxford in 1691. He achieved this not only thanks to his own scientific competence but also via a testimonial from Newton.[155] Gregory and Newton were very close, they worked on a second edition of the *Principia* together and Gregory functioned as a messenger from Oxford to Newton at Cambridge. Through this role, Gregory was in contact with many leading mathematicians at the time who wanted their work read by Sir Isaac Newton. It is in 1691 that the correspondence between Gregory and Amsterdam was initiated. Gregory reported to Newton about the correspondence with his Amsterdam friends to Newton. In a letter dated on the 27th of August 1691 Gregory says "Yesterday I got letters from those Amsterdamers of whom I spoke to you".[156] From what follows we can conclude that Gregory refers to the letter which we discuss in this chapter.

The connection between Gregory and Verwer was maintained. In the summer of 1693, Gregory made a visit to Holland. He bought books in Amsterdam with Jean Le Clerc and seemed to be especially interested in the mathematicians at Leiden and Amsterdam. It is certain that he met Christiaan Huygens and, having established a connection through the discussed letters, Gregory consolidated his contact with Verwer, together with Burchard de Volder, Arnoud Leers and Pieter vander Aa.[157]

Verwer's answer to Gregory is a six page Latin letter which we can divide into three main topics. It should be noted that Verwer does not mention Newton in his letter. In 1691, Verwer was probably studying the *Principia* together with other contemporary mathematical literature. It is therefore interesting to find out what Verwer was working on at the time and what problems he encountered which he wants to discuss with Gregory. The first thing Verwer does, is update Gregory on what is going on at the universities of the United Provinces. He mentions a number of people who

---

[152] Friesen (2003), page 16.
[153] Friesen (2003), page 9.
[154] Friesen (2003), page 8 and Stewart (1980).
[155] Stewart (1980) Newton favoured Gregory above Halley, whom Newton considered to be of lesser faith.
[156] *The Correspondence of Isaac Newton, volume III* page 165-6.
[157] Quoted from Gregory's memoranda by Vermij (2003), page 186, note 15.

are studying mathematics as well. Hence the first topic we distil from the letter is the Dutch context based on the names which Verwer mentions. After this update, Verwer commences with more mathematical subjects. He asks Gregory several questions of which he needs verification or more explanation. Verwer's mathematics will be our second topic. Third, Verwer discusses a topic which lies close to his heart: the connection between mathematics and other knowledge and natural philosophy. Here we see what value Verwer attached to mathematics in his quest for truth and this step is central in this thesis on Verwer's interest in Newtonian mathematics and its usefulness.

Updates on Dutch affairs

Verwer updates Gregory on the activities of some of the people who can be considered as members of the "Amsterdam mathematical amateurs".[158] They are Johannes (Jan) Makreel (born ca 1653), Johannes Hudde (1628-1704), Abraham de Graaf (1635-1717), Jean Le Clerc (1657-1736), and Burchardus de Volder (1643-1709). Especially Makreel is often mentioned. Makreel was a broker living in Amsterdam who was important in the intellectual life of the town. He was in contact with German philosopher Ehrenfried Walter von Tschirnhaus (1651-1708).[159] Throughout the letter, Verwer makes it clear that he and Makreel have been studying and discussing mathematical problems together. Verwer poses some questions to Gregory which Makreel brought up while studying.[160] Verwer and Makreel do not always agree, and at times Verwer asks Gregory to choose sides.[161] The cooperation between Verwer and Makreel shows that the task of understanding this mathematics was taken seriously by both men and that it was not an straightforward one. Not much is known of Makreel, unfortunately. Vermij calls him one of the well-off gentlemen who worked on natural philosophy as a hobby.[162]

Makreel is considered to be part of the mathematical amateurs group, of which Verwer also mentions Johannes Hudde and Abraham de Graaf. Hudde was at the time of Verwer's writing predominantly busy with his task as burgomaster of Amsterdam, a role he fulfilled 19 times after 1663. Before that, Hudde worked on mathematical problems and was relatively well known for his work. Especially his work on theories of maxima and minima of equations, first mentioned in 1658, was well known. Verwer also alludes to work by Hudde and says that Hudde is momentarily too busy

---

[158] Vermij (2003), see also Introduction.

[159] Vermij (1988).

[160] "Estque ejus sententiae D[ominius] J[ohannes] Makrell".

[161] "et sin minus, exiguae quadam operatiuncula absurditatem indices (negat verum esse D. Makrell, sed non demonstrat) et si quidem verum sit, determinationem ejus puncti uno aut altro exemplo analytice exhibeas et quidem universaliter,".

[162] Vermij (1988), page 160.

to do any more mathematics.[163] The same holds for De Graaf, a mathematician and nautical scholar, who according to Verwer has retired apart from his work for the VOC and that De Graaf might publish something about this.[164] De Graaf was working on several different algebraic topics and Verwer mentions a work in which De Graaf comments on Descartes.[165] A fourth mathematical amateur which Verwer updates Gregory on is Jean Le Clerc (Johannes Clericus). Originally a Swiss, Le Clerc was a theologian and philosopher who was for a time professor at the Remonstrant seminary of Amsterdam. Le Clerc was a friend of John Locke's who was in the Dutch Republic from 1683-1688.[166] Le Clerc is mentioned as editor of the journal *Bibliothèque ancienne et modern*. Verwer tells Gregory that if Gregory has any intention of publishing in the Dutch Republic, Verwer would be able to arrange this through his friend Le Clerc. [167]

Verwer also speaks of Burchardus de Volder, professor of philosophy at Leiden, who according to Verwer is having a bad time there because of censorships and strict rules.[168] De Volder had met Newton in 1674 and was very much impressed by him, Boyle and Hooke at the Royal Society. So much so in fact, that De Volder initiated the foundation of a *theatrum physicum* at Leiden. He remained a good contact of Newton's, judging from the fact that he received an author's copy of the *Principia*. De Volder never publically advocated Newtonian philosophy, however.[169] Apart from these mathematical amateurs, Verwer also mentions other, more established mathematicians: he says that he does not know what Christiaan Huygens (1629-1695) is up to nowadays and he refers to a publication of Gerard Kinckhuysen (ca 1625-1666).[170] From this we conclude that Verwer was active in both the informal mathematical scene and that he was also well read in scholarly mathematics.[171]

---

[163] "Johannes Huddenius, magistratu hic fugens summo cum decore; at curis Reip [rei publicae]; adeo distractus atque distentus ut labente aetate frustra quidquam de eo inposterum expectemus."

[164] Nieuw Nederlandsch Biografisch Woordenboek, part 10, page 293
http://resources.huygens.knaw.nl/retroboeken/nnbw/#source=10&page=154&view=imagePane .

[165] "De Abrahamo de Graaf, viro mihi familiari, aliud non habeo quod addam nisi quod jam cum aetate provectiori studiis metam videatur posuisse nam post Algebram 1672, nihil molitus est, praeter quam quod praefectus si examini nauclerorum societatis Indicae, atque ita in eorum commodum luci dederit Tractatulum Histiodromicum, haud sublimem".

[166] Vermij (2002).

[167] "Verum cum et hac in urbe prodeant per trimestre ephemerides, titulo bibliotheque univers[elle] et historique, si quid iis destinaris, nobis mandes; ac ubi harum compilator, nobis amicus, materiae rudis fuerit; nos ei opem feremus."

[168] "Haec et similia in causa esse ferme audio, quod D. Burghero de Volder minus sit animi quaedam in publicum protudere, quamvis ego etiam metuam ne assiduo isto silentio, velut rubigine, torpeant ingenia."

[169] Jorink and Zuidervaart (2012).

[170] "Vivit itidem Christianus Hugenius, Zuilichemus, verum num post tractatum (Gallicum) de Gravitate et Lumine quid novi meditetur, ignoro" and "Gerardus Kinkhuisen junior, cujus ea sunt quae Harlemi 1660 excusa, multis abhinc annis diem obiit. Ejus Canonion Lunare hasce literas concomitabitur".

[171] This distinction is emphasised a number of times throughout this research. Even though it is perhaps artificial to do so for early modern academia, we believe that it underlines the idea that the group of

Verwer also mentions two Scottish mathematicians. He speaks to Gregory of Archibald Pitcairne (1652-1713) and John Craig (1663-1731). Both men are close acquaintances of Gregory. Gregory met Pitcairne during his time at Edinburgh where they became ardent followers of the new Newtonian philosophy. Pitcairne studied medicine and was professor at Leiden from 1691 to 1692. There is no evidence that Pitcairne had many Dutch followers. Verwer tells Gregory that he hopes that Pitcairne will obtain a place at Leiden University.[172] Verwer explains that in the Dutch Republic there is a very different culture and atmosphere than in Scotland. Indeed, Pitcairne left Leiden after barely a year. The other Scot mentioned is John Craig, a mathematician, who was a student of David Gregory's at Edinburgh but who eventually opted for a more religious path. He became a vicar in the Church of England and published a number of religious mathematics publications. Craig's texts included the Leibnizian notation and one of his treatises was the first text published in England to contain the integration symbol.[173] Verwer says he is looking forward to Craig's next publication. Mentioning these two Scotsmen to Gregory is a way for Verwer to show that he is up to date and interested in the affairs of the Scottish mathematicians. In addition to this, Verwer passes on the Dutch news.

Mathematics: tangents

Having fulfilled his role as news bearer, Verwer departs for his mathematical discussions. One of the central problems concerning mathematicians contemporary to Verwer and Gregory was to attempt a method of finding the area and tangents of a curve while avoiding the algebraically dense method as presented by Descartes and Fermat.[174] Verwer's mathematics should be understood in this context. He is busying himself with finding the centre of gravity for different elements. The centre of gravity is an imaginary point in a body of matter where the total weight of the body can be concentrated. This is convenient in calculations, since when a body of matter is subject to certain (external) forces, its centre of gravity moves just as though all the mass were concentrated at that point and it were acted on by a net force equal to the sum of the forces.[175] Verwer and Gregory were working with a method

---

mathematical amateurs had multiple interests in studying mathematics, whereas for academically inclined readers this would not necessarily be the case. Again this is an artificial distinction, but we will continue to use it since it enables us to construct our story. The term 'amateur' is borrowed from Vermij (2003) where it is used to signify the group which was influenced by David Gregory and Archibald Pitcairne through informal contact as opposed to academic teaching. Vermij (2003), pages 186-7.

[172] "Generoso illi viro officia mea deferri rogo, digno sane qui in patriam nostram ad rei medicae professionem advocatur; si modo id ferrent tempora".

[173] Baron (1969).

[174] Baron (1969), pages 214-217.

[175] Young & Freedman, *University Physics*, page 309. Centre of gravity is, assuming a uniform gravitational field, identical to the centre of mass of a body.

to determine the centre of gravity of an element by calculating the sum of all the moments of the element.[176] This method works as follows: if a body of matter is divided into smaller parts, then the sum of all the moments of these smaller parts is equal to the moment of the total mass working at the centre of gravity. Since the total mass equals the sum of the masses of the smaller parts, this can be divided out to find the distance to the centre of mass. In equations, where $\bar{X}$ is the distance to the centre of gravity from a certain axis and M the total mass of the body:

$$M\bar{X} = \sum_i m_i x_i \ \ and \ M = \sum_i m_i \ \ hence \ \bar{X} = \frac{\sum_i m_i x_i}{\sum_i m_i}$$

Instead of mass, the same calculation can be done using the area of the body. For modern day physicists, this is an elementary calculation. However, the calculus which enables modern physicists to do this quickly was under construction when Verwer and Gregory were working on these questions. To divide a body into parts so as to find their moments, one needs to know the area of the body. In order to do this, Verwer tries to described the body as a curve and therefore he needs to find the tangent to the curve so that he can calculate the area inscribed by it.

Verwer refers to a method of finding tangents as presented by Walloon mathematician René François de Sluze (or Sluse or Slusius) (1622-1685).[177] De Sluze's method is based on redefining the

---

[176] We know this from the way in which Verwer recalls a previous letter from Gregory. Verwer addresses a question which Gregory had apparently answered in a previous letter. The question is about a universal method of finding a given magnitude of gravity. He says: "meum quaesitum de methodo universali pro indagando uniuscujusque magnitudinis gravitatis" NB: I have decided to translate "gravitatis" as gravity, however, it could also mean weight or heaviness or even mass. Verwer seems to agree with Gregory's explanation when it comes to finding the centre of gravity. Judging from Verwer's quick recap of Gregory's answer, Gregory explained to Verwer how he can find the centre of gravity using the sum of all moments of an element.

[177] Born in Liège, De Sluze studied law at Louvain after which he moved to Italy where he earned his doctorate and studied many other subjects such as mathematics and astronomy. De Sluze was also very closely involved with church life, but he remained interested in mathematics. De Sluze corresponded with many mathematicians such as Blaire Pascal, Christiaan Huygens and John Wallis. His main contact who kept him up to date with the latest developments was Henry Oldenburg. In 1659, De Sluze published his work on geometrical constructions, the cubature of various solids and geometrically obtained solutions to 3rd and 4th degree equations under the title *Mesolabum seu duse mediae proportionales inter extremas datas per circulum et ellipsim vel hyperbolam infinitis modis exhibitae*, or *Mesolabum* for short. It is also in this work that the 'pearls of Sluze' are first described: the family of curves described by the equation $y^n = k(a - x)^p x^m$ for positive integer exponents. In 1668, De Sluze published the second edition of the *Mesolabum* including *Miscellanie*, in which De Sluze also discusses the problem of the volume of a cissoids rotating around its asymptote. Clearly, De Sluze was immersed in problems of finding the area and volume of various elements.
Through Oldenburg, De Sluze learnt of new methods to find tangents to curves. As a consequence of this, De Sluze sent Oldenburg a letter on an easier method to find tangents of all geometrical curves without laborious algebraic calculations. This was published in *Philosophical Transactions*, volume 7, in 1672.[177] De Sluze also studied Newton's method of which he said that "De … Methodo nihil aliud dicere possum, nisi mihi videri meam esse, qua nempe tot ante annos usus sum".[177] Indeed, upon reading this, Newton agreed that De Sluze was first in understanding this particular method of finding tangents and, since the discoveries were made

subtangent. The subtangent is the projection of the x-axis of the portion of the tangent to a curve between the x-coordinate of the point of tangency and the point where the tangent intersects the x-axis.
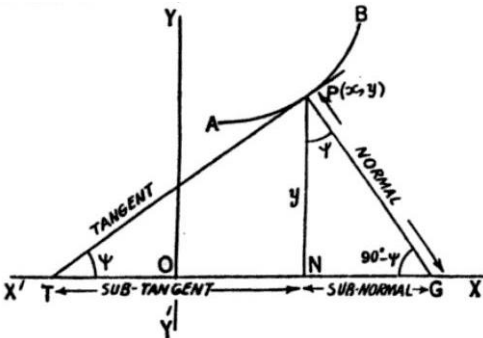

Figure: The tangent in point P(x,y) of curve AB gives the subtangent TN, normal PG and subnormal GN.

By redefining the subtangent, De Sluze essentially can conclude (in modern mathematical notation) that $\frac{dy}{dx} = -\frac{\frac{\partial f}{\partial x}}{\frac{\partial f}{\partial y}} = -\frac{\sum a_{pq} y^q p x^{p-1}}{\sum a_{pq} x^p q y^{q-1}}$. To start with, we focus on the first equations. In words this says that the x derivative of an equation y is the same as the negative fraction of the partial derivatives of the curve. A simple example illustrates this as follows. Say $y = x^2$, then $f(x,y) = y - x^2$. The x derivative of equation y equals $\frac{dy}{dx} = 2x$. The partial derivatives for the curve f give us $\frac{\partial f}{\partial x} = -2x$ and $\frac{\partial f}{\partial y} = 1$. Hence we see that to get $2x$ (the x derivative), we can divide $-2x$ by -1 and so we get $-\frac{\partial f}{\partial x} \Big/ \frac{\partial f}{\partial y} = -\frac{2x}{1} = 2x = \frac{dy}{dx}$ as we set out to show. The second part of the equation is equivalent to

our modern definition of the partial derivative. A modern interpretation of De Sluze's proof based on Margaret Baron can be found in the second appendix to this thesis, but for now it suffices to emphasise that this was De Sluze's conclusion. Using this, De Sluze could calculate tangent curves without any intricate algebraic steps. Verwer has his doubts about De Sluze's method and sends Gregory a commentary written by De Volder. Verwer asks Gregory to explain to him which method is correct and can be used to find the centre of gravity. Gregory comments on what Verwer has sent him to Newton. In this comment, Gregory says that he has indeed received a demonstration (or

---

independently of one another starting from different principles, there was no further dispute on the priority of it. The method enabled De Sluze to find an algorithm of general nature which allowed direct determination of the tangent without much calculation. De Sluze only gave a full proof of the method in these notes and letters in 1672/3, but it is clear that he used this method from 1655 onwards. Baron (1969), page 215.

improvement) of De Sluze's method by De Volder, but that he is not very impressed by the level of algebraic skill in the proof.[178]

Having dealt with the finding of tangents, a logical next step for Verwer is to understand the characteristics of different types of curves. He attempts this by considering different ratios of numbers or series, and how these ratios can be written as equations. In this way, Verwer discusses the equations $y = ax$, $y = ax^2$, $y = ax^3$, and $y = a\sqrt{x}$.[179] It is clear from the start that Verwer's goal is to describe the conic sections: parabola, ellipse, hyperbola, and circle. Hence, the steps he takes in generalising these first simple equations and ratios are all in the direction of conic sections.[180] In this sense, he looks at $y^2 - b^2 = \frac{a}{b}x^2$ and variations to this. Verwer describes the different conic sections and their geometrical constructions. Attempting generalisations of these curves gives Verwer a better understanding of the curves and their equations, enabling him to think of their tangents.

After discussing the conic sections, Verwer mentions other types of curves such as the conchoids, cycloids, cissoids and Archimedean spirals.[181] Verwer also refers to figures from Gregory's *Exercitatio* which show different types of curves and their tangents. Verwer discusses figures 6, 7, 8, 9, 16, 17, 18 and 21. Especially figure 8 is of interest to him and he gives an equation to calculate the length of the curve AC. Verwer expresses his admiration of Gregory's work and asks him to check Verwer's comments on it.

---

[178] "ther is a demonstration and improvement (as the author says) of Slusius Methodus tangentium by De Volder at Leyden, wherein in my opinion he hath not shewn great skill in Algebra." Gregory to Newton, 1691, in: *The Correspondence of Isaac Newton, III,* page 165-6.

[179] Verwer first defines series of numbers which are squared or cubed or roots and then concludes from their ratios how to describe the numbers using an equation. This methods reminds us of the method in modern mathematics where certain x-values are plugged into an equation y of x to obtain the corresponding y-values.

[180] Jordan and Smith (2002) *Mathematical Techniques: An introduction for the engineering, physical and mathematical sciences.* 3rd edition.

[181] "Conchoidibus, Cycloidibus, Cissoide, Spiralibus archimedeis, item Curva Huddenii".
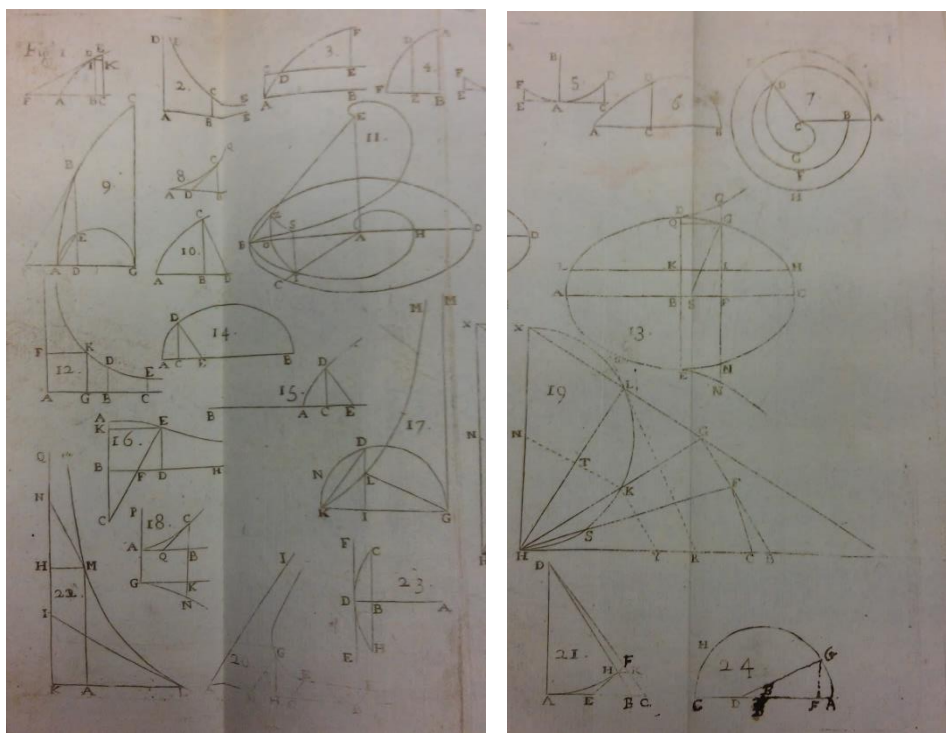
Figure: Own photographs of the Figures from Gregory's *Exercitiatio* 1684, available at Utrecht University Library. Note a reader has filled in figures 21 and 24 with ink, probably because the printing was not clear.

Verwer's last mathematical topic concerns a famous episode recorded in the *Acta Eruditorum* 1691 concerning the problem of catenaries. Catenary curves (or funicular curves) are those curves which are best described by an idealised hanging chain with gravity working on it, supported only at its ends. Since a catenary curve is something other than a simple parabola, the problem at hand was to give a mathematical description of this curve in a mathematical way.[182] In a number of articles in this *Acta Eruditorum*, Bernoulli, Leibniz and Huygens present their solution to the mathematical description of the catenary curve.[183] In these articles, the $\frac{dy}{dx}$ notation (as coined by Leibniz) is used to demarcate derivatives and tangents. Verwer asks Gregory to comment critically on this series of articles and tells that he has studied this together with Makreel, but that he has not readily understood it. Indeed, in 1697, Gregory published a paper in the *Philosophical Transactions of the Royal Society* entitled "Catenaria".[184] This paper was the first complete mathematical description of the catenary curve. To realise this, Gregory uses Newtonian fluxions instead of Leibnizian calculus. This must have been a very satisfying answer to Verwer's question.

---

[182] Lockwood (1961), page 124.

[183] *Acta Eruditorum* 1691, pages 274-290.

[184] Gregory, D. (1697) "Cateneria" in: *Philosophical Transactions, 19*, 637-652.

From these mathematical exchanges we can conclude that Verwer's mathematics was good, especially considering the fact that he was an autodidact. Some of his elaborations and explanations seem slightly crude, but this can be explained by the fact that Verwer's Latin was not very elegant. Verwer shows that he can discuss mathematical topics on a level which Gregory also finds interesting. Evidence for this is that Gregory deems their conversation worthy of informing Newton about. Even though he mentions that he is not impressed by De Volder's algebra, he does seem impressed by the rest of the letter. Gregory explains to Newton that he needs more time to fully understand the implications of the letter and its mathematical content.[185] In addition to this, it is striking that Gregory picks up on many of the topics which Verwer mentions in his letter. An example is the proof of the mathematical description of catenary curves. Gregory apparently regards Verwer's comments worth his time and work to answer. This leads us to conclude that Verwer's mathematics must have been quite profound.

Connection Mathematics and (Natural) Philosophy

In addition to this big chunk of mathematics, Verwer writes about a topic which is of a more philosophical character. Throughout the letter, Verwer expresses his wish to be able to connect mathematics with "all known matters".[186] Verwer emphasises that this connection is important and even necessary when attempting to study the truth. For, Verwer claims, studying areas of knowledge like mathematics, theology, philosophy or law separately, is like worshipping too many different Gods as the pagans do. If the connection between these fields is not made, then a scholar's mind will go blind. Verwer acknowledges that the connection is not readily made and says that he is happy to be able to do so. Here, Verwer announces that he intends to put a small dissertation on mathematics to paper in which he makes this connection for mathematics. It is unclear whether Verwer calls the letter at hand a dissertation or whether he alludes to a different document. There is a second mention of this subject in the letter. Throughout his mathematical discussion, Verwer emphasises that he is looking for principles of all knowledge. Furthermore, Verwer claims that with his proof he can show that there is no difference between mechanics and geometry, again alluding to the idea that all knowledge is connected.

The topic of a connection between mathematics and natural philosophy returns in Verwer's work. In his treatise *Inleiding tot de Christelyke Gods-geleertheid*, Verwer uses natural philosophy to prove his religious arguments. Verwer, for example, gives a proof of the existence of God using Newton. We see from Verwer's comments on this to Gregory that Verwer had been pondering such ideas for several years. Here we see the idea of Newton's "usefulness" being put to work. Already at

---

[185] Gregory to Newton, 1691, *The Correspondence of Isaac Newton, III,* page 165-6.
[186] "cum matriae scibilis toto".

the beginning of his studies of Newton does Verwer forge a link between mathematics and natural philosophy. At this stage Verwer does not call the mathematics Newtonian, maybe because he is working on topics and questions from Gregory. Nevertheless, he values the correct use of mathematics and argues that it should be used in all knowledge. Verwer is working on his ideas of this correct mathematics and discusses them with Gregory.

Conclusion

All in all, Verwer's contact with Gregory can be divided into three topics. Firstly, we have seen that Verwer carries out the role of new bearer, updating Gregory on Dutch affairs. Verwer discusses his acquaintances who together are called the mathematical amateurs and mentions Scottish mathematicians. By doing so, Verwer shows that he is well acquainted with contemporary affairs in mathematics and interested in the newest developments. This was also what Gregory would expect of Verwer: to be kept up to date on the concerns in the Dutch Republic. Verwer's main aim of his letter to Gregory, however, is to discuss a number of mathematical questions and problems. These problems are mostly pertaining to the matter of determining tangents to curves and many different types of curves are discussed. Verwer refers to mathematical publications, showing that he knows what he is talking about. He asks Gregory to clarify certain problems. These problems with Gregory's reactions and clarifications can be placed within the broader context of the development of calculus and infinitesimal algebra. Verwer discusses his mathematics in a more philosophical context as well. He argues for a connection between mathematics and natural philosophy. This is a connection which Verwer makes in later works as well and it is interesting to see that he writes to Gregory about it at this stage. Verwer argues for the importance of a proper use of mathematics and mathematical methods when searching for knowledge and truth, not only restricted to knowledge of mathematics. Here we see a kind of usefulness which Verwer attributes to the mathematical methods when applied properly.

Verwer's contact with Gregory merits a contextualisation within the Dutch Republic. The correspondence is exemplary for how knowledge was transferred between different members of the intellectual community. Additionally, we gain insight into what knowledge was deemed important and how it was studied. In this case, the letter enables new understanding of the mathematical knowledge of seventeenth-century Dutch scholars. We have seen what Verwer was studying and the questions he wanted to answer. Hence, the correspondence can tell us more about the time Verwer was living in. This enables our research into how Newtonian mathematics was received in the Dutch Republic, since it shows us the potting soil in which Newton's ideas were planted and who was doing the planting. In the following chapter we look at Verwer's study of mathematics and the problems he encountered by looking first hand at Verwer studying Newton's *Principia*. The theological

foundations and interpretations of mathematics which Verwer mentions to Gregory are also present in these annotations. We find the combination of mathematical work and theological arguments return in its most explicit when we study Verwer's *Inleiding tot de Christelyke Gods-geleertheid* in chapter 5.

4. Verwer's Annotations of the 'Principia'

"We have all seized the white perimeter as our own
and reached for a pen if only to show
we did not just laze in an armchair turning pages
we pressed a thought into the wayside,
planted an impression along the verge."

from "Marginalia", Billy Collins, in *Picnic, Lightning* (1998)

Introduction

In 1687, Sir Isaac Newton published his famous, world changing book *Philosophiae Naturalis Principia Mathematica* (commonly known as the *Principia*).[187] Of the first edition, twelve copies were sent to Pieter van der Aa in Leiden to be sold on the Dutch market and the Frankfurt book fair. After two years, Van der Aa was forced to return 7 of these copies which remained unsold.[188] Adriaen Verwer acquired a copy of the first version of the *Principia* in 1687. A review of the *Principia*, published anonymously but later attributed to Locke, appeared in the journal *Bibliothèque Universelle*, which was under the editorial command of one of Verwer's acquaintances, Jean Le Clerc. When exactly Verwer read his Newton is not clear: it is certain that he studied the book multiple times. This can be concluded from the comments which are written in the margin of Verwer's copy of the *Principia*.[189] Apart from adding an "Ex Libris" in 1687, there are comments which are dated as 1714, and even notes on the second and third editions of the *Principia*. It is dubious whether Verwer himself wrote these annotations: the second edition of the *Principia* was published in 1713 but the third in 1726 and by that time Verwer had passed away. This does not, however, automatically mean that these annotations are posthumous and therefore not Verwer's. It could very well be that Verwer was referring to the pirated edition printed in 1714 in Amsterdam as "the third edition".

---

[187] For a solid mathematical translation of the *Principia* I have used both Motte's English translation (1846) and Cohen & Whitman's translation (1999).

[188] Jorink & Zuidervaart (2012).

[189] Verwer's annotated copy of the *Principia* is available online via www.annotatedbooksonline.com .
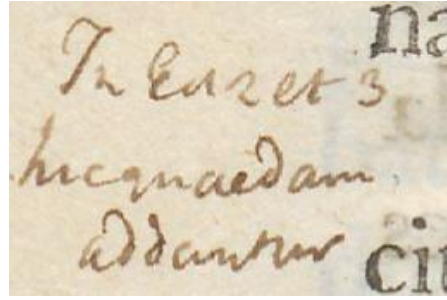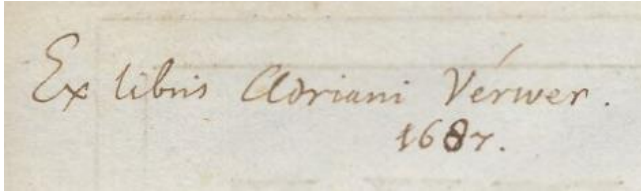
Even though it is not entirely clear when Verwer read the *Principia*, it is undoubtedly true that Verwer read the book several times and studied it in detail. We see different colourings of ink and some annotations have been crossed out or corrected. Verwer must have been quite occupied by the material, and in this chapter we plan to look at this interest of his.

To understand Verwer's annotations, we should briefly consider the realm of the marginalia. Studying annotations or marginalia is a popular discipline in both mediaeval and early modern historiography. The study is grounded on the idea, as argued by Jardine and Grafton, that early modern readers were not passive, but actively engaged with the text. Early modern scholarly reading was often goal-oriented and intended to give rise to something.[190] To illustrate this, Jardine and Grafton present a study of how Elizabethan scholar Gabriel Harvey (1550-1630) read his Livy. Harvey was very pragmatic about his reading, he spelled out the virtues of good reading and annotating in his own annotations in Livy. Harvey read the same book several times with different goals and with that different methods of reading. He interacted with the book differently for each goal. Jardine and Grafton analyse these interactions and by doing this deduce a methodology to study annotations.[191] They categorise the different types of interactions which a reader could adapt when reading and annotating a text. The idea of active reading is shared by Sherman, who suggests that instead of 'reading', we should call the action 'use' of the book.[192] The term 'reading' has narrowed in the modern English language, and early modern scholars "had as many words for 'reading' as the proverbial Eskimo has for 'snow'".[193] Not all active readers are interacting with the text though. As Sherman argues, 'annotations' really acknowledge the idea that the reader was interacting with the text, whereas many 'marginalia' have nothing to do with the text itself but can be seen as graffiti or doodling. Where nowadays writing in books is frowned upon and libraries even consider it a crime for students to write in books, in particular in rare books and manuscripts, Renaissance readers were taught to write notes in and on their books.[194]

---

[190] Jardine & Grafton (1990), page 30.

[191] It should be noted that it was not necessarily their intention to develop a methodology for studying marginalia. However, their seminal article is often used as such.

[192] Sherman (2008), page xiv.

[193] Sherman (2008), page xv.

[194] Sherman (2008), page 4.

First of all, Jardine and Grafton emphasise that we should take care not to focus on paragraphs or pages of the book which we as modern scholars deem important, but to let ourselves be led by the early modern reader.[195] Hence, we will not go straight for the main sights of the *Principia*, but we are curious as to what Verwer himself responded to. Sherman warns us that marginalia rarely speak directly to the questions we most want answered.[196] Therefore it is essential to let Verwer do the talking. In addition to this advice, Sherman discusses a threefold categorisation as posed by Whitaker to typify marginalia: editing, interaction and avoidance marginalia. Editorial notes can be forms of censorship or affirmation of the text. Notes signalling interaction imply devotional use or social critique. Typical avoidance notes are doodling or daydreaming.[197] Where Sherman defines the marginalia themselves, Jardine and Grafton study the underlying purpose of the reader. Jardine and Grafton distinguish three ways in which Harvey reads his Livy: a "pragmatic" or "military" type; a "moral, politic" or "careerist" type of reading; and a third type of reading in which Harvey "positions" the book.[198] The latter, where Harvey is "positioning" the book in a certain context, could be considered as more of an editorial type of annotating instead of an interaction with the text. These types of reading are defined by Harvey himself; he is well aware of his different goals and methods. Verwer, on the contrary, is not as explicit about his method or goal when reading Newton. Therefore, for us, both systems are interesting, since to understand his purpose we look at the type of annotations Verwer made. However, the types of interaction which Jardine and Grafton find in Harvey and the categories which Sherman presents become somewhat problematic when applying them to Verwer's work with the *Principia*. Verwer did not read in the same way as Harvey did, so using Jardine and Grafton's types of interaction are of little use. Sherman's categories of editing, interaction and avoidance are too superficial to say something about Verwer's intent behind the annotations, since they merely define a type of note. This is why we shall define a new framework to analyse Verwer's annotations, based on the examples as presented by Sherman, Jardine and Grafton.

Our hypothesis is that Verwer is primarily a "positioning" reader, as he wants to position the *Principia* in a context of other mathematical books, and hence many of his annotations will be of the Sherman's editorial type. The first category of annotations we distinguish is therefore that of the editorial notes. We find cases of this when, for example, Verwer's copy of the first edition of the *Principia* is compared with later editions or in the many references to other authors which Verwer makes. In addition we also expect Verwer to be a "political, moral or careerist" type of reader as

---

[195] Jardine & Grafton (1990), page 31.
[196] Sherman (2008), page 15.
[197] Sherman (2008), page 16.
[198] Jardine & Grafton (1990), page 51-53.

Jardine and Grafton call it, which means that the notes give evidence of an interaction with the text. The notes signalling interaction are then our second category of annotation which we divide in two subcategories: we find two different kinds of interaction with Verwer's *Principia*. First, Verwer is working on the mathematics which Newton presents. This subcategory of Verwer's annotations then consists of the <u>mathematical notes</u>. Explicit mathematical notes can be found when Verwer is looking for arguments in the context of his greater purpose of establishing the role of mathematics within all knowledge. Verwer also elaborates on several of Newton's calculations by writing out derivations. Arguably, this could be considered to be an editorial type of annotation, since Verwer does not change any of Newton's work but merely expands it. However, we see this elaboration of Newton's own derivation as an interaction, since Verwer actively uses Newton's text in an attempt to understand it and make it his own. This interaction is different from a purely editorial comment such as a reference to a different text. In addition to Newtonian mathematics, Verwer studied Newton with theological questions in mind. Here Verwer is also interacting with the book, so Sherman's category of interaction can again be applied. A second subcategory of interaction which Verwer has with the text are <u>theological notes</u>. The most explicit theological note is when Verwer claims to have found an argument for the existence of God in Newton's text. With this division into three sections, we hope to understand what Verwer was looking for when he was reading Newton in such detail. By studying Verwer's reading action, we can understand more about what his interest in Newton's *Principia* consisted of. Was he merely interested in mathematical problems, or was something else at stake? In earlier chapters of this thesis we have seen what Verwer was working on before and during his encounter with Newton. In this chapter we look at Verwer's work with the *Principia* itself.

Editorial notes

First, we can distinguish different cases where Verwer is editing the text. We commence by looking at Verwer's references to other scholars. In total Verwer writes down 24 different names of scholars whom he connects with Newton's text 113 times. Of the 24 names, it is David Gregory who is mentioned most often: Verwer refers to him 42 times. This is significantly more than the runner ups, Galileo and Barrow[199], who are both mentioned 9 times each. Euclid and Huygens are mentioned 8 times, Kepler and Descartes score 5 mentions each, Archimedes and Wallis earn 3. Apollonius,[200] Torricelli, Hayes,[201] De Sluze, Fabri,[202] and Picard[203] are all mentioned twice. De la Hire,[204] Vossius,[205]

[199] Isaac Barrow (1630-1677), *Lectiones Geometricae* (1670).
[200] Apollonius of Perga (262 BC – 190 BC), *Conics.*
[201] Charles Hayes (1678-1760), *Treatise of Fluxions* (1704).
[202] Honoré Fabri (1607-1688), known for his work on the diffraction effect.
[203] Jean Felix Picard (1620-1682), known for his *Mesure de la terre*.
[204] Philippe de la Hire (1640-1718), *Sectiones conicae* (1685).

Leibniz, Mariotte,[206] Tycho, Copernicus, Longomontanus,[207] Mercator[208] and Whiston[209] all deserve one mention each.

Name	Number of mentions
Gregory	42
Galileo, Barrow	9
Euclid, Huygens	8
Kepler, Descartes	5
Archimedes, Wallis	3
Apollonius, Torricelli, Hayes, De Sluze, Fabri, Picard	2
De la Hire, Vossius, Leibniz, Mariotte, Tycho, Copernicus, Longomontanus, Mercator, Whiston	1
Total: 24 names	113

Notably, these references are to mathematical works in a broader mathematical context and mathematicians who use mathematical methods for natural philosophical goals.[210] Apparently, Verwer positioned the *Principia* within a broader mathematical context and saw connections with natural philosophy. Following Jardine and Grafton's types of reading, this would mean that Verwer read the book with his mathematical knowledge in mind. We have already seen that Verwer did not want to separate mathematics from other areas of knowledge. Our view of Verwer, gained from the research in previous chapters, gives rise to a different interpretation than that Verwer read the *Principia* purely for its mathematical knowledge: he had other – call them philosophical or theological – associations as well. Therefore, we conclude from the fact that Verwer refers to works by authors which focus on natural philosophical topics through mathematical methods, that Verwer studied Newton with more than merely mathematics in mind.

Verwer clearly saw a strong connection between Gregory's work and Newton's. This can be explained by the fact that Gregory might have recommended Verwer to read Newton's work. Additionally, we have seen that Verwer and Gregory were in close contact during this period in time and hence the link is easily made. Moreover, there are many connections between Gregory and Newton since they were working on closely related subjects and were in touch about these on a

---

[205] Isaac Vossius (1618-1689), *De lucis natura et proprietate* (1662).

[206] Edmé Mariotte (1620-1684), *Traité du mouvement des eaux et autres corps fluides* (1686).

[207] Christen Sørensen Longomontanus (1562-1647), *Astronomica Danica* (1622).

[208] Nicholas Mercator (1620-1687), *Astronomicae sphaerica* (1651).

[209] William Whiston (1667-1752), known as a leading figure in the popularisation of Newton.

[210] As we discussed in the Introduction, use of the terms 'mathematics' and 'natural philosophy' are not mutual exclusive. Hence, the fact that Verwer lists these authors of works on natural philosophy is not very atypical, since we are using this term to refer to any topic related to the study of nature. However, in this case, the authors which Verwer mention are typical: all explicitly favour mathematical reasoning and mathematical methods in their argumentation. Here we mean something different than the more common use of the *mos geometricus*, but more analytical mathematical arguments.

regular basis.[211] Of the 42 mentions of David Gregory's, Verwer refers to Gregory's *Astronomiae Physicae et Geometricae Elementa* 34 times. It is therefore plausible that Verwer was working through both books simultaneously or at least shortly after one another.[212]

Gregory's Proposition 60 of Book 1 is specifically mentioned a number of times. Gregory's proposition concerns the lapse made by a body L, revolving around a great body T in a system which is revolving around a greater S due to the attractive forces between the three bodies. In other words, it is about a planet with a moon in orbit around it which are together revolving around the sun. Body L will not follow Kepler's law of equal areas and equal radii about T, since it is being effected by the greater body S. Gregory shows this using the attractive force between the three bodies which follow the inverse square law. Verwer refers to this proposition of Gregory's next to Newton's Proposition 66, Theorem 26, in which Newton shows that he can describe this erroneous trajectory only with the attractive forces between the bodies. The two propositions therefore work out the same theorem. Newton's proposition, however, is 13 pages long and considers many cases and corollaries, while Gregory only uses 3 pages with fewer cases and just the proof. It seems as though Verwer needed a reminder of this proof while working through Newton's lengthy proposition. Furthermore, Verwer simply mentions Gregory's name twice. In both cases, Verwer is not impressed by Newton's explanation and exclaims that Gregory is more clear.[213] The topic of these pages in Newton's *Principia* is also the motions of bodies which tend towards each other with centripetal forces. This topic clearly intrigued Verwer, especially the concept of the erroneous trajectory due to attractive forces. The fact that Newton and Gregory can explain these errors using their theory of attractive forces is seen as a strong endorsement by Verwer and he studies this in detail.
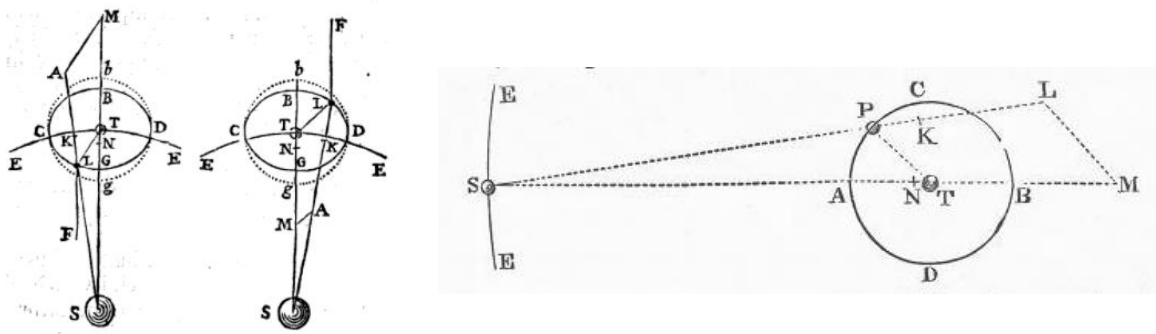
Figure: Left: Gregory *Astronomiae Elementa* page 73 and Right: Newton *Principia* page 203

---

[211] Turnbull (1959), Volume III.

[212] Jardine and Grafton infer from their study of Harvey's many references to a certain set of books that Harvey must have been using a "book wheel" to read all these books together. This intriguing and enviable instrument, which Jardine and Grafton mainly see as an emblem more than an actual tool, is described on pages 46-49.

[213] This occurs on page 176 "D. Gregorius istud correxit sibi" and page 184 "binos casus hos exequitur clare Dav. Gregorie locu ante adnotato".

Verwer also mentions Gregory's work *Exercitatio Geometrica de Dimensione Curvarum* (1684) on six occasions. These references are not towards a specific page or theorem, but offer a more general point. Verwer explains that what Newton says, is also illustrated in Gregory. One of these occasions is on page 250, surrounding Lemma 2 of Section 2 of Book 2, where Newton introduces the idea of a "genita". Newton proposes to divide an element into smaller parts which he calls "genitae" or "generated quantity". Of each quantity he then states that he can calculate the moment using the elements which generated the quantity. All this sounds extremely vague to modern mathematical ears, but it should be understood in the context of finding the area under a curve or the slope of a curve. Newton is working on new methods to do these mathematical operations and this is part of that. It is complex to decipher exactly what Newton means when he defines these generated quantities and their generators since for modern mathematics it does not make sense. However, Verwer is exceptionally interested in this Lemma. We have seen that in his letter to Gregory, Verwer is also working on the method of finding tangents and moments. In his annotations, Verwer says that for better understanding of the lemma, one should look at his notes in Gregory's *Exercitatio Geometrica* on page 5 where he analyses the lemma.[214] Looking at page 5 and 6 of the *Exercitatio Geometrica*, we indeed find the lemma in which Gregory applies the same method to define the moments of different generated quantities.[215] Apparently, Verwer wrote a note based on this version of the lemma and after this also consulted Gregory about it.[216]

From Verwer's references to Gregory and other authors we learn more about how Verwer "positions" the *Principia*. On the one hand, he is mathematically interested and therefore positions the *Principia* within a mathematical context. Verwer studies methods to find tangents, areas and moments and he finds information in Newton's work on this. Verwer's mathematics itself is discussed in the next section of this chapter. Verwer connects this to what he has learned from Gregory's *Exercitatio Geometrica* and *Astronomiae Elementa*. Verwer gives note of studying these works in detail, next to the *Principia*. In addition to Gregory's mathematics, Verwer also provides links to many other authors and texts which are natural philosophical but use mathematical methods. Clearly, Verwer considers the *Principia* to be a book on the broad application of mathematics. Furthermore, Verwer uses other mathematical authors to clarify what Newton is

---

[214] "pro pleno hujus lemmatis intellectu vide adnotata nostra ad D. Gregorii exercitationam geometricam de dimensione figurarum pag 5 ubi Lemmatis Analysis damus". Page 250.

[215] Gregory (1684) *Exercitatio geometrica de dimensione curvarum* page 6.

[216] Whether Verwer wrote the note in Gregory's *Exercitatio geometrica* before or after he contacted Gregory about the same topic. It is clear, however, that Verwer was working on these topics during this whole period and that he was already in possession of the *Exercitatio geometrica* before writing Gregory. Hence, the idea that Verwer was already working on this lemma seems plausible. The same holds for the annotation in the *Principia*. Here the argument for before or after the letter is even more difficult, since Verwer does not explicitly mention reading the *Principia* in his letter to Gregory.

doing. The references Verwer makes are mainly to place Newton's propositions and proofs in a broader mathematical context. For Verwer, however, mathematics was not necessarily something which was completely separated from other fields of study. As we have seen in *'t Mom-aensicht*, mathematics could be used in theology and philosophy and the *mos geometricus* was respected and aimed for in all fields of study.

Other examples of editorial notes are the annotations which mention the second and third editions of the *Principia*. The vast majority of the annotations in the *Principia* are of this type, saying for example: "this is different in the second and third editions". As was already discussed above, we cannot be certain whether Verwer wrote these notes or not. Whoever wrote them, however, was evidently studying Newton in great detail. This is interesting for someone who is looking at the development of the work, but not necessarily for its contents. Errata are corrected in these next editions, and this is also done in the notes in Verwer's edition. If anything these notes concerning other editions show how strenuously the text was studied. Another indication of this detailed approach is the fact that notes on the same page are clearly made with different inks and therefore at different times. The same holds for annotations which were crossed out. Apparently, Verwer returned to reread the text, in order to add to or correct the annotations which he had made before. At times these crossed out or improved annotations have an extra reference to Gregory, which seems to imply that Verwer changed his mind after (re-)reading Gregory's work.
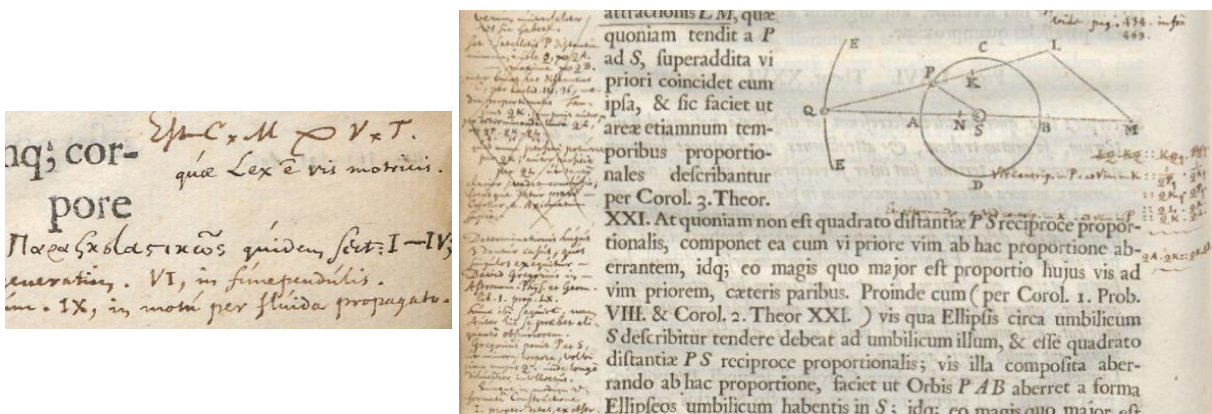
Figures: Left: an example of different inks on one page, indicating a returning reader (page 2) and Right: an example where the returning reader has crossed out what had been written before (page 174).

A different type of editing occurs in book II of the *Principia*. Verwer starts almost every section of the second book with a small summary. These summaries consist of approximately two sentences and describe what Newton explains in the section. Sometimes these summaries are accompanied by a reference to Gregory which point to a proposition or theorem in Gregory's

Astronomiae elementa which treats the same topics as Newton. These commentaries are notable because apart from the parts discussed above, there are little to no other annotations throughout the rest of the second book. There are, however, multiple notes at the start of book III of the *Principia*. This is where Newton gives his "Rules of Reasoning in Philosophy" and "Phenomena". In the first edition of 1687, this is section is entitled "Hypotheses".[217] Here Verwer adds a relatively long note on how hypotheses 5, 6 and 7 can be linked to Kepler's and Tycho's work and observations. This is not surprising because Newton himself does the same, stating that what Kepler has discovered is accepted by everyone.[218] Verwer also refers to "David Gregorie"'s [sic] *Astronomiae Physicae et Geometricae Elementa*, proposition 66. This proposition is indeed completely devoted to explaining Kepler's heliocentrism.[219] Verwer notes that this is essentially Copernican astronomy and he refers to Longomontanus and his Danish astronomy. Furthermore, Verwer gives a specific reference to a section of Mercator's *Astronomica sphaerica* and a vague reference to Whiston. It is an odd annotation which definitely would benefit from further research, but not for our questions.

The last four pages of Verwer's copy of the *Principia* are full of notes.[220] On the first two of these pages, Verwer seems to have made an index. All the entries in the index refer to the pages approximately in the range from 300 to 500. No specific order can be found in these entries: they are not listed alphabetically, thematically or by page number. It almost seems as if Verwer wrote down what he was thinking while reading and turned back several times. If this is true, then we could establish the order in which Verwer read these last books. Furthermore, this would explain why there are almost no annotations in the second and third book: they have all been written down here. All notes are mathematical, giving summaries and derivations of Newton's words and sometimes referring to either Euclid or Descartes. As we have seen in other cases, Verwer preferred to write down mathematics in the form of equations and he does this again here, even adding a diagram. The third page of these notes is an appendix in which Verwer summarises some cases from Barrow's *Lectiones Geometricae*. First he discusses nine "Rules concerning uniform motion"[221] and secondly three "Rules concerning uniform acceleration, which is proven in triangles and trapeziums."[222] Every rule is accompanied by a reference to a different mathematical author, namely Galileo, Euclid,

---

[217] Cohen gives a tabular scheme of how the hypotheses of the first edition are edited to the rules and phenomena of the second and third editions. When numbers are given here, we refer to the first (Verwer's) edition.

[218] In Cohen's translation: page 800.

[219] "To explain briefly the Sustance of the Caelestial Physics of Kepler, or the Cuase and Reason which Jo. Kepler has assigned, why the Planets are carried in Orbits about the Sun." Gregory (1684) translation by Gregory and Halley (1715), page 135.

[220] In ABO this is page 526-530.

[221] "Regulae circa motum aequabilem".

[222] "Regulae circa motum uniformiter acceleratum, quae in Triang., et Trapesiis comprobantur".

Huygens and Archimedes. Gregory is notably absent from these pages. It is still to be investigated where these rules come from and what their connection to the *Principia* is. The last page is entitled "Index propositionum Libri III", in which Verwer gives a short one sentence summary of what he has studied for every proposition of the third book. Again we understand the fact that there are little to no annotations throughout book three, since they have been placed at the end. These pages are still very mysterious and deserve a more in depth analysis than we have been able to do here.

We have seen Verwer editing the text of the *Principia* in three different ways. He refers to many mathematical authors and books which he connects to what he is studying in the *Principia*. From this we conclude that Verwer saw the *Principia* primarily but not exclusively as a mathematical book. The connotations which Verwer had with other works are mostly to treatises which discuss natural philosophical topics while applying a mathematical method. Most references are to Gregory and we have been able to reconstruct some of Verwer's work on the *Principia* using Verwer's contact with Gregory himself. Verwer also attempts to connect the contents of the *Principia* with other fields of study, such as theology or philosophy, as we have seen from his mentioning of many natural philosophers. Verwer did not consider mathematics as a completely separate discipline to these fields, as we have seen before in Verwer's other work. Apart from references, Verwer's editorial notes also include comments on the second and third editions of the *Principia*, where his remarks concern differences with these versions. This indicates that Verwer studied the *Principia* more than once. More proof of this is given by the fact that we found different colour inks in the annotations and annotations which have been crossed out. This shows that Verwer was a returning reader who studied Newton meticulously. We now turn to what Verwer's more content related comments.

Mathematical notes

Verwer also annotated the mathematics of the *Principia*. These notes are interactive because through these notes Verwer is seen to actively work on the text. Verwer studies Newtonian mathematics and in order to do this, he adds little calculations as an elaboration or clarification of the text. In our opinion, this is an active form of reading. This differs from what Jardine and Grafton define as "action" because Verwer has no other intentions with his notes than understanding the text. Whereas Jardine and Grafton's methodology of studying annotations is defined specifically for the research on Harvey's annotations, Verwer's case is significantly different and therefore we can use a different definition of a reader's interaction with a text. Verwer's interaction with the mathematics in the *Principia* gives us an idea of which parts of Newton's mathematics Verwer was interested in. We have already seen that Verwer was working on the pages of Newton's proposition 66 (book 1) in which the problem of the three bodies is solved due to forces of attraction. These annotations of Verwer are intended to compare Newton's text with Gregory's. Gregory's argument is

summarised and apparently this helps Verwer to understand Newton. Verwer works out a derivation from Newton's text and notes that he is working on the "vis centrip[eta]".[223] His derivations are elaborations on the different ratios which Newton is explaining but in equations instead of Newton's words. As we have seen in the letter to Gregory, Verwer prefers to write ratios in the form of equations. On these pages, Verwer has crossed out a large part of his notes and corrected them. This indicates that Verwer was actively working on the text and even went back to correct his mistakes. The corrected notes have specific references to Gregory in them, hence Verwer appears to have realised his mistake after (re-)reading Gregory. Perhaps Verwer even discussed his work with Gregory and found a mistake. What we know for sure is that Verwer spent a large amount of time on these pages, together with Gregory's books.

Significantly more annotations than anywhere else in Verwer's *Principia* are to be found near the first three sections of the first book. These pages are on ratios between quantities in which Newton defines his square law, on the definition of centripetal forces, and on the motion of bodies in eccentric conic sections.[224] From what we have seen of Verwer's mathematics, we are not surprised that he is interested in these topics. In chapter 5 we discuss Verwer's use of the square law in the *Inleiding* which can be seen as a result of his interest in these sections. However, the annotations we find here are more of the positioning type, not the interacting one. Especially at Lemma X, the lemma in which Newton introduces the square law for forces, Verwer refers to Gregory while working through Newton's definitions. Verwer's annotation or comments on Gregory's book then are probably more interactive with the material. Nevertheless, Verwer is intrigued by Newton's mathematics and makes many connections with other texts he knows. Eventually Verwer writes a theoretical piece using all this, the *Inleiding*. In this way, the act of positioning also has a philosophical touch, more than it did in previous instances, where the positioning was intended to clarify.

As for section 2 of book 1 in which Newton gives his derivation of Kepler's laws, Verwer's annotations are again mathematical. Here Verwer is summarising and clarifying Newton's work. Verwer is interested in the ratios between the different quantities. For example, he gives an "analysis of this proposition" which is a set of equations representing different ratios.[225] This is Newton's proposition on how to understand and draw the centripetal force, using the tangent of a circle.

[223] Newton himself was hesitant in using the terms "centripetal" or "centrifugal". The reason is that the centripetal or centrifugal forces were still vague and unknown terms and even though they were crucial to his theory, Newton attempted to keep them as open as possible. Cohen (1999).

[224] These translations are from Cohen's translated version of the *Principia* (1999).
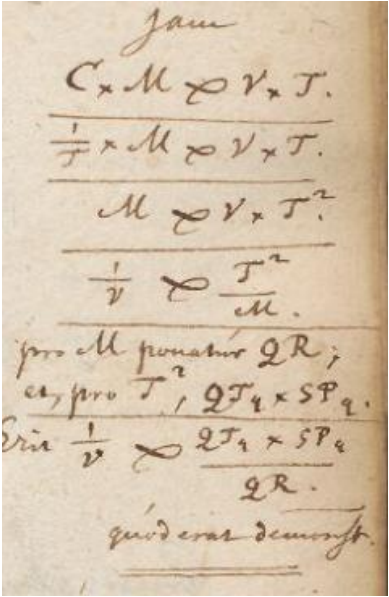
[225] Newton (1687), Verwer's annotated copy, pages 44-5.

Newton himself explains the ratios in words, but Verwer apparently prefers these equations as representation.
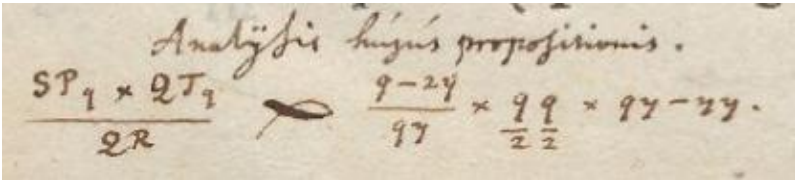
The proof continues on the next page and again Verwer works out the equations, ending with "quod erat demonst[randum]". This is indeed the same conclusion as Newton finds.

From these annotations we can conclude two things. First, that Verwer's mathematics was up to standards. He is able to translate Newton's words into equations and end up with the same points. His work is thorough and correct. Verwer is capable of linking what is being done to other parts of the book where Newton continues with these points and to other books which deal with similar topics. Second, we find that Verwer was mostly working on defining ratios between quantities and, through that, Newton's square law. These ratios lead to different geometrical representations, as Newton explains as well. The square law is introduced to calculate the attractive forces between bodies which help to explain planetary trajectories. As we have seen, all these calculations fit comfortably into the context of searching for a method of calculating tangents and areas. This coincides with Verwer's work in his letter to Gregory and thus we now have a clear idea of the mathematics Verwer was interested in. His annotations here are both interactive and positioning: Verwer actively works through the material, elaborating, summarising and commenting on what Newton is studying, and he compares the text to the mathematics he knows from Gregory and other authors. In a way, this positioning is also active, since it is in the form of a comparison. Only in a couple instances does Verwer indeed actively conclude something from his comparison, namely that he finds Gregory's versions to be clearer.

Theological notes

The other type of interaction which we have defined for Verwer's annotations is when Verwer has a more theological goal in mind. It should be mentioned that the distinction between mathematical and theological is even more problematic than the one between editorial or interaction. The reason for this is that Verwer himself wanted to break down any differences between mathematics and other knowledge, as he said in his letter to Gregory in 1691. Therefore, for Verwer at least, mathematics and theology merged into one another. We have decided to discuss the mathematical and theological annotations separately, however, because in our opinion Verwer's goal is different. Where his intentions for the mathematical annotations was mostly elaboration and clarification, here Verwer attempts to prove the existence of God. He will use the arguments which he finds in the *Principia* in later works. If we were to apply Jardine and Grafton's types of interactions, we would argue that here Verwer is more of the "moral, political" type than before. In our case, we do not discern moral or political views from Verwer's notes, but theological.

Arguably the most remarkable annotation is a four word note on page 2 in which Verwer simply notes "argumentum pro Existentia DEI". Verwer has found an argument for the existence of God in Newton's text. The asterisk accompanying this sentence has its referent in the text of Newton's definition III which states that "Inherent force of matter is the power of resisting by which every body, so far as it is able, perseveres in its state either of resting or of moving uniformly straight forward".[226] The star * is at the point where Newton says that "a body exerts this [inertia] force only during a change of its state, caused by another force* impressed upon it". Apparently, Verwer sees the necessity for a role for God in these lines. It is clear that Newton does not explicitly argue this himself. We know of Newton that at this point in time he was keen not to get involved in such epistemological debates, but rather stick to the mathematics. Only in the second edition of the *Principia* does Newton imply a more theological background to the forces of gravitation when he writes the now famous "General Scholium".[227] For Verwer, this annotation is the most theological annotation in the book and really the only one which is so outspokenly religious.

Verwer returns to a somewhat similar argument for the existence of God when writing his 1698 work *Inleiding tot de Christelyke Gods-geleertheid*. In this little book of approximately 110 pages, Verwer claims that he can prove that God exists using Newton's *Principia*.[228] The proof in the *Inleiding* boils down to the fact that the orbits of planets are elliptical instead of simply round: Verwer argues that this can only be the case when some mover is controlling these motions. This is

---

[226] Cohen (1999), 404.

[227] Ducheynes'discussion of "The General Scholium: Some Notes on Newton's Published and Unpublished Endeavours." [preprint retrieved from: http://philsci-archive.pitt.edu/3461/ on 26-01-2016].

[228] Verwer (1698), page 13.

surprising since it is not mentioned in Newton at all, and only marginally has a connection with the argument which Verwer's annotation refers to. We will look at this comment in more detail in chapter 5 on the *Inleiding*. Bart Jaski also alludes to the passage from the *Inleiding* in his tentative synopsis of Verwer's annotation for the Utrecht University Library.[229] Jaski points out that Newton himself only mentions God once, when Newton on page 415 talks about the different distances which the planets have from the sun. Verwer has underlined this passage, but added no comment in the margin.[230] However, in Verwer's appendix of notes at the end of the book we do find a comment related to this passage: "the most perfect knowledge of the arranging of the planets by God".[231] For us, these cases are again clear indications that Verwer was not reading Newton merely for its mathematical acclaim, but also for theological purposes. The fact that he uses that what he has learnt from Newton in his *Inleiding* emphasises the amount of value which Verwer attached to the *Principia*. Already in 1698, Verwer saw the usefulness of the *Principia*, not only as for its mathematics, but also as a tool for theological arguments.

Conclusion

All in all, we have been able to gain an understanding of Verwer's reading of the *Principia* through his different annotations. We have considered the editorial notes with which Verwer refers to 24 authors who were working on natural philosophy using mathematical methods. Most references are to David Gregory. Thereby he positioned the *Principia* within a broader mathematical frame of reference. From his other editorial annotations, we can conclude that Verwer studied the *Principia* in close detail and read his own annotations multiple times as well. He even compiled an index of his notes for the second and third books. This shows that Verwer valued the contents of the *Principia* greatly: Verwer clearly considered the *Principia* to be an important mathematical work. By studying Verwer's mathematical interests, we have uncovered his fascination for ratio's and equations. Verwer worked on those parts of Newton where the square law was defined and put to use for the Newtonian centripetal forces. Verwer's mathematics was of a good enough level to be able to translate Newton's wordy proofs into symbols and equations. We have seen in Verwer's letter to Gregory that this was indeed what Verwer was working on. Verwer read Newton to study more mathematics but also to place it within his argument that mathematics and all other knowledge is connected. The remarkable annotations on the argument for the existence of God and the reference he makes to the *Principia* in later work confirm this conclusion. Verwer did not see a distinctive difference between reading the *Principia* as a mathematical work or a philosophical or even religious

---

[229] Jaski (2013).
[230] Corollary 5, page 415.
[231] "Dei perfectissima scientia in collocandis planetis", page 526.

text. Apparently, he found these connections in Newton's *Principia*. In this chapter, we have discussed the main interests Verwer had in this contents and his methods of reading them. Verwer positioned the book within his own mathematical and – at the same time – theological context and he was intrigued by its mathematical consequences.

Taking care not to extrapolate too much from Verwer's case, this is interesting as it gives new insight into how the *Principia* was received in the Dutch Republic. As we have seen in the Introduction, there was little initial reaction to the *Principia*. Even though a review of the book appeared in 1688 already, not much mention of scholars reading the book can be found. It is therefore tempting to follow the idea that the Dutch Republic reacted to the *Principia* as Huygens did: accepting its mathematics but discarding its natural philosophy. Shank's research into the French reception of the *Principia* indeed also tells this story. However, from our study of Verwer's annotations, we can conclude that Verwer's reception was more than the 'Huygian' one.[232] Verwer attributes more value to Newton than just his mathematics, but sees important theological consequences in Newton's text. This leads us to believe that the reception of the *Principia* in the Dutch Republic for Verwer and his acquaintances was distinctly different from the common interpretation which lies closer to the 'Huygian' and French reception. Verwer's reception of the *Principia* as discussed in this chapter can be seen as illustrating this difference. In the following chapters we study Verwer's use of his newly learned mathematics as we turn to his own publications during the time in which he was reading the *Principia*.

---

[232] Just like in the Introduction, we coin this 'Huygian reception' to signify the reception of Newton's *Principia* in which Newton's mathematics is separated from his natural philosophy.

5. Inleiding tot de Christelyke Gods-geleertheid

Adriaen Verwer was deacon of his Mennonite church Lam en Toren in Amsterdam from 1697 to 1702.[233] During this time, Verwer was also reading Newton's *Principia*. As we have seen in the previous chapter, Verwer read Newton with a twofold goal: first to learn more about Newton's mathematics, and second to position this mathematics in his own framework of philosophy and religion. Verwer was inspired by Newton's method, style and mathematics. We see the results of this inspiration in Verwer's publications. In this chapter we dive into Verwer's religious appropriation of Newtonian mathematics and philosophy, in the next we look at Verwer's use of Newtonian knowledge in his linguistics and law studies.

In 1698 Verwer published a book on the Christian faith entitled *Inleiding tot de Christelyke Gods-geleertheid*.[234] Verwer indicates in the introduction that he has written the book from notes which he compiled over many years and that the book was originally meant for educating his children.[235] The *Inleiding* is generally ignored by scholars writing about Verwer, linguists and philosophers alike.[236] Yet, this text is important in our story, since it illustrates how Verwer appropriated the knowledge he gained from reading Newton's *Principia*. Furthermore, in the *Inleiding* we see a development of the same ideas which Verwer discussed in *'t Mom-aensicht*. A correct method of reasoning and reaching out for the truth is still one of the major themes of Verwer's research. We shall examine how Verwer fitted the newly learned Newtonian method with his method coined in *'t Mom-aensicht*. A third reason to include the *Inleiding* into our research is that Verwer himself assigned significant importance to the work in a letter to David Gregory in 1703.[237] In this letter, Verwer is forced to translate the main points of his book from Dutch into Latin. This gives us the opportunity to determine what Verwer deemed most important to discuss with Gregory and perhaps through him with Newton. From the letter we can already conclude that it was Verwer's intention that Newton would read the *Inleiding* for he writes that he has given two copies to William

---

[233] van de Bilt & Noordegraaf (2001).

[234] Published by Jan Rieuwert, Amsterdam. From here on we will abbreviate this title as *Inleiding.*

[235] Verwer (1698), "Voorrede", *2v. Also quoted in Van de Bilt (2009), page 35.

[236] Van Driel (1992), notably misses the *Inleiding*. As Noordegraaf comments, not many scholars of the Dutch language bother to read this religious text. Noordegraaf (2002), page 237.

[237] Verwer to Gregory (1703), letter LXXXVI of Rigaud (1841), pages 248-253.

Moncrief: one for Newton and one for Gilbert Burnet.[238] Hence, let us examine these arguments which Verwer wanted to present to Sir Isaac Newton.

To come to a thorough discussion of the *Inleiding*, we first look at how Verwer has structured his book. Here we already find some clues for Verwer's interest in mathematics: the work is ordered as if it is a book on geometry. This fits into the tradition prevalent in early modern philosophical works which adopt the *mos geometricus* style of reasoning. As discussed before, the most notable of these works was Spinoza's *Ethica* [239] The fact that Verwer also adopted or maybe even imitated this style of reasoning plays an important role in our argument. Next, we will discuss four examples of the role which natural philosophy plays in the book. The first two are in the "Voorreden", where Verwer discusses the virtues of mathematics ("wiskonst") and manners of reasoning and studying.[240] The latter reminds us of Verwer's argumentation from *'t Mom-aensicht* in which Verwer set out his empiricist epistemology based on a distinction between hypothetical and real arguments and concepts.[241] The third example which we shall expand on is Verwer's proof of the existence of God. Here Verwer explicitly mentions Newton and the *Principia*. In the previous chapter we have already discussed Verwer's annotation which emphasised this argument. The fourth and last example of natural philosophy in Verwer's *Inleiding* entails the seventh chapter of the book. This last chapter of the *Inleiding* involves:

> "een wiskonstige bevestiging, dat en hoe die wegen en middelen, welke de Heere Jesus heeft geleerd ons tot de gelykheid met God te moeten brengen; de eenigste middelen daertoe sijn; en datse 't noodsakelijk sijn."[242]

> a mathematical proof that and how the approaches and means, which the Lord Jesus has taught us to equate with God, are the only means to this end and that they are necessary. (own translation)

---

[238] "Vellem et Newtonum hae posse persentire. Moncriefio trado exemplar ei perferendum, ut et D. Thomae [Gilberto] Burnet episcopo" Rigaud (1841), page 253. Also quoted in Noordegraaf (2002) and Van de Bilt (2009). Guillielmus Moncrief or Moncreif (born ca 1661) studied law at Leiden in 1689, aged 28 ("Guillielmus Moncreif, Scotus, 28, J." in *Album studiosorum Academiae lugduno batabae MDLXXV-MDCCCLXXV* (1875) column 706). Gilbert Burnet (1643-1715), Scottish philosopher and historian.

[239] See chapter on *'t Mom-aensicht* for more on *mos geometricus* and Spinoza's style of reasoning.

[240] Verwer (1698), page *7v.

[241] See chapter *'t Mom-aensicht*. "Empiricist epistemology" is a term coined by Jongeneelen to describe what Verwer is defining.

[242] Verwer (1698), "Sevende Hooftdeel", page 37.

In addition, Verwer ends the book with a summary of chapter 7 in the form of a formula "in the language of Newton" (*dialecto Newtoniana*).[243] Verwer proudly describes the formula to Gregory in his 1703 letter. With these four examples, we gather an idea of how Verwer appropriated his newly learned Newtonian thought. It will appear that Verwer found in Newton not only a proof of the existence of God, but also an example of his idea of a proper method to present this proof, compatible with what Verwer had already been working on.

The structure of the *Inleiding* strongly reminds us of the *Principia*. Verwer starts with a definition of the concepts "godsgeleerdheid" and "godsdienst", theology and religion. Verwer defines theology as a "science" (wetenschap) which acts on the object and the demand of religion.[244] After he defined two main concepts, Verwer sets forth the principles on which his book is founded (chapter 2). These are then consolidated in chapter three. The main principles are: (1) that there is a God, (2) that there is an eternal Blessedness, (3) that there is an eternal Unhappiness.[245] To consolidate these principles, chapter three contains a series of proofs, including a proof based on Newtonian mathematics which we shall discuss further on. In the fourth, fifth and sixth chapters of the *Inleiding*, Verwer discusses the consequences of his proofs. These consequences are linked to biblical texts and interpretations thereof. Since these do shed no new light on Verwer's interest in Newton, we will largely ignore them. Chapter seven, on the other hand, merits a closer discussion. In this chapter Verwer gives a "mathematical" confirmation of the proposition that Jesus' teachings offer the only correct means to arrive at equality with God. Verwer arrives at this confirmation through thirteen "voorstellen" or propositions. A number of these propositions include proofs, corollaries, and a scholium. Furthermore, Verwer ends the chapter and the book with a formula to explain the contents of the seventh chapter in a Newtonian way.[246] This structure resembles the Newton's structure of the *Principia* and of many other contemporary mathematical books, for Newton also starts the *Principia* with a list of definitions, followed by a chapter on axioms on which the further chapters are based. Every chapter then consists of a number of propositions and theorems which are proven and which involve corollaries and sometimes a scholium.

This type of structure or style is not unique for the *Principia*, but had been customary for books on mathematics, since the ancient Euclidean example in his *Elements*. The fact that Verwer adopts this structure in a treatise on religion, however, is not typical. It indicates that Verwer intended his work to have a mathematical ring to it. In Verwer's preface to the *Inleiding* he alludes to

---

[243] Verwer (1698), "Analysis Geometrica cap. 7", page 86.

[244] "De Godsgeleertheid is de wetenschap die van het voorwerp en van den eisch der Godsdienstigheid handelt." Verwer (1698), page 1.

[245] Summarised like this in chapter three. Original: "(1) Dat'er een GOD is. (2) Dat'er een eeuwige Geluksaligheid is. (3) Dat'er een eeuwige Ongeluksaligheid is." Verwer (1698), page 7.

[246] Verwer (1698), page 86.

the mathematical structure of his book, saying that it is shorter and easier for himself to adopt this structure.[247] On the other hand, he admits that in the past his attitude towards mathematics was ambivalent. As we have seen in our analysis of *'t Mom-aensicht*, Verwer did not trust mathematical reasoning on its own. Verwer had claimed that mathematics could misguide those people who are not used to such reasoning and therefore mask the true points. Now in the "Voorreden" he says:

> "since in past years I have perceived some sort of extra mask, which such a mathematical structure entails, misguiding those who are not used to it, hence we have decided to omit superfluous mathematics and present our basic principles in a more common style."[248]

It appears that Verwer had intended the *Inleiding* to propagate a mathematical view of theology and religion, yet he decided to contain the mathematics to a certain extent. The structure of the book still resembles a mathematical treatise and there are explicit excursions to religious mathematics in chapter seven. We see the power which Verwer attributes to *mos geometricus*. Intriguingly, Verwer adds a marginal note to this statement saying "Scientifica και ἐπιστημονικὸν λόγον".[249] Verwer deems the convincing elements of his method to be "scientific". With this, Verwer labels his method of argumentation as systematic and mathematical.[250] The comment shows that on the one hand Verwer does not consider his book to be merely on religion, and on the other that he does not find it unusual to combine mathematics with religion.

A second example of this combination can also be found in the preface. Verwer claims that one must attempt to apply proper reasoning to the study of theology, so as to come to "a complete thesis" of the subject matter.[251] Verwer calls this "complete thesis" a "systema", a whole consisting of several parts.[252] Hence Verwer believes that theology should be studied as a whole system. In order to do this, Verwer argues that one must "penetrate to the foundations on which the texts

---

[247] "De ordre en schikking nu hier in gelustede het ons *wiskonstig* voor te stellen; om de meerder kortheid en ons eigen gemak" Verwer (1698), page *7v.

[248] "evenwel in vervolg van Jaren bespeurende dat eenig byspel, 't welk die wiskonstige ordre met sich heeft, den ongewonen ende eenvoudigen te veel verstrooit, soo hebben we daer naderhand uitgenomen al wat daer eenigsins af kon blyven; ook onse allereerste grond-bewijsen wedergebragt in een algemeene doorgaende stijl." Verwer (1698), page *7v.

[249] Printed in the margin of Verwer (1698), page *8r. The referent is "een *overtuigende manier van verhandelen, afleiden en besluiten".

[250] NB: this is in our interpretation of the word "scientifica".

[251] "Men moet sijn best doen om nopende de Godsgeleertheid een bevatting te verkrijgen by manier van [251]geheele stelling, in welke het achterste op 't voorste sluyt en dat lanx eenen draed" Verwer (1698), page *5r.

[252] Marginal note of Verwer (1698), page *5r, with referent "geheele". Latin translation from Lewis & Short Latin Word Study Tool: http://www.perseus.tufts.edu/hopper/morph?l=systema&la=la#lexicon .

themselves rest".[253] This resembles Verwer's argumentation which we have studied in *'t Mom-aensicht*. We found that Verwer defined an empirical epistemology: only arguments based on concepts from reality can say something about the truth.[254] In addition to this, Verwer stressed the importance of returning to the foundations of arguments to uncover what they are grounded on. These foundations should then again have a referent in reality, otherwise they are meaningless. This attitude towards proper reasoning reoccurs in the *Inleiding*. Verwer recommends his readers to always study the foundations of the texts: that is where true understanding of the text can be found. From here, theorems can be proven and strengthened, using proper reasoning. Hence, to study theology in a meaningful way and to come to a good understanding of the propositions pertaining to this study, Verwer argues that just as before the method of reasoning is essential. Only when this is done properly, based on real foundations, can one reach arguments which have the ring of truth to them. In this way, Verwer uses what he has done before with the religious point that he wants to make now.

The third case of a connection which we can discover between Verwer's natural philosophy and theology can be found effortlessly in the third chapter of the *Inleiding*. Here Verwer consolidates the axioms which he has proposed in chapter two, namely that God, eternal blessedness and eternal unhappiness truly exist. Verwer claims that he can readily give a large number of proofs that God exists. These proofs would all rest on things from daily life and hence things which are really there.[255] He has, however, chosen one of which he says that it is the easiest and clearest. Verwer's proof that God exists is based on the fact that the orbits of the sun, moon and planets are not circular but elliptical. Verwer says that the dominant astronomers have now reached consensus on this idea.[256] This means, Verwer claims, that there is no other way for the orbits to be elliptical than by the existence of some "mover" who controls all these motions.[257] For a better understanding of these elliptical motions, Verwer refers his reader to Newton's *Principia*.[258] From Verwer's annotations, we know exactly the passage which Verwer is referring to. On page 2 of his copy of the *Principia* Verwer notes "argumentum pro Existentia DEI". This note accompanies Newton's definition of inherent

---

[253] "men moet doordringen tot die fondamenten waer op de texten self rusten" Verwer (1698), page *5v.

[254] See chapter *'t Mom-aensicht*.

[255] "de stukken welke men tot vastmaking van dit ons bewijs kan aentrekken uit den dagelijksen loop en schikking der sienlijke dingen sijn veelvuldig in getal" Verwer (1698), page 12.

[256] Verwer mentions the "dominant astronomers" Kepler, Bullialdus, Cassini, Huygens, Flamsteed and Newton. Verwer (1698), page 13.

[257] "nu en is 'er immers geen middel nocht voege by den mensch te bedenken dat een Ovaelse draying ergens in kan uitgevoerd en gaande gehouden werden sonder tusschenkomste van een bestierder die buiten deselve dingen bestaet" Verwer (1698), page 13.

[258] "En wil iemand de waerheid van de Ovaelse draeyingen breeder weten, hij herkaeuwe maer rijpelijk de voornaemsten inhoud van 't Latijnse boek des gemelten Isaak [sic] Newton, geheten Wiskunstige gronden der Natuerkennisse." Verwer (1698), page 13.

forces or force of inertia of matter. Newton claims that a body can only be moved by an external force which is greater than the inherent force of that body. The body only exerts this force of inertia when it is in a state of change, and it can be seen as a form of resistance against the impressed force. This definition is important to Newton's argument since he makes clear that the distinction between motion and rest is relative, not absolute: a body can seem to be in rest even if a force is pressing on it.[259] Verwer has placed his annotation at the point where Newton discusses "external forces". Apparently, Verwer sees the influence of God in these forces. Verwer then uses what he has found in Newton for his *Inleiding* to argue that the existence of God is necessary in nature. With this information, Verwer claims to have proven that God exists – a central point for the rest of his argument. Therefore, we discover a significant role for Newtonian natural philosophy in Verwer's theological argumentation.

The fourth example of the influence of natural philosophy on Verwer's theology is from the final chapter of the *Inleiding*. In this chapter, Verwer lists thirteen propositions to prove that the teachings of Jesus to arrive at equality with God are indeed the only right approaches and means. The first seven propositions serve to prove that the eternal Blessedness is something real, yet not something a man can reach in his life, although the deeds in his life do determine whether he will reach it or not. Then, in proposition eight, the eternal Damnation is introduced and means to fall into this, namely sins, are defined. Deeds of Mediocrity are introduced in proposition nine and ten as acts which are in between blessings and sins but will still lead to the eternal Unhappiness. Propositions eleven and twelve concern the ceremonies which should accompany all these deeds. The final proposition dictates that of all schools of religion, only the Christian school is the correct one.

The contents of these propositions are not necessarily important for our research, but the structure of Verwer's argumentation does matter. These statements are based on believe and texts, and cannot be structured as if it were a mathematical proof. This is, however, exactly what Verwer does. Verwer sees this method as impeccable and necessary for his case. The proofs themselves are all based on logic and reasoning, there is no geometry or mechanics involved here. Nevertheless, Verwer ends the book with a "geometrical analysis" of chapter seven:

$$\overline{D \times efb} - \overline{D \times fhm} \times Geff. \propto 0.$$

Adding that "this is; in Newtonian dialect: eternal Blessedness is connected in direct ratio with pious deeds and inversely with Divine Grace"[260] Without further context or explanation, this formula with the accompanying sentence is gibberish. Verwer gives a Latin translation of his formula with more

---

[259] Cohen (1999), pages 404-5.

[260] "id est; *dialecto Newtoniana*: Beatitudo aeterna est in ratione composita ex operum piorum ratione directe, & ex Gratiae Divinae ratione inverse." Verwer (1698), page 86.

information on its derivation when he describes it to David Gregory in 1703.[261] Verwer introduces the formula saying that he was inspired by Pitcairne's "tract on the Inventors".[262] This is a reference to Pitcairne's 1688 pamphlet entitled *Solutio Problematis de Historicis; seu, Inventoribus*.[263] In the pamphlet, Pitcairne argues against Hippocrates, stating that Hippocrates never truly understood the circulation of blood. Instead, Pitcairne defends Harvey's theory of blood circulation.[264] Harvey had established his theory of blood circulation by working with mathematical principles. Pitcairne claims that anyone who understands geometry would never argue in a way that would contradict geometry and that one should always trust those who understand geometry. In the *Solutio*, Pitcairne expresses his admiration for Harvey's method and claims to build his medicine entirely on mathematical principles as well.[265] Indeed, in the Latin version of Pitcairne's pamphlet, he introduces a complicated formula based on Gregory's theory of the quadrature of curves. [266] What Pitcairne intends to achieve with this formula is unclear because he does not define the variables or the method he is using. However, it is interesting for our case that Pitcairne choses to coin a formula of such a complexity in this medical and philosophical text. Apparently, this inspired Verwer to do the same.

Verwer's derivation of the formula in his letter to Gregory unfortunately does not bring much clarity. Verwer defines D as God, f as happiness, h man, m medium, e limit, and G grace. Then $\frac{Dh}{f}$ is the eternal gratitude for men and $\frac{Dhm}{ef}$ signifies the works of piety. Verwer claims that he can equate these two after multiplying $\frac{Dhm}{ef}$ by Grace, which is inversely proportional to this.[267] Hence, $\frac{Dhm}{ef} \times \frac{1}{G} = \frac{Dh}{f}$ and therefore $Dhef - Dhmf \times \frac{1}{Geff} = 0$ or $\frac{1}{Dhef} - \frac{1}{Dhmf} \times Geff = 0$.[268] Having derived this, Verwer is satisfied and instead of explaining his conclusion, he moves on to list the propositions from chapter seven of the *Inleiding* which relate to the variables from his formula.

[261] Verwer to Gregory (1703) pages 248-253 in Rigaud (1841).

[262] "Observaveram dudum id cum fructu factitatum a Pitcairnio in tractatu de Inventoribus."

[263] Pitcairne (1688). It was later included in *The Whole Works of Dr. Archibald Pitcairne, published by himself* (1715) and translated as *A Solution to the Problem Concerning Inventors*, pages 135-163.

[264] Casteel (2007), page 80. Casteel discusses Pitcairne's appointment at Leiden University. He claims that Pitcairne would not have been given a seat if the Senate had read the *Solutio* before his inaugural lecture.

[265] Casteel (2007), pages 89-90.

[266] Casteel does not mention the formula or the references which Pitcairne makes to Gregory. Furthermore, the later English version of the *Solutio* does not include the formula or the mathematical discussion at all. The first part is a translation of the Latin, but then where the Latin version starts with the mathematics, the English version includes a discussion of Hippocrates' texts and arguments, a textual analysis. It seems as if Casteel has read this version of the *Solutio* and not the Latin original.

[267] In Rigaud's transcription, this fact that Grace is inversely proportional is not included in the formula. I assume this is a transcription error. However, Verwer says it clearly and only when one takes this inverse ratio into account does the formula make sense algebraically.

[268] It must be noted that this derivation is only possible when one knows the answer that Verwer wants to find. If not, then these steps do not make much sense.

Through this analytical route, Verwer claims to have consolidated his conclusion with much weight.[269] Therefore, we can conclude that Verwer attributed quite some value to his formula.

When we translate Verwer's interpretation of the formula, we find that it implies that eternal gratitude is proportional to pious works of man while inversely proportional to divine Grace. To understand this statement we look at chapter 7 of the *Inleiding*: Verwer has established that divine grace always exists, hence it is never equal to zero. This means that Verwer's inverse proportion is mathematically possible. To interpret the formula, however, is more ambiguous. The proportions can be interpreted in two ways. Either they show that when a man works hard enough to be pious, then his works of piety can equalise any amount of divine Grace that he receives so as to always reach eternal gratitude. Or we interpret the equation as a sign that divine Grace will always have its influence, no matter how pious one lives. These two interpretations speak to two different religious movements: with a focus on one's own hard work or on interference of divine Grace. As a Mennonite, we would expect Verwer to argue that hard work can way up to divine Grace and that whether one receives eternal gratitude is in some way controllable. Clearly, this is unorthodox, since a Calvinist believes that only God can determine who receives eternal gratitude or not. Gregory's Episcopalian faith, while on many points polar opposite to the Mennonites, dictated that even though one can never truly be independent of God's influence: man did have a free will. In this sense, both Gregory and Verwer would agree that the formula shows how eternal gratitude can be received through a combination of hard pious work and divine Grace.

This theological interpretation is still quite trivial. It should be noted that in Verwer's formula he explicitly adds a factor of f, happiness. By doing this, the fraction $\frac{1}{Geff}$ contains a square: happiness is squared. This recalls Newton's inverse square law, where force is inversely proportional to the distance squared. Nevertheless, when one would start working with this formula mathematically, one would quickly find that the square cancels out. Hence, mathematically the squared happiness is meaningless. Verwer does not mention this himself and that leaves us only guessing as to what he might have meant here. Hence, we need to understand more of Verwer's theology in order to come to a solid interpretation of his Newtonian formula. We cannot research this here, however. For our argument, it suffices to say that Verwer gave Newton an important role in his theological theory. The combination of mathematics and theology which we have been studying throughout this chapter, can be found here in its most explicit format. But neither his nor Pitcairne's formulae make a lot of sense mathematically. Clearly, the mathematical meaning of the formulae is not what is important for Pitcairne or Verwer.

---

[269] "Atque ita observabis, vir clarissime, me per viam talem analyticam omnes meas conclusions tuto potuisse perficere".

With these four examples we have seen how Verwer combined that which he had been working on in various fields, with his goal of doing theology properly. From each case we conclude that Verwer appropriated that what he had studied in Newton and in contact with Gregory, into a system with which he then turned to religion. Verwer applied the mathematical structure which he found necessary for proper reasoning and organised his book so that it was congruent with that. Verwer also stressed this in his letter to Gregory in 1703, saying that he wants to approach theology in a rational and geometrically ordered way, just as Spinoza had done, using the *mos geometricus*.[270] In addition to this use of geometry in his style, Verwer used natural philosophy to consolidate his arguments.

Verwer had been studying Newton's *Principia*, when he found his argument to prove the existence of God. We have seen him refer to this proof in his copy of the *Principia* itself, but we also find the argument here in the *Inleiding*. Judging by his annotations, Verwer also expressed interest in Newton's work on the inverse square law, something which again comes to the fore when reading the last chapter of the *Inleiding*. The extraordinary formula with which Verwer concludes the *Inleiding* is again proof of his precise work on Newton's *Principia* and other mathematically inclined books. All in all, Verwer found in Newton not only a method which was consonant with the method Verwer himself had been adapting, but also the mathematical tools which he could use to strengthen his conclusions. Using Newton, Verwer could prove the existence of an active God in the universe and the Newtonian method of reasoning could easily be combined with Verwer's own. This was what Verwer had been looking for whenwas what Verwer had been looking for when he was working on his refutation of Spinoza in *'t Mom-aensicht,* as we discussed in chapter 2. When we consider the Dutch reception of Newton's *Principia*, this fits in with our statement that Verwer was interested in more than merely Newtonian mathematics.[271] Here we see tell-tale signs of Verwer's 'use' of the *Principia*: Verwer finds theological arguments in Newton's work. The following chapter illustrates that Verwer did not only use Newton for theology.

---

[270] "ratiocinio et geometrico ordine" Verwer to Gregory (1703) in Rigaud (1841).
[271] See our discussion of the Verwer's reception at the end of chapter 4.

6. Other Publications: Linguistics & Maritime Law

From what we have seen of Adriaen Verwer in the previous chapters, we could already conclude that he was an intriguingly diverse man who combined his study in mathematics with ideas in theology and religion. We realise the same when we discuss Verwer's linguistics and judicial background. For the sake of this research, these publications are categorised as "other". This is a biased categorisation, however, since today Verwer is well known as a linguist by Dutch historians of language and Verwer's publication on maritime law enjoyed international fame in the 18th century. The title of "other publications" fails to do justice to this. Furthermore, we have already established that it is not possible or even fruitful to attempt to give Verwer a label of any kind: mathematician, linguist, merchant, natural philosopher, Mennonite, theologian, none of these really describe Verwer properly. Such modern labels are always problematic when considering early modern characters. Modern scholars increasingly acknowledge the problems of disciplines in early modern scholarship. When discussing Verwer's *Mom-aensicht*, Jongeneelen argues that the empiricist epistemology which Verwer coins in this work would be "most fruitful for eighteenth century linguistics".[272] Noordegraaf, whose research focuses on Verwer as a linguist, motivates his decision to study Verwer's *Inleiding* by saying that "scholars too often consider their colleges from then and now to be

---

[272] Jongeneelen (1996), page 21.

one-dimensional."[273] Clearly, we have never seen Verwer as a one-dimensional scholar and we will continue with this in mind. We discuss Verwer's work on the Dutch language with his 1707 publication of *Linguae Belgicae Idea Grammatica, Poetica, Rhetorica* and Verwer as a scholar of maritime law on the basis of his *Nederlants See-Rechten; Avaryen; en Bodemeryen*, published in 1711. Even though we will not go into the detail of the primary sources themselves, these "other" publications from Verwer still tell us more about how Verwer appropriated what he had learned from studying Newton. Here we see Verwer's Newtonianism at work.

Throughout our research into Adriane Verwer, we have come across mentions of his interest in linguistics and the Dutch language. In the *Inleiding*, for example, Verwer discusses the idea of reaching a "volmaekte tael", a perfected language, by studying its foundations.[274] Most of the secondary literature on Verwer focuses on his legacy for the study of language. When he is introduced, Verwer is often called a *mercator sapiens* who was actively involved in linguistic debates.[275] Not only did Verwer participate in religious communities and a group mathematical enthusiasts, he was also part of a linguistic company, together with, amongst others, Lambert ten Kate (1674-1731) and possibly Tiberius Hemsterhuis (1685-1766).[276]

Verwer's linguistic aim was to structure the Dutch grammar just like Latin grammar was structured. In this sense, Verwer can be placed in a transition period from seventeenth century Renaissance linguistics which focused on speech to the eighteenth-century study of language which had a more normative inclination and was based on historical comparisons of language.[277] Inspired by Arnold Moonen's *Nederduytsche Spraakkunst* (1706), in which Moonen also claims to perfect the Dutch language by structuring it in a classical way,[278] Verwer reacted by publishing the *Idea* in 1707, in which he argued that Moonen's approach would lead to nothing.[279] Nevertheless, Verwer dedicated the *Idea* to Moonen. Notably, Verwer published the *Idea* anonymously, with the pseudonym "Anonymus Batavus", the anonymous Hollander. Verwer's reason for publishing pseudonymously was that he did not consider himself a member of the established authors on matters of Dutch language and hence did not want to connect his name to his work.[280] As we

---

[273] Noordegraaf (2002), "Te vaak zien wetenschappers hun collega's van toen en nu als eendimensionaal.", own translation, page 13.

[274] Verwer (1697), Voorreden. Also pointed out by Noordegraaf (2002), page 4.

[275] Noordegraaf (2002) & (2004), Van de Bilt (2009).

[276] Van de Bilt (2009).

[277] Van Driel (1992), page 133.

[278] Arnold Moonen (1644-1711). For more on Moonen, see Lindeboom's monography (1958) "Arnold Moonen 1644-1711. Mededelingen der Koninklijke Nederlandse Akademie van Wetenschappen, afdeling Letterkunde. Nieuwe Reeks, deel 21, nummer 3."

[279] Van de Bilt (2009).

[280] "ik geen lidt der schryveren van name en ben" Van de Bilt (2009), page 36 .

established in chapter 1, Verwer did not attend a university and was educated by acquaintances and through experience. This could be an explanation why Verwer was so modest about this matter. Also in the realm of linguistics, Verwer was more of an enthusiast, an amateur, than a scholar. Furthermore, the *Idea* was followed up by a series of letters in which Moonen's and Verwer's approaches were discussed. Three letters from Verwer belong to this series: two to David van Hoogstraten in 1708 and a 52 page letter to Adriaen Reland in 1709.[281] The letter to Reland included a reaction to Moonen's critique on the *Idea*. In this letter, Verwer compared his own scientific linguistic method with Moonen's approach which was based on hypotheses. [282] As we have seen before, this approach was unacceptable for Verwer, also in the study of language.

Verwer's central principles in linguistics are summarised by Igor van de Bilt as the following three points: language was seen as a system and use of language as an expression of the regularity of that system; Verwer saw an empirical foundation of language; and according to Verwer, language was constructed by people and must therefore be preserved by humans too.[283] The system of language was based on laws. These laws were not produced from the intellect, "e cerebro", but they lay at the basis of the deepest reality of language.[284] Reproduction of these laws occurred through the correct usage of language. This meant that for Verwer it was of utmost importance to understand the origins of the Dutch language, "linguam nostram *ex origine* nosse".[285] As for the origin of Dutch, Verwer argued for the *gothica-genetrix* theory, which considers Gothic as the mother of all Germanic languages. In the past, the Dutch language had adhered to a certain order, a regularity or *analogia*, Verwer claimed, he called this era a *speculum analogum*. Verwer believed that the order of Dutch language could be found in studying this period of history. This meant that Verwer studied Gothic and Middle Dutch in an attempt to restore the regularity in the Dutch language.[286]. In describing this period of regularity, Verwer relies on the Dutch mathematician Simon Stevin.[287] When a system of laws has been observed, a linguist should formulate a "*hypothesis*" on the basis of these observations. This hypothesis should then be tested multiple times on other linguistic observations and facts. When the hypothesis is of such a general character and covers all phenomena, then it can

---

[281] Van de Bilt (2009), page 33.

[282] Verwer (1709) *Brief aan den Heere Adriaen Reland, professor der Oostersche talen in de Academie tot Utregt, vanden Schryver der Linguae Belgicae Idea Grammatica; &c. tot rekenschap vande Aenmerkingen vanden Heer Arnold Moonen op dezelve Idea; en van 't richtig Nederduitsch, zoo als door onze Hooge Overheidt gebruikt is in Hare nieuwe overzettinge des Bybels.* Published in Utrecht, by Willem Broedelet.

[283] Van de Bilt (2009), page 50.

[284] Noordegraaf (2002): "de taalwetten hier niet 'in het brein [*e cerebro*] verzonnen' zijn, 'maar uit den diepsten grond der tale zelf en deszelfs recht gebruik te berde gebragt worden'." page 6. Also Noordegraaf (2004), page 2 and Van Driel (1992), page 129.

[285] Noordegraaf (2004), page 2.

[286] Noordegraaf (2004), page 2.

[287] Van Driel (1992), page 134.

be considered a law. Furthermore, if it were to occur that a linguist should find regularities in certain phenomena, then these regularities could be used to predict other phenomena which have not yet been observed. Verwer argues this on the basis of the principle of analogy, following the "natural axiom" that "like stems from like".[288] No preposterous claims are needed to argue that this is a Newtonian speaking. On the contrary, the "natural axiom" can be found in Newton's "Regulae Philosophandi".[289] However, Verwer already proclaimed this statement in 1709, whereas Newton's rules for doing philosophy were part of his second edition of the *Principia* in 1713. Verwer had read the 1687 edition of the *Principia* in which the rules are called "Hypotheses" and cannot be copied exactly to the later "Regulae".[290] From this we can conclude that Verwer was actively engaged with the principles of Newtonian philosophy and appropriated them to fit with what he was working on himself, in this case linguistics.

Van de Bilt and Noordegraaf argue that Verwer's linguistics had a philosophical or even religious foundation. Verwer's student, Lambert ten Kate, is more explicit about this than Verwer himself. Ten Kate and Verwer lived at a five minute walking distance from one another in Amsterdam.[291] They were both Mennonite merchants, socially engaged and immensely interested in theological and linguistic issues.[292] For Ten Kate, language was what made humans distinct from animals, it was a 'divine gift' and the *nota discriminis*.[293] This is explained in Ten Kate's refutation of Cartesian mechanics. According to Ten Kate, a frightening consequence of Descartes' mechanical worldview was the mechanisation of the human mind. From this, there would be no distinction between man and animal. Hence, for Ten Kate, language was essential to underscore the difference between human minds and that of an animal.[294] Ten Kate propagated these ideas in his translated and edited version of George Cheyne's *Philosophical Principles of Natural Religion*, published in 1705. Ten Kate's version was entitled *De Schepper en Zyn Bestier te kennen in Zyne Schepselen; Volgens het*

---

[288] Noordegraaf (2002), page 7 and Noordegraaf (2004) page 3. Verwer is quoted by Noordegraaf: "Dat gelijk uit gelijk voortkomt".

[289] Noordegraaf (2002) page 7. Noordegraaf does not comment on the fact that these rules were only present in the second and third edition of the *Principia*.

[290] In his translation of the *Principia*, Cohen gives a table in which he translates the hypotheses from the first edition to the rules and phenomena in the second and third editions.

[291] Noordegraaf (2002) page 1. In a recent article by Zuidervaart and Rijks, the importance of such details is emphasised. Just as Zuidervaart and Rijks argue that the proximity between seventeenth-century painters, scholars and optical practitioners enabled developments in the study of optics at Delft, here we see the influence of such factors on the ripening of the Newtonian method in linguistics. Zuidervaart, H. & Rijks, M. (2014) "'Most Rare Workmen': Optical Practitioners in Early Seventeenth-Century Delft" in: *The British Journal for the History of Science, 48*(1), 53-85.

[292] Noordegraaf (2002) page 1-2.

[293] Noordegraaf (2002) page 10 & (2004) page 7.

[294] Noordegraaf (2002) page 12-13.

Licht der Reden en Wiskonst. Tot Opbouw van Eerbiedigen Godsdienst en Vernietiging van alle Grondslag van Atheistery, and was published in 1716, just after Cheyne's second edition in 1715. In Cheyne, Ten Kate found in words those ideas which he himself had always had.[295] He added his own refutation of Descartes and Spinoza to the book and in the preface Ten Kate praised both Christiaan Huygens and Isaac Newton for their empirical inductive reasoning.[296] Ten Kate attempted to adopt this method in his linguistics. His empirical vision on linguistics is cited by Van Driel: "Now we must find the laws of language (…) from within, and not make them."[297] Again we see the idea that language is a system of which the laws can be found in reality, like Verwer argued, which are then to be tested, not to be simply constructed. Ten Kate mentioned explicitly the "faultiness" of the Cartesian system of mechanics in which one sticks to "a mixture of untested guesswork".[298] From what we have seen in Verwer's work from *'t Mom-aensicht* onwards, we can conclude that he would indeed agree with Ten Kate's arguments.

Verwer and Ten Kate's Newtonian principles in linguistics were quite well received and especially Ten Kate was known by scholars of the Dutch language in the eighteenth and nineteenth centuries. Verwer's *Idea* was reprinted in 1783 and, judging from his correspondence, he was seen as a kind of oracle in linguistic matters in the Dutch Republic.[299] Verwer enjoyed international fame, however, in the realm of maritime law. An interest of Verwer's since his work with Pedy in Rotterdam, maritime law was Verwer's first topic of study. We have clear evidence of Verwer's international acclaim on this topic. In 1681 when the *Grande Ordonnance de la Marine* was established, Verwer was consulted for his advice. The Great Ordinance of Marine, or marine code, which Louis XIV had ordered to be drafted, comprehensively systematises affairs in maritime transport. The code was based on the customs and statutes of the Dutch Republic and hence advisers were consulted during the process. Apparently, Verwer's name in maritime law was such that he was on this list of advisers.[300] Verwer himself later mentioned the event saying that: "the 'Ordonnance de la Marine' of 1681, to which, when I was still living in Rotterdam, my town of birth, in 1679, I have

---

[295] Noordegraaf (2002) page 10.

[296] Noordegraaf (2002) page 11.

[297] Van Driel page 135, own translation of: "De tael-wetten, even als de Land-wetten, nu van agteren te vinden, en niet te maken."

[298] Noordegraaf (2002) page 11, own translation of: "gebreklyheid" and "een Mengsel van onbeproefde Gissingen".

[299] Van de Bilt (2009), page 33 and Noordegraaf (2004) page 1. It is striking that after writing the *Inleiding* in Dutch, Verwer writes the *Idea* in Latin. Perhaps his experience with having to explain his main argument to Gregory because he did not read Dutch, motivated Verwer to write in a more international language like Latin, which was the *lingua franca* in early modern scholarship. Apparently, Verwer intended his *Idea* to be read by more people than only the ones who could read Dutch.

[300] Hermesdorf (1967), page 227.

contributed following a request from a certain Monsieur Legras".[301] Legras was the man who was sent to the Dutch Republic to learn whatever might be of use for the marine code and who maintained a correspondence with Verwer.[302]

In 1711, Verwer's book *Nederlants See-rechten; Avarijen en Bodemerijen* was published, dedicated to the magistrate of Amsterdam. This book was reprinted three times in the eighteenth century and was known internationally.[303] Furthermore, Hermesdorf claims that there is no book that pays attention to the history of the maritime law which does not mention Verwer and his book.[304] It would be interesting to look more closely at this influence of Verwer's on maritime law, but for this current research it is not fruitful. Verwer's adventures in the land of maritime law clearly enabled him to have international contacts and fame. [305] It might have been a reason for Verwer to learn and practice his languages. It is known that Pedy mostly worked with international clients, so this must have been a very diffuse environment for Verwer.[306] As for his methodology when it comes to the study of maritime law, Verwer founded his arguments on historical works which were on law such as Roman law.[307] Verwer's focus was on preventing persecutions, saying that this was more practical since merchants were not interested in theoretical judicial essays.[308] This was Verwer's job, translating the theoretical works into practical guides, the same thing he did while working on the "Ordonnance". Here there is no philosophical or theological motivation, and we find no Newtonian methodology. Verwer clearly intends to write a more practical work.

Throughout this research the focus has been on Verwer's mathematics and his theology. This chapter, however, deviated from this path. Even though recent scholarship does acknowledged Verwer's role in natural philosophy, he is still primarily remembered for his work in linguistics and maritime law. This not only adds an extra dimension to Verwer's life, but also to the idea of the mathematical amateurs. We have put emphasis on the fact that Verwer was not educated at an institute for higher education and had no academic background in mathematics by calling him a

---

[301] Quoted in Warlomont, R. (1955) "Les sources néerlandaises de l'Ordonnance maritime de Colbert (1681)", page 341, from *Aentekeningen over Bodemereyen*, page 160: "'Ordonnance de la Marine' van 1681 (waer aen ik binnen Rotterdam, myne geboortestadt, in 1679, mede noch iets hebbe gewerkt gehadt op aenzoek van eenen Mr. le Gras, …" own translation.

[302] Hermesdorf (1967), page 227-8.

[303] Van de Bilt & Noordegraaf (2001).

[304] Hermesdorf (1967), page 253.

[305] Hermesdorf (1967), page 233. In light of footnote 298 it is extra noteworthy that Verwer published the *See-Rechten* in Dutch. Even though Verwer knew his worth in this area on an international level, he decided to write in Dutch. This highlights the idea that Verwer mainly wrote this book as a practical manual.

[306] Hermesdorf (1967), 230.

[307] Hermesdorf (1967), 243.

[308] Van de Bilt (2009), page 37 own translation: "Aan rechtsgeleerde theoretische verhandelingen heeft de koopman niet zo veel."

mathematical amateur.[309] This concept is brought to the fore once again when we consider Verwer's work in these 'other' areas of knowledge: Verwer studied mathematics next to and in combination with these disciplines. His work in these different fields influenced each other, especially because Verwer himself strived towards combining them. Evidence of this can be found in his discussion of such combinations in his letter to Gregory, but also in the fact that Verwer used mathematical principles in his linguistics and theology. When it comes to maritime law, Verwer is practical: a manual for merchants should not contain more details than necessary. Looking at Verwer from so many different perspectives also shows how the reception of Newton's *Principia* in the Dutch Republic was varied and multidisciplinary. Actors from various backgrounds like Verwer were involved. Verwer used his Newtonian knowledge in many different disciplines and therefore it was fruitful for us to dive into this multidimensional world in order to understand the Dutch reception of Newton.

---

[309] We recognise that this distinction is somewhat artificial in early modern academia. We borrow this term from Vermij (2003).

Conclusion

This research thesis addressed the case of the early Dutch reception of Newton's *Principia*. We have examined how the first version of the *Principia* was read in detail by Mennonite merchant Adriaen Verwer. Verwer was a member of a group of people who can be labelled as mathematical amateurs: without academic schooling in mathematics he studied several mathematical works and was especially interested in natural philosophy. Verwer's motivation for this came from the polemic against the philosophy of Spinoza. Verwer saw the Spinozist idea of a passive God in the universe who did not interfere with man as a threat to his religion. The main problem with Spinoza's philosophy was that Spinoza used a mathematical method to support such threatening claims. Mathematical reasoning, or *mos geometricus*, was valued greatly in early modern philosophy and Verwer felt especially threatened by the fact that Spinoza's method was so alike his own. To be able to counter Spinoza, Verwer would need a better mathematical method and a different mathematics.

Verwer grew up in Rotterdam and was involved in maritime trade. He did not attend a university but was an autodidact, something which was not uncommon in Mennonite communities. Verwer did not only learn through doing and experiencing, however: he was also well-read and participated in discussions during gatherings of his Mennonite acquaintances and fellow mathematical enthusiasts. Verwer acknowledged the influence of these discussions and debates in his first publication: *'t Mom-aensicht* of 1683. In *'t Mom-aensicht*, Verwer argued against Spinoza's philosophy. Verwer's main point was that Spinoza reasoned through hypotheses and not through experiments or phenomena which have a referent in real life, and therefore Spinoza was unable to say something pertaining to reality. This empirical epistemology was combined with the idea that mathematics, albeit a solid method of reasoning, should also have a referent in reality and, hence, should be based on experiments. Since Spinoza's mathematics did not have that, it was incorrect and could be refuted.

In search of a mathematics that was capable of replacing Spinoza's, Verwer had contact with the Scottish mathematician David Gregory. Their correspondence shows that Verwer was working on high level mathematical problems, but also on philosophical issues pertaining to different types of mathematics and mathematical reasoning. The same can be concluded from Verwer's annotations in his copy of the first edition of Newton's *Principia*. Through Verwer's notes we have seen that he was actively studying the text and focused on the mathematical problem of finding tangents. Verwer was

also interested in Newton's inverse square law and gave his interpretation of gravity and external forces: this proved the existence of God. We have seen that Verwer used this reading of Newton in his theoretical theological work entitled *Inleiding tot de Christelyke Gods-geleertheid* in 1698. In the *Inleiding*, Verwer explicitly referred to the proof of the existence of God which he found in Newton and even attempted a "Newtonian" formula of his own. With Newton's example of proper mathematical reasoning, Verwer could argue that there was indeed an active God in the universe, thereby refuting Spinoza. Influence of Newtonian thought can also be found in Verwer's linguistic work, which had strong philosophical and theological foundations. In his work on maritime law, however, Verwer did not refer to Newton or any mathematics whatsoever, but kept his book practical and added no unnecessary details.

All in all, through an analysis of these primary sources, we have seen in what way Newton was "useful" for Verwer. As Jorink and Zuidervaart claim, Newton's usefulness was predominantly present in the debates surrounding the Spinozist conclusion of a passive God in the universe. In order to refute Spinoza, Verwer was in search of a different mathematics and a better mathematical method of which he found models in Newton's *Principia*. In accordance with secondary literature by Jorink, Zuidervaart and Vermij, we can conclude that Verwer studied Newton within the context of physico-theology in order to counter the threat of Spinozist atheism. This could be studied first-hand by examining the captivating combination of primary sources as we have done in this research. Thus, this answers our research question: in Newton, Verwer found a mathematical language and method of proper reasoning to prove the existence of an active God in the universe.

Placing this in the broader context of the Newtonian reception in the Dutch Republic, we reconvene with the group of mathematical amateurs of which Verwer was an important member. This network of enthusiasts, who were active in various fields of study, studied Newton with the same goals as Verwer did. We see this when we consider publications from members of the group: Nieuwentijt's *Gronden van Zekerheid* imitates the arguments from *'t Mom-aensicht* and Ten Kate's linguistics is full of natural philosophical references which Verwer also alluded to. The network included correspondence with Willem Jacob 's Gravesande. Jorink and Zuidervaart argue that it was this popularisation movement, involving Nieuwentijt, Le Clerc and 's Gravesande, that led to the reprint of the *Principia* in Amsterdam in 1714. Through all these actions, the interest in Newtonian thought in the Dutch Republic was sparked and many more scholars became involved. This later reception, however, had a notably different focus. Following 's Gravesande and Petrus van Musschenbroek, the later Dutch Newtonians emphasised the practical and experimental aspects of the *Principia*. This development of experimental science is labelled as the traditional story of Newtonian reception in the Dutch Republic. In this research, we have seen an earlier and more theological reception and popularisation of Newtonian thought through the eyes of one of the

popularisers. This reception is different from what we have seen in the traditional story of Newton in the Netherlands, but also distinct from the case in France. Here the reception of Newtonian natural philosophy can also be divided into two instances, where the first reception was based on mathematical interpretations and discarding Newton's natural philosophy and the second after 1715 can be characterised as an attempt to recombine the mathematics with the natural philosophy. Verwer and his acquaintances, however, where constantly aware of this combination in the 1690s already and it was there that they found Newton's usefulness.

Important throughout this research was the fact that we looked at Verwer's work as multidisciplinary and did not consider Verwer to be one-dimensional. Where Jongeneelen, Van Driel, and Van de Bilt studied Verwer as a linguist and Hermesdorf examined Verwer's influence in studies concerning maritime law, we reasoned that it was not possible to put a disciplinary label on Verwer's work and legacy. Not only did Verwer appropriate Newtonian mathematics into his theoretical religious work and linguistics, he argued that such combinations were essential in order to properly understand them. Otherwise, he told Gregory, scholars would seem to be worshipping multiple deities, instead of one true knowledge which Verwer aimed at. Even though separation into disciplines is a modern habit and did not prevail as strongly in early modern academia, Verwer was already aware of the importance of multidisciplinary research. Nevertheless, we do not see concrete traces of Newtonian influence in Verwer's work on maritime law. For some reason, this was not appropriate. Perhaps maritime law was too practical for mathematical or philosophical interpretations: Verwer himself says that it is better and more effective for merchants to avoid theoretical details. Hence, Verwer's goal in maritime law is to be practical and this does not involve theoretical or philosophical discussions. When it comes to theology or linguistics, however, such research benefits enormously from natural philosophical arguments and therefore Newtonian mathematics is included in Verwer's work. To understand this value which Verwer attached to Newton's mathematics, it was essential to study Verwer from different perspectives and combine these influences from different sources to a conclusive picture of Verwer's interest in Newton.

While examining Verwer's work on Newtonian mathematics, we have learnt more on the role of mathematics in late seventeenth and early eighteenth century thought. Apart from the *mos geometricus* which was already prevalent in philosophical works, the idea that Newtonian mathematical analysis could lead to strong argumentation was becoming common in other disciplines as well. Pitcairne and Boerhaave, for example, paved the way for a Newtonian branch of medicine, involving experimental methods, mechanics and geometrical analysis.[310] The idea that research should be done based on experiments and mathematical analysis of these experiments,

---

[310] For more on Pitcairne and his Newtonian medicine, see chapter 5, pages 61-62.

found wider acclaim than Verwer's circle of mathematical enthusiasts. Especially with the more practical interpretation of Newton's work by 's Gravesande from 1715 onward, Newtonian mathematics became a methodology for proper research in many disciplines. Even though this was not necessarily done in the theoretical way which Verwer proposed, the value Verwer attributed to Newton's work can be found to echo in these later developments.

In conclusion, by studying Verwer's work on Newton, we have examined pivotal developments in the late seventeenth and early eighteenth century. The popularisation and reception of Newtonian mathematics in the Dutch Republic is considered to be momentous in the understanding of early modern knowledge. With the Dutch Republic as a laboratory for science and Enlightenment, this research could even claim to take a shot at understanding modern knowledge as it is studied today. This claim would of course be an exaggeration, but Verwer's work on Newtonian mathematics offers remarkable insights into early modern natural philosophy. The combination of sources which enabled us to study Verwer this thoroughly opens new perspectives as to how Newton was received in the 1690s, 20 years before the *Principia* was well known in the Dutch Republic. Verwer's search for a better mathematical method and a different mathematics in order to refute Spinozist atheism should be seen as an illustration of this early reception.

Literature

Primary Sources

Gregory, D. (1684) *Exercitatio Geometrica de Dimensione Figuram.* Edinburgh.

(1697) "Cateneria" in: *Philosophical Transactions, 19*, 637-652.

(1702) *Astronomicae Physicae et Geometricae Elementa.* Oxford.
Translated by Gregory and Halley (1715)

Newton, I. (1687) *Philosophiae Naturalis Principia Mathematica*. London.

Adriaen Verwer's annotated copy retrieved from:
http://abo.annotatedbooksonline.com/#binding-31-5

Translated by Motte, A. (1846) *Newton's Principia: the mathematical principles of natural philosophy*. New York.
Translated and edited by Cohen, I.B.; Whitman, A.; & Budenz, J. (1999) *The Principia: Mathematical Principles of Natural Philosophy*. University of California Press, Los Angeles.

Pitcairne, A. (1688) *Solutio Problematis de Historicis; seu, Inventoribus*. Edingburgh

(1715) "A Solution to the Problem Concerning Inventors" in: *The Whole Works of Dr Archibald Pitcairne, published by himself*. 135-163

De Sluze, F. R. (1673) "Illlustrissimi Slusii Modus, Quo Demonstrat Methodum Suam Ducendi Tangentes ad Quaslibet Curvas Absque Calculo, Antehad Traditam in Horum Actorum No. 90" in: *Philosophical Transactions of the Royal Society, 8*. 6059

Verwer, A. (1683) *'t Mom-aensicht Der Atheistery Afgerukt door een Verhandeling van den Aengeboren Stand der Menschen, Vervattende niet alleen een Betoogh van de Rechtsinnige Stellinge; maer ook voornamentlijk een Grondige Wederlegging van de tegenstrijdige Waen-gevoelens en in 't bysonder van de geheele Sede-konst Van Benedictus de Spinoza*. Amsterdam

(1698) *Inleiding tot de Christelyke Gods-geleertheid*. Amsterdam

(1707) *Linguae Belgicae Idea Grammatica, Poetica, Rhetorica.* Amsterdam

(1711) *Nederlants See-Rechten; Avaryen; en Bodemeryen*. Amsterdam

(1683) Oudaen to Verwer, University Library of Amsterdam, OTM: hsGI30

(1691) Verwer to Gregory, Bodleian Library Oxford, MS Tanner 26 folio 42, 46 and 47

(1697) Verwer to R. Leers, University Library of Amsterdam, OTM: hsBI87

(1711) Verwer to Van Hoogstraten, Leiden University Library, PAP15

SECONDARY LITERATURE

Baron, M.E. (1969) *The Origins of the Infinitesimal Calculus*. Dover Publications, Inc., Mineola, New York.

Van de Bilt, I. & Noordegraaf, J. (eds.) Kluit, A. (tr.) (2000) *Adriaen Verwer: Letterkonstige, dichtkonstige en redekonstige schetse van de Nederduitsche tale 1707*. Stichting Neerlandistiek VU, Amsterdam.

Van de Bilt, I. & Noordegraaf, J. (eds.) (2001) *Lambert ten Kate Hz: Gemeenschap tussen de Gottische Spraeke en de Nederduytsche*. Stichting Neerlandistiek VU, Amsterdam.

Van de Bilt, I. (ed.) (2002) *Adriaan Verwer "Daer moet maer naerstig gelezen worden" Brieven over taalkunde (1708-1709).* Stichting Neerlandistiek VU, Amsterdam.

(2009). *Landkaartschrijvers en landverdelers: Adriaen Verwer (ca. 1655-1717), Adriaan Kluit (1735-1807) en de Nederlandse taalkunde van de achttiende eeuw*. Amsterdam: Stichting Neerlandistiek VU, Amsterdam.

Bots, J. (1972) *Tussen Descartes en Darwin. Geloof en Natuurwetenschap in de achttiende eeuw in Nederland.* Van Gorcum & Com. N.V., Assen.

Van Bunge, W. (2001) *From Stevin to Spinoza. An Essay on Philosophy in the Seventeenth-Century Dutch Republic.* Brill, Leiden.

(ed.) (2003) *The Early Enlightenment in the Dutch Republic, 1650-1750. Selected Papers of a Conference held at Herzog August Bibliothek, Wolfenbüttel 22-23 March 2001.* Brill, Leiden.

Van Bunge, W. & Klever, W. (eds.) (1996) *Disguised and Overt Spinozism around 1700. Papers Presented at the International Colloquium held at Rotterdam, 5-8 October 1994.* Brill, Leiden.

Casteel, E. G. (2007) *Entrepôt and Blackwater: A Cultural History of the Transfer of Medical Knowledge from Leiden to Edinburgh 1690-1740*. University of California Press, Los Angeles.

Cohen, I.B. (1971) *Introduction to Newton's 'Principia'*. Cambridge University Press, Cambridge.

Cohen, I.B. (1983) *The Newtonian Revolution*. Cambridge University Press, Cambridge.

Cohen, I.B. & Westfall, R.S. (eds.) (1995) *Newton. Texts, backgrounds, commentaries.* A Norton Critical Edition, New York.

Van Driel, L.F. (1992) "'Eene geauctoriseerde tale' Adriaen Verwer, koopman, jurist en taalliefhebber" in: *Voortgang. Jaargang 13.* 121-143.

Ducheyne, S. (ed.) (2009) *Future perspectives on Newton scholarship and the Newtonian legacy in 18th century science and philosophy. 28 September 2007.* Koninklijke Vlaamse Academie van België voor Wetenschap en Kunsten, Brussels.

"The General Scholium: Some Notes on Newton's Published and Unpublished Endeavours." [preprint retrieved from: http://philsci-archive.pitt.edu/3461/ on 26-01-2016].

Friesen, J. (2003) "Archibald Pitcairne, David Gregory and the Scottish Origins of English Tory Newtonianism, 1688-1715." In: *History of Science, 41*, 163-191.

Guerrini, A. (1986) "The Tory Newtonians: Gregory, Pitcairne, and their circle." In: *Journal of British Studies, 25*, 288-311.

Hermesdorf, B.H.D. (1967) "Adriaen Verwer (1655-1717) en de Ordonnance de la Marine (1681): Een Amsterdammer geworden zoon van Rotterdam als mens en schrijver." In: *Rotterdams Jaarboekje, Series 7, Volume 5*. 227-261.

Hoftijzer, P.G. (1998) "Het Nederlandse boekenbedrijf en de verspreiding van Engelse wetenschap in de 17^e en vroege 18^e eeuw." In: *Jaarboek voor Nederlandse boekgeschiedenis, Volume 5.* 59-71.

Israel, J. (2001) *Radical Enlightenment. Philosophy and the making of modernity 1650-1750.* Oxford University Press, Oxford.

Jacob, M. (1976) *The Newtonians and the English Revolution, 1689-1720.* Cornell University Press, New York.

Jardine, L. & Grafton, A. (1990). "'Studied for Action': How Gabriel Harvey Read His Livy." In: *Past and Present , 129*, 30-78.

Jaski, B. (2013). *Newton door de ogen van een amateur*. Universiteitsbibliotheek Utrecht: Bijzondere Collecties: http://bc.library.uu.nl/nl/node/670 .

Jorink, E. (2010) *Reading the Book of Nature in the Dutch Golden Age, 1575-1715.* Brill, Leiden.

Jorink, E., & Zuidervaart, H. (2012). " 'The Miracle of Our Time': How Isaac Newton was fashioned in the Netherlands." In: Jorink, E. & Maas, A. (eds.) *Newton and the Netherlands*. Leiden University Press, Leiden. 13-66.

Lawrence, P.D. & A.G. Molland (1970) "David Gregory's Inaugural Lecture at Oxford" in: *Notes and Records of the Royal Society of London, 25*(2), 143-178.

Lockwood, E. H. (1961) *A Book of Curves*. Cambridge University Press, Cambridge.

Mijers, E. (2012) *'News from the Republick of Letters': Scottish Students, Charles Mackie and the United Provinces, 1650-1750.* Brill, Leiden.

Noordegraaf, J. & Zemel, R. (eds.) (1991) *Accidentia. Taal- en letteroefeningen voor Jan Knol*. Stichting Neerlandistiek VU, Amsterdam.

Noordegraaf, J. (2002) "Amsterdamse kringen. Taalkunde en theologie rond 1700." uit: '*Teeckenrijke Woorden' voor Henk Duits: opstellen over literatuur, toneel, kunst en religie, meest uit de zestiende en zeventiende eeuw*. De Bree, F.; Spies, M. & Duits, H. (eds.), Stichting Neerlandistiek VU, Amsterdam. 235-252

(2004) "From 'Radical Enlightenment' to Comparative Historical Linguistics: The study of language in the Netherlands around 1700." In: *The History of Linguistics in Texts and Contexts – Geschichte der Sprachwissenschaft in Texten und Konzepten.* Haßler, G. & Volkman, G. Volume I. Nodus Publikationen, Münster. 155-168.

Rigaud, S. J. (ed.) (1965) *Correspondence of scientific men of the seventeenth century. Volume I.* Oxford University Press, Oxford.

Sherman, W. H. (2008) *Used Books: marking readers in Renaissance England*. University Pennsylvania Press, Philadelphia.

Stewart, A. G. (1980) *The Academic Gregories*. *Famous Scots Series*. Oliphant Anderson & Ferrier, Edinburgh and London.

Turnbull, H.W. (ed.) (1959) *The Correspondence of Isaac Newton*. Cambridge University Press, Cambridge.

Vermij, R. (1988) "Bernard Nieuwentijt en de physico-theologie" in: *Documentatieblad werkgroep Achttiende eeuw. Jaargang XX* (1)*.* 215-229

(1991). *Secularisering en Natuurwetenschap in de zeventiende en achttiende eeuw: Bernard Nieuwentijt*. Rodopi, Amsterdam.

(2002) *The Calvinist Copernicans. The reception of the new astronomy in the Dutch Republic, 1575-1750.* Koninklijke Nederlandse Akademie van Wetenschappen, Amsterdam.

 (2003) "The formation of the Newtonian philosophy: the case of the Amsterdam mathematical amateurs." In: *British Journal for the History of Science, 36*(2), 183-200.

Van der Wall, E.G.E. (2004) "Newtonianism and religion in the Netherlands" in: *Studies in History and Philosophy of Science, 35*, 493-514

Weingartner, P. (1983) "The Ideal of the Mathematization of all Sciences and of 'More Geometrico' in Descartes and Leibniz." in: Shea, W. (ed.) *Nature Mathematized. Historical and Philosophical Studies in Classical Modern Natural Philosophy*. D. Reidel Publishing Company, Dordrecht. 151-195.

Wightman, W.P.D. (1957) "David Gregory's Commentary on Newton's 'Principia'" in: *Nature, 179*(1), 393-394.

Zijlstra, S. (2000) *Om de ware gemeente en de oude gronden. Geschiedenis van de dopersen in de Nederlanden 1531-1675.* Uitgeverij Verloren, Hilversum.

Appendix: Transcription of 1691 Letter

Viro eruditissimo Davidi Gregorio, in academia Edinburg, matheseos professori solertissimo S.P.D. Adrianus Verwer.

Per D. Robertum Grahamum, concivem tuum, haud exiqua cum voluptate accepi eas, quas xii kalend. Junias ad me dare dignatus es, literas; non uno vir eximie, tibi devinctus nomine ob candidam, qua me prosequeris, benignitatem perplacuerunt res, quas ibi suggeris, neque mihi solummodo: verum est mihi amicus hic, prae aliis carus, quidam Joannes Mackrell, pararius (a broker penes vestrates) vir in studio analytico versatissimus, ac cui ne sum adhuc qui me comparem: Et cum illo tuas literas communicavi: (scilicet mercatores inter et pararios haud parva semper intercedit necessitudo) atque summopere etiam illum virum juvarunt. Methodus reducendi, in speciebus, radicem equationis ad seriem infinitam; specimen quadrandi curvas, quae in excercitatione tua illibatae remanserunt, velut κειμήλια a nobis excipiuntur; ut quoque ostensio generaliorum illorum de quibus pag. 40. Super eo quod innuis de indifferenti statu earum curvarum quas ipsi quidem Cartesio adhuc visum fuit in Geometricas et Mechanicas dispescere, mox tibi aliquid sum propositurus, judicium tuum postulans quatenus procedat. Gratias interea tibi habeo, vir humanissime, de transmisso Exercitat[ionis] tuae 1684 exemplari quemadmodum et D. Archibaldo Pitcarnio desuo, et magis quod manuum vestrarum inscriptione decorata. Epicheirema ejus altius ruminari nondum tulit otium, et forsan erit quod in secuturis literis te eatenus amplius quid lucis exposcam. Generoso illi viro officia mea deferri rogo, digno sane qui in patriam nostram ad rei medicae professionem advocatur; si modo id ferrent tempora: Ea quidem et hic et apud vestrates, uti refers, sunt effectu prorsus similia, licet causarum ratione toto distent coelo; conspirant certatim quasi in persequendo, imo devovendo, liberiori philosophandi modo. Academiarum moderatores sunt apud vos Presbyteriani, apud nos Episcopalibus propiores, dogmatis sc. rigore, non institutis. Hi autem licet alteri ab alteris e diametro diversi, tamen utrobique in eo tertio tam mirifice consentiunt, quod stupiditati plerique, ceu Deae, immolent, (saniori cuiquam prejudicatum nolo) quod puriori [*sic, pro* purioris] philosophiae et certitudinum mathematicarum sint osores et hostes capitales, ideo quia ignorantes: et si res ex eorum cederit voto, tractionem earum facultatum si non exilui plecterent, saltem tam angustis circumscriberent cancellis, ut parum esset reliqui. Habet Lugdunum Batavorum suum Fredericum Spanhemium, Theologum, qui clavo assidet, censoria potestate. Haec et similia in causa esse ferme audio, quod D. Burghero de Volder minus sit animi quaedam in publicum protudere, quamvis ego etiam metuam ne assiduo isto silentio, velut rubigine, torpeant ingenia. Est enim viro illi acuminis affatim, cujus quidem defectus effecit antea in Melder et P. Schoten ut Spartam, quam nacti, haud

adornarint. Res certa interim juxta ea quae refers, rumores de Te ad hasce oras allatos, quasi tu in verae nostrae fidei amplexu vacillasses umquam, ex nullo alio fonte scaturiisse, quam e praejudiciis a presbyteris vestris ignoranti vulgo perverse ac falso subinculcatis.

Vivit etiamnum vir ampliss. Johannes Huddenius, magistratu hic fungens summo cum decore; at curis Rei p[ublicae]; adeo distractus atque distentus ut labente aetate frustra quidquam de eo inposterum expectemus.

Vivit itidem Christianus Hugenius, Zuilichemus, verum num post tractatum (Gallicum) de Gravitate et Lumine quid novi meditetur, ignoro: te certiorem redditurus, quam primum rescivero interea videtur vir ille studium nondum valedixisse.

Gerardus Kinkhuisen junior, cujus ea sunt quae Harlemi 1660 excusa, multis abhinc annis diem obiit. Ejus Canonion Lunare hasce literas concomitabitur; quod mihi est vero simile te avere ob problemata Gnomonica ad calcem subnexa. ipsummet quippe Canonion parvi pendet.

De Abrahamo de Graaf, viro mihi familiari, aliud non habeo quod addam nisi quod jam cum aetate provectiori studiis metam videatur posuisse nam post Algebram 1672, nihil molitus est, praeter quam quod praefectus si examini nauclerorum societatis Indicae, atque ita in eorum commodum luci dederit Tractatulum Histiodromicum, haud sublimem; adjunctis canonibus parallelorum et loxodromiarum ex Snellio et Metio, item Logarithmorum ex Neppero aut Briggio.

Quantum nunc, vir amicissime, ad ea quae tu reponis ad meum quaesit[um] de methodo universali pro indagando uniuscujusque magnitudinis gravitatis cer[te] tecum agnosco, agnovique dudum regulam, qua tua nituntur, sc[ilicet] moment[um] figur[ae] ad ar. adplicatum exhibere distant[iam] centr[i] gr[avitatis] ab apice axis, omni rogato in ea materia facere satis. Verum inquisitionis meae causa erat quod perfunctorie rem intuens observasse mihi videbar, quod in plano quocunque genito motu elementi per axem, centrum gravitatis dispesceret lineam tam axi, quam ordinatae maximae, parallelam in 2 segmenta aequalia: (tu scies an id verum sit nec ne.) cogitabamque porro summum nos attigisse ubi punctum tale in plano, dispescens lineas istas parallelas in 2 segmenta aequalia, determinassemus, et quidem analytice, et quod magis est, methodo quadam universali, quae in suo genere haud abluderet ab ea quam cernis in adsecto hic adversario, quod proprie est Slusianae Tangentium Methodi exegesis a D. burghero de Volder expedita, ac discipulo cuidam suo tradita, quamque ego intellectulo meo concinniorem multo invenio quam ipsam slusii exegesin, Transact. philos. Londin. Januar. et Maj. 1673 insertam [tunc] cum mihi id exequi non vacit, meumque potius sit aliorum exegeses examinare, me devinxeris quam maxime si perpendas num verum sit tale meum observatum nec ne; et sin minus, exigua quadam operatiuncula absurditatem indices (negat verum esse D. Makrell, sed non demonstrat) et si quidem verum sit, determinationem ejus puncti uno aut altro exemplo analytice exhibeas et quidem universaliter, uti est in suo genere dicta exegesis D. de

Volder. Intelligo determinationem quae non dependeat a dicta regula modo ita fieri detur. Ignosce, vir humanissime, quod tam audacter de tempore tuo jubeam.

Ego eo summopere delector, ut de scientia aut facultate quam contemplandam mihi propono (licet ex eo tempore, quo a studiis sim avocatus, parum iis amplius possim intentus esse) pernoscam quam connexionem habeat (ut pars considerata) cum matriae scibilis toto nam ejus connexionis ignorantiam id operari deprehendi, ut mens nostra perpetuis laboret nebulis: veneratur et suspicit quidem scientias et facultates E.G. mathesin, philosophiam, theologiam, jurisprudentiam &tc singulas seorsim, eumdem ad modum quo verebuntur Ethnici Deos Deasque singulares: verum quamdiu mens non sibi comparaverit notitiam connexionis illarum scientiarum (ut partium) cum suo toto, caecutit haesitatque haud secus ac Ethnici in cognitione summi numinis seu Deitatis atque istud me movit aliquando, ut mihi ipsi in chartan conjicerem Dissertatiunculam ad Mathesin anagogicam, in qua istud quoad scientias mathematicas efficere conatus sum. En ejus apographum.

Secundo in facultate quadam proposita id mihi praecipuum fuit nos[cere] velut in synopsi, quaenam ibi sint materiae principes, quo istis exhauriendis mens apte possit incumbere. Ita dicam me repperisse in Geometria analytice sc. inspecta, materias ad quas omne possit referri, 3 ibi principes haberi. I. Locorum compositionem. II. Quadraturas. III. Doctrinam Centrobary(ij)cam. Nam per apicem elementi, juxta axem moti, describitur linea quaecunque: perque Elementi integri procedent[em] fluxionem formatur spatium planum: denique per processum ejusdem Elementi, considerati ut gravitate praediti, conflatur magnitudo gravis, in qua tunc Centri grav[itatis]. inquisitio locum habet. Has 3 igitur materias exhausisse mihi insummo fuerit voto. Et de compositione quidem locorum hic post meditata mea cernes. Quadraturarum materiam ad summum fastigium perductam esse pono per methodum tuam, ut nihil porro desiderem et si procedit quod supra attuli circa determinationem puncti, mihi id videretur integratio Doctrinae Centrobarycae istud propius me movit ut te id postularem: etsi non procedit, aliud istud fundamentum quo tua nituntur, abunde suffecerit.

Cum hisce literis etiam una tibi transmitto Sturmii Mathesin enucleatam; opusculum quod pauca continet quae rem Geometricam promoveant: lineas enim generat ex difficilibus istis, compositisque, veterum elementis. Verum vos omnia debetis habere, ut de cunctis responsum ferre valeatis. Quod si ante hac ejus tractatus tibi copia fuerit, alii cuidam amico unum inpertiri potes.

Promisit etiam D. Mackrell se hisce quid adjuncturum desuo Anglico sermone (Londini egit adolescens penes mercatorem) quae in scribendo eo familiarior est Latino: Verum latine potes responsum dare ipse cum D. de Tschirnhausen, medicinae mentis authore, valde familiariter egit. Meditata mea circa locorum compositionem nunc judicio tuo submittam, unde cernes num recte statuam nullum quasi discrimen poni oportere lineas Geometricas inter atque mechanicas.

Considero id methodo analyticae proprium esse, ut magnitudines quas realiter in hoc universo tri[me]dimens[inas] duntaxat offendimus resol[vat] in certa quaedam principia vel elementa; supponentque magnitudines inde revera consistere, tum porro eas quasi a priori ex illis elementis aggrediatur componere; quo nullum effugiat symptoma:

Quousque veteres in ea methodo fuerint provecti, nonprobe constare verum ab omni aevo id exercitoribus innotuisse, consimilem resolutionem plane necessariam: dum tamen indelectu elementorum, unde rei summa pendet, forent infeliciores; per composita et intricata s[c]: expedientes ea, quae per mere simplicia assequi natura concedit: infelicitatem istam, ad secula nostra usque transmissam, intantum ut viri prae aliis clarissimi ne ipsi quidem ab ea in totum immunes fuerint.

Infelicem istam conditionem plane in melius mutatam ubi (iisdem bonis avibus quibus illud nunc ab aliis auspicatum circa curvas quadraticas) ita faciamus ut ad

" generandam lineam, imo magnitudinem qualemcunque solo indigeamus motu sim-

" plici, uniformi et continuo; tribuentes, nimirum, Elemento certam quandam

" progressionem, in qua istud juxta axem latum statuatur crescere aut vicissim

" decrescere.

Tum, progressionis natura cum hic utramque faciat paginam, si ex adsumpta

" qualibet eliciamus analogismum; hunc deducamus ad aequalitatem; ex cujus

" terminis sive in priorem sive in novam proportionem reductis et diversimode adsectis

" eliciamus constructionem ad ipsummet locum, aut ad loci symptomata.

Conceptum meum exempli quibusdam trivialibus clariorem faciam.

        I. De progressione adsumpta et analogismo elicito.

I. Ex adsumpta arithmetica simplici, ubi (uti ubique) est enim terminorum 1.2.3.4.5.. / seriei termini 1.2.3.4.5..

exsurgit proportio haec numerus terminorum (quem semper $= y$ pono) ad ipsummet seriei terminum (semper $= x$) ut quantitas simplex ad quantitat[em] simpl[icem] id quod est in terminis analyticis.

$y \cdot x :: a \cdot b$ unde $ax = by$.

II. Ex adsumpta arithm[etica] duplicat[ionis] ubi seriei termini 1.4.9.16.25.36... manat analogismus.

Numerus term[inorum] ad seriei term[ini] uti quantitas simplex ad quantitatem quadraticam.

$y \cdot xx :: a \cdot bb$ unde $axx = bby$ aut $xx = \frac{b}{a} by$.

III. Ex adsumpta arithm[etica] triplicata, ubi series termini 1.8.27.64.125.. exurgit [*sic*] proportio numer[orum] terminor. ad seriei termi. ut quantitas simplex ad dign[itatem]

$y \cdot x^3 :: a \cdot b^3$ unde $ax^3 = b^3y$ aut $x^3 = \frac{b}{a} bby$ et sic in aliis.

Haud sum ignarus, quod hic tribus exemplis monstro, id uno solo universali monstrari posse, tribuendi nempe a et b exponentem potesatis infinitae.

IV Ex adsumpta serie arithm[etica] subduplicata $\sqrt[2]{1}. \sqrt[2]{2}. \sqrt[2]{3}. \sqrt[2]{4}. \sqrt[2]{5}..$

manat proportio, num[erorum] term[inorum] ad seriei termi[num] ut dign[itas] simplex ad dign[itatem] subsecund[am].

$y \cdot \sqrt[2]{x} :: a\sqrt[2]{b}$ unde $\sqrt[2]{aax} = \sqrt[2]{bby}$ aut $\frac{a}{b}ax = yy$.

V. Adsumpta serie procedente in defectu terminorum, sese subsequentium decrescendi(?) in serie arithm[etica] duplicata, ubi terminor[um] numerus, pro lubitu

7.6.5.4.3.2.1. / 49.36.25.16.9.4.1./13.11.9.7.5.3.

Seriei termini

erit haec proportio, seriei terminus, proximo termino multatus, ad num[erorum] term[inum] uti dignitas 2^a ad dignitatem simplicem.

id est $zz - vv \ (= xx) \cdot \ a - y :: bb. a. \| abb - bby - axx = 0 \ \| \frac{b}{a}by = bb - xx$ et sic in ceteris.

Conspicuum in tali progressione, terminorum numero cedere quantitatem determinatam (supremus enim terminus hic pro lubitu determinate adsumptus est) inde terminata quantitate multatam.

  II. quod quantitates adsectas attinere, ita statuo[?] posse nos terminos aequationum diversis, imo infinitis pene modis adficere signo + et - : modo haec tria fugiantur. I. affectiones absurdae, id est constructiones Geometricae prorsus impatientes. II. qua nihil prosunt, ut cognitae cum cognitis, incognitae cum incognitis. III. quae in difficiliorem inducunt constructionem.

Atque hunc in finem aequationem supra elicitarum terminos revoco ad analogismum, sive ad priorem ut in $ax = by$ scilicet $a \cdot b :: y \cdot x$. Sive ad novum ut $y \cdot \frac{a}{b}x :: x \cdot b$. (In transitu addo, si proportionem $a \cdot b :: y \cdot x$, pro ut directa muto in reciprocum, in qua nimirum est tem. 4us ad 2^{um}, uti 1us ad 3^{um} tunc exurgere $a \cdot y :: x \cdot b$. et inde $ab = xy$.)

Ad exempla venturus nullas ad sectiones $a \cdot b :: y \cdot x$, neque $a \cdot y :: x \cdot b$ recenseo. E terminis autem $y \cdot \frac{a}{b}x :: x \cdot b$ (vitatis quae ante admonita) prodeunt.

$b - y \cdot \frac{a}{b}x :: x \cdot b + y$ inde $\frac{a}{b}xx = bb - yy$

item $y - b \cdot \frac{a}{b}x :: x \cdot y + b$ inde $\frac{a}{b}xx = yy - bb$.

inde iterum deduco 2 alias analogias.

Sc. $b \cdot a :: bb - yy \cdot xx$

 $b \cdot a :: yy - bb \cdot xx$

Plura tibi non addam, ne aquam fluvio inferam omnia quippe sese ultra sequuntur, ac menti nostra mirandum in modum definiunt cuncta symp[to]mata earum linearum quarum productionem hoc modo prosequimur, in tantum ut neque plura neque pauciora dari valeamus determinare.

III. Constructionem Geometricam ubi aggredior sumo in auxilium similitudinem, imo identitatem seriei termini cum figurae ordinata; terminorum mundi cum figurae abscissa.

Interim formam lineae generatae (rectane sit an curva et cujus nam speciei quae indigetet) sola est mechanica epharmosis.

Verum symptomata mihi prodit aequationis constitutio. E.G. Lineas aequationis $ax = by$ et $\frac{a}{b}xx = by$ (quarum illam rectam, hanc curvam esse epharmosis evincit) ejus naturae esse, ut ordinatae et abscissae una in infinitum et crescant et aequales nihilo fiant.

Iterum in linea aequationis $\frac{a}{b}xx = bb - yy$, abscissa maxima, ordinatam minimam esse et contra.

Porro in aequatione $\frac{a}{b}xx = yy - bb$. abscissam simul cum ordinata in infnitum 2x crescere: destructa abscissa absurdam fieri aequationem: destructa licet ordinata abscissam tamen manere aequalem quantitati datae.

Denique ut colophonem imponam, in aequatione $ab = xy$ neutram incognitorum, destructibilem, at unam versus alteram in infinitum decrescere et crescere alternatim. Ex aequationibus in Exemp. 4 et 5. etiam patefit, e co[pluribus]

consequi ejusdem curvae constructionem, ea solum cum distinctione, quod quae in una est abscissa, in alia aequatione fiat ordinata; et contra.

Omiseram supra inter adsectiones (quod tamen ibi est palmarium) terminorum continua, et quasi in infinitum, adsectione rem eo casuram; quod aequatio facta nihilo aequalis, si ad quadratam ad surgit, semper ejus formae sit futura; ut involvat combinatum duarum incognitarum simul cum una cognita, ad omnes illarum trium possibiles multiplicationes [bimedimensinas]. E.G. $xx \pm yy \pm bb \pm ax \pm dy \pm xy = 0$. qua quidem pro variis signis erit aut ad Ellipsin (circulumve) aut hyperbolen: aut post destructum quaedam terminus ad parabolen: inter ea etiam quasi digito monstrans, quot numero curvae in toto eo dimensionis gradudentur constructibiles. Par factio continebit in locis dign[itates]. 3^{ae},4,5, etc omnibusque gradibus ulterioribus. Ac videtur illud summum fastigium, ad quod mens hac in parte potest contendere. Illam combinandi pragmateiam SLUSIO deberi, fere auctor sim; nam, in analysis suae limine, specimen offendimus.

Ex hisce nunc ita praefatis id tandem concludere animus fuit, quod si via eadem aperta, jacere statuatur ad generatonem omnium aliarum linearum quarumcunque, (nimirum adscripta Elementa, procedenti juxta axem motu simplici atque uniformi, quadam progressione) linearum considerationem, ut Mechanicarum in totum possit insuper haberi. Tuum grave judicium nunc expeto, vir doctissime; nunc factio haec, velut supra a me in trivialibus iam ostensa est, parabilis etiam sit in lineis, vulgo mechanicis appellatis sim minus, absurditatem verbo uno aut altero evincas: sin vero parabilem reperias (quem admodum in praesentiarum nihil mihi, qui tamen errare possum,

succurrit in contrarium) adeo sis ~~mihi~~ benignus ut series eas mihi transmittere digneris, ex quibus sive directe sive effectionum via deriventur aequationes, exhibentes relationem inter puncta omnia et abscissarum et ordinatarum in Conchoidibus, Cycloidibus, Cissoide, Spiralibus archimedeis, item Curva Huddenii (Schoten Exercit. Math. pag 498) et si in quid amplius possideas. Probe novi, in Exercitatione tua 1684, quae quidem hac in parte mihi oculos aperuit (uti figur: 6.7.9.16.17.) valores eorum elementorum poni; atqui isti non sunt deducti e seriebus. Iterum veniam te posco quod nimium sim importunus. Ego demiror summopere, eam extensionem ab aliis numquam fuisse institutam: arduam sane adgnosco, verum semel expedita mihi videtur immensae utilitatis futura. Curva enim elementorum vice frugi non amplius foret necesse in praedictis lineis: licet forsitam tota linearum, ut Mechanicarum consideratio eo tolli non posset e mathesi. impossibile est enim lineas omnes, pro ut noviter occurrunt, e vestigio a priori contemplari.

Methodus tua rectificandi curvas in fig. 8.9.18.21. perplacet, ob brevitatem et quidem eo audaciae procederem ut te rogarem de subministrandis his tribus. 1°. demonstratione brevicula Element. (fig. 8) rectae AB esse ad Elem. ACQ sicut DB ad DC. 2^0. operatiunculam qua, ex $\sqrt{1 + \frac{9x}{4a}}$ cognito, producis longitud[inem] curvae AC. 3^0. operatiunculam, qua in fig. 21 devenis ad productum $\dfrac{r^2 \times \sqrt{r^2+x^2} - r^3}{\overline{r^2+x^2}^{\frac{3}{2}} - r^3 - rx^2}$ sanulus tibi erit absque dubio, qui ea breviter describet: et ei isto nomine quidquam pecuniae solvere volo, aut libelli cujusquam munusculo pensabo tibi.

Ratio porro, quare extensio modo memorata ab Doctis non sit promota, erit fortassis, quod molestia ejus executionis, utilitati par non sit visa; quatenus in nullam abeat consequentiam circa curvas, nondum consideratas quaeque nobis noviter proponuntur. Estque ejus sententiae D[ominus] J[ohannes] Makrell.

Tractatulum Joannis Craige prima cum occasione expectabo, et de eo non sinemus libere sensum nostrum tibi proferre.

Causa, quare et tua et D. Pitcarnii epicheiremata, pridem D. Leers missa non fuerunt excusa in Ephemeridibus procul dubio fuerit, quod harum compilatores sint matheseos expertes, ut talia in aliam linguam nesciant transfundere. adde, ubi figurae adsunt excudendae ipsi bibliopolae sumptus metuunt. Verum cum et hac in urbe prodeant per trimestre ephemerides, titulo <u>bibliotheque univers[elle] et historique</u>, si quid iis destinaris, nobis mandes; ac ubi harum compilator, nobis amicus, materiae rudis fuerit; nos ei opem feremus.

Antequam praecedentem epistolam tibi exarassem disquisieram penes Jacobum Cunningham, mercat[orem] Crayli, de vita ac bona valetudine tua ad quod responsum mihi dare dignatus est vir eximius D. Jacobus Fento, Andreaepoli mathesis profitens ac tibi valde familiaris; me salutis tuae certum reddens, deque sorte sua suspensi muneris conquerens. Ego illi viro me obstrictum nomino,

rogans proinde eum salutare mea vice ac omnia fausta precari. Primo commodo, imo forte proximis navibus, gratias meas de eo persolvam. Rettulit mihi, se curvarum omnium, quas tu per infinitas progressiones quadrasti, exponentes finitos concinnasse: quod quidem data occasione etiam libenter videbo.

Hisce exaratis hucusque occurrit in Act[is] Lips[iensibus] Mensis Junii 1691 evulgatis solutiones Bernulii, Leibnitzii et Hugenii super problemata de linea catenaria, qua propter et illud adversarium tibi transmitto: ut si et tu de eo meditatus fueris, possis aperire, vel saltem judicium de aliorum solutionibus et de eo semper securus esse potes, ut si vel mihi, vel D. Makrell, liberius paulo sententiam dicas de aliorum labore aut inventis, id lapidi dictum fore novimus enim quo pacto vivendum coram proximo. Interim problema istud meum exercitium aliquantisper superat, non autem D. Mackrelli. Ego novitius adhuc sum, et semper absque duce aut praeceptore luctandum mihi fuit. Nam etiamsi incidamus quandoque in hominem versatum, accidit tali quidem deesse domus sese rite explicandi. Variegena enim sunt dona spiritualia.

Ibunt ad te hae literae cum D. Moncreif, qui mihi spem fecit se te Londini offensurum. Dum hisce finem impono, subvenit legenti figur[am] tuam 8 parabolem $x^3 = azz$ derivari ex serie cujus terminor[um] numer[i] 1.4.9.16.25.36.etc. Termini seriei 1.8.27.64.125.216.etc. posito enim $zz \cdot x^3 :: bb \cdot a^3$ conflatur $a^3zz = bbx^3$ sive $\frac{b}{a}x^3 = azz$ et si linea DB, tibi $\frac{2}{3}x$, quaeratur per mors(?) tangent. promanabit (assumpta y pro linea quaerenda) $3xxy = 2azz$ $(2x^3)$ unde per divis[ionem] $y = \frac{2}{3}x$ = DB. quod hujus factionis maximus etiam est, in eo consiste… quod non solum aequationes producat lineis in universum congruentes, verum quod per medium fractionis $\frac{b}{a}$ etiam speciem curvaturae, in uno eodemque dimensionis gradu suggerat. Id concludimus una D. Mackrell mecum, non esse possibile exclu[dere] considerationem Mechanicarum, qua talium, ex Geometria: non enim nos posse impedire quo minus ita nobis ab aliis proponantur; verum quotiescumque datur easdem lineas ex seriebus a priori componere, tunc nos induci ad earum cognitionem quam perfectissime ac simplicissime. Atque in eo credimus te nobis assensurum.

Vale, vir humanissime, παῤῥησίῃ meae ignoscens ac me amare perge.

Dabam Amstelodami X kalendas Septembris anni MDCXCI Stylo batav[orum]

Appendix: Modern Interpretation of De Sluze's proof

It was De Sluze's goal to reduce the method of finding tangents to a method which involved less heavy algebra. He did this by redefining the subtangent. The subtangent can be described as the projection on the x-axis of that portion of the tangent to a curve which is between the x-axis and the point of tangency. Hence, it is that part of the x-axis from the point where the tangent intersects the x-axis to the x-coordinate of the point of tangency. The subtangent can be found using the following:

$$subtangent\ for\ f(x) = -y\frac{\partial y/\partial f(x,y)}{\partial x/\partial f(x,y)}$$

Here the derivatives of the formula are used to calculate the subtangent. De Sluze, however, reasoned the other way round: to find the derivatives, he used the subtangent. In what follows, we give a modern interpretation of De Sluze's proof, based on the publication about his method in *Philosophical Transactions* and Baron's work.[311]

Let $f(x,y) = \sum a_{pq}x^p y^q = 0$

then for any point on the curve in the neighbourhood of (x_1, y_1):

$$f(x_1, y_1) - f(x,y) = 0$$

and

$$\sum a_{pq}(x_1{}^p y_1{}^q - x^p y^q) = 0$$

We can rewrite this, after adding and subtracting $x_1{}^p y^q$, as

$$\sum a_{pq}\left(x_1{}^p(y_1{}^q - y^q) + y^q(x_1{}^p - x^p)\right) = 0$$

Now we know from geometric series that

$$\frac{x_1{}^p - x^p}{x_1 - x} = x_1{}^{p-1} + x_1{}^{p-2}x + x_1{}^{p-3}x^2 + \cdots + x^{p-1}$$

and

$$\frac{y_1{}^q - y^q}{y_1 - y} = y_1{}^{q-1} + y_1{}^{q-2}y + y_1{}^{q-3}y^2 + \cdots + y^{q-1}$$

Therefore

$$x_1{}^p(y_1{}^q - y^q) = x_1{}^p(y_1{}^{q-1} + y_1{}^{q-2}y + y_1{}^{q-3}y^2 + \cdots + y^{q-1})(y_1 - y)$$

---

[311] Baron (1969), pages 215-6.

and

$$y^q(x_1{}^p - x^p) = y^q(x_1{}^{p-1} + x_1{}^{p-2}x + x_1{}^{p-3}x^2 + \cdots + x^{p-1})(x_1 - x)$$

which means that the above sum becomes

$$\sum a_{pq}\big(x_1{}^p(y_1 - y)(y_1{}^{q-1} + y_1{}^{q-2}y + y_1{}^{q-3}y^2 + \cdots + y^{q-1})$$
$$+ y^q(x_1 - x)(x_1{}^{p-1} + x_1{}^{p-2}x + x_1{}^{p-3}x^2 + \cdots + x^{p-1})\big) = 0$$

We can split this sum and rewrite it as follows

$$\sum a_{pq}\big(x_1{}^p(y_1 - y)(y_1{}^{q-1} + y_1{}^{q-2}y + y_1{}^{q-3}y^2 + \cdots + y^{q-1})\big)$$
$$= -\sum a_{pq}\big(y^q(x_1 - x)(x_1{}^{p-1} + x_1{}^{p-2}x + x_1{}^{p-3}x^2 + \cdots + x^{p-1})\big)$$

so that the equation becomes

$$\frac{y_1 - y}{x_1 - x} = -\frac{\sum a_{pq}\big(y^q(x_1{}^{p-1} + x_1{}^{p-2}x + x_1{}^{p-3}x^2 + \cdots + x^{p-1})\big)}{\sum a_{pq}\big(x_1{}^p(y_1{}^{q-1} + y_1{}^{q-2}y + y_1{}^{q-3}y^2 + \cdots + y^{q-1})\big)}$$

Next, we let y_1 approach y and x_1 approach x, then

$$\frac{y_1 - y}{x_1 - x} \to \frac{y}{t} \ or \ \frac{dy}{dx}$$

where t is the subtangent.

Then

$$\frac{y_1 - y}{x_1 - x} \to -\frac{\sum a_{pq}y^q px^{p-1}}{\sum a_{pq}x^p qy^{q-1}} = \frac{\frac{\partial f}{\partial x}}{\frac{\partial f}{\partial y}}$$

and hence

$$\frac{dy}{dx} = -\frac{\partial f/\partial x}{\partial f/\partial y}$$