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The Observer Priests: Stonyhurst Observatory, 1846-1919

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Abstract:
This thesis presents and combines detailed information upon the characters, lives and activities of three Jesuit priest scientists at Stonyhurst Observatory (England) during the 19th century, with research into the historical and contemporary context surrounding Jesuit scientific activity in order to understand why the three priests, Frs. Weld, Perry and Sidgreaves, were able to succeed as scientists during the height of secularisation in the sciences. This is done using contemporary secondary accounts, modern scholarship and primary material from the subjects themselves, and concluded by putting forward the argument that much of the priests' scientific success was due to their position as priests, rather than despite it.

Introduction

Stonyhurst College in Lancashire, north-west England, is famous for several things besides being a private, Jesuit-run school and seminary: firstly, legend holds that Oliver Cromwell once slept on a table at Stonyhurst Hall (the college building) in full battle armour while campaigning during the English Civil War. Secondly, it is famous for the story of its first student, George Lambert Clifford, who gained the honour of first entry (and a bust in the College's Do Room) by climbing through an open window in order to beat a rival. Clifford was also the college's last student at its former premises in Liege, Belgium, where it had settled following eviction from two earlier locations at St Omer and Bruges as suppression of the Society of Jesus grew. Finally, it is famous for being attached to an outstanding observatory, founded in 1838 on the Stonyhurst grounds.

Stonyhurst Observatory's period of preeminence ran from 1846 until the early 20th century, while it was under the care of three directors, Frs. Alfred Weld, Stephen J. Perry, and Walter Sidgreaves. All three were Jesuit priests as well as first rate scientists specialised in the various fields of meteorology, astronomy and magnetism. This period also coincides with a sea change in the scientific hierarchy of Victorian Great Britain, as the clergy were forced aside in favour of professional scientists, led by the members of the X Club in London. The main purpose of this paper is to uncover what it was that made the priest-scientists of Stonyhurst successful at a time when the ordained were being excluded from the scientific community, and what this says about the commonly held perception of there being a conflict between science and religion.

To begin, the opening chapter examines the individual directors themselves to better understand their personal characters, backgrounds and abilities. This is necessary as most modern attention is given to Fr. Perry, and so a key question of the first chapter is whether or not Frs. Weld and Sidgreaves are deservedly overlooked, and if their role in Stonyhurst's wider success is underestimated.[1] In order to answer it, the

[1] G. D. Bishop, *Stephen Joseph Perry (1833-1889) Priest, scientist, educator*. Master Sci. Thesis, University of Manchester, 1977.

chapter develops and presents in depth biographies of the three based upon a mixture of primary and secondary accounts including works by their own hands as well as obituaries and other sources. The biographies of Frs. Sidgreaves and Weld are broader and more complete than any other known published works on the subject.

Aside from contributing to scholarship on this issue, the chapter seeks to develop a well defined image of the individual directors and, just as importantly, a thorough understanding of their relationships with each other. The directors were each of a similar age, and shared much interaction, particularly Frs. Perry and Sidgreaves; their tenures were not a simple case of picking up where their predecessor left off - they each contributed in different ways due to their varying approaches, characters and abilities. The final aim of the chapter is to develop a continuous picture of how each contributed to Stonyhurst's success, as there is reason to believe that laying the accolades only at Fr. Perry's feet is too short-sighted an answer.

Chapter two answers how being Jesuits contributed to the directors' success, by examining both the Jesuit tradition in mathematical sciences and the development of that tradition with reference to the Galileo affair. The chapter uses this examination to better evaluate the various theories on the roles science and education play in the Jesuit Apostolic Spirituality put forward by Steven J. Harris, Rivka Feldhay and Agustín Udías.

The examination begins with the Society's early decades, and the unexpected germination of education as a key part of their mission in Sicily and then the wider world. The chapter looks at how and why mathematics first entered the Jesuit community, as well as the frustrations often faced by those looking to promote the topic - this is a key counter-point to Udías' presentation of mathematics being a long standing and central tenet in the Jesuit curriculum. The chapter then clarifies this by explaining the Jesuit role within the wider Galileo affair, showing how the infamous incedent was not damaging to Jesuit (and Italian) scientific progress because of prior held, long-standing dogma, but that this damage was caused by the dogma the affair (and the Jesuits) helped to establish off the back of it. It is important to understand the role of education in the Jesuit mission and Mathematics within that curriculum: it allows for a better evaluation of the modern theories on the role of science in the

Society of Jesus historically, and provides context for understanding the key concept of 'frontier work' and what that meant for the Jesuit mission. This allows us to ultimately provide an answer to the question of to what extent Jesuits are particularly attuned to conducting scientific research.

With a grasp on the pre-suppression[2] context in place, Chapter Three seeks to understand the motivations of the Jesuits at Stonyhurst, following the restoration of the order following the end of the Napoleonic Wars, by examining cultural and social changes external to the Order. The broader context of sea-change in the scientific establishment during the latter half of the 19th century, as the clergy became excluded from the scientific hierarchy in favour of professional scientists, shifted the balance towards a professional/amateur dynamic in the sciences, as natural philosophy was becoming known. Chapter Three thus examines the role played by the X Club in driving this change, their motivations and methods and how this forged new archetypes in the Victorian scientific establishment. The chapter is concluded with an explanation as to how Stonyhurst's directors achieved all they did in spite of this cultural rebalancing, relating those hypotheses back to knowledge of their personal character and the wider context they worked within as Jesuit priest-scientists, as discussed in chapters One and Two.

Finally, Chapter Four presents and analyses first hand accounts of the observatory's history and activities to uncover how the directors in question described themselves, and how this relates to the contemporary and traditional context discussed in the two chapters prior. This trove is composed of a series of unpublished notes, half-manuscripts, accounts and letters, and so the chapter focuses on the elucidation of the content, as well as analysis and comparison with the matters discussed in previous chapters. To close the chapter, we'll refer the primary evidence back to the specific points, assertions and characterisations made in previous chapters.

The concluding chapter will summarise the answers to the initial research questions, and draw the broader arguments together, explaining the influence each of the Stonyhurst directors had on the observatory's success, and how the Jesuit tradition - as well as Stonyhurst's rather unique position within that tradition -

[2] The Society of Jesus was suppressed by Papal Bull in 1773.

boosted that success, even in the face of massive social change driven by trends that might otherwise run against the likes of the observatory's priest-scientist. It will also introduce questions related to the topics discussed, pertaining to the role played by Fr. Perry in establishing a post-suppression Jesuit 'school' of priest-scientists, whether or not the Jesuits still hold advantages over their lay colleagues in certain scientific fields, and whether the broad exclusion of clergy from the sciences at the end of the 19th century was merely a tactical disadvantage, or a strategic disadvantage as well in the advance of scientific progress.[3]

[3] I am especially thankful to three people for providing the inspiration and material for this research: Firstly, Mr. Fintan O'Reilly, Classics Master at Stonyhurst College and the master currently responsible for the Observatory, for his painstaking work in finding, making and sending copies of the manuscripts that provide the bulk of primary material for this paper. Secondly, Prof. Agustín Udías, Professor Emeritas of Geophysics at Universidad Complutense de Madrid, for his direct support in answering my questions and sharing his resources with me, as well as the inspiration and information his broader work on the subject has provided. Finally, Brother Guy Consolmagno, the recently appointed director of the Vatican Observatory, who inspired my initial interest in the roles and characters of Jesuit priest-scientists and answered my numerous questions during a visit to his observatory atop the Papal Residence at Castel Gandolfo. My principal supervisor, Dr. David Baneke, also receives my endless gratitude for *his* endless patience, guidance and support in the writing of this thesis.

Fathers Weld, Perry and Sidgreaves

In this first chapter we will discuss the diverse characters of the three Jesuit directors with which we're concerned: Frs. Weld, Perry and Sidgreaves. This will be done by presenting short biographies of each, derived from a selection of obituaries, secondary and primary literature. This is important to develop a close understanding of our subjects, and hopefully improve the body of scholarship on them.

In the context of this paper, however, the core aim is to demonstrate the important, crucial role they each and all played in Stonyhurst's success. Such a demonstration is necessary to contrast with most modern scholarship on the topic, which focuses primarily on Fr. Perry, elevating him above his colleagues to too great a degree.

In brief, Fr. Weld in particular played a vital role in the foundation of the observatory. His well-to-do Catholic family background, and his wider profile and social standing, alongside his capable talents as a scientist, administrator and diplomat, were necessary to turn Stonyhurst's observatory from a small, rural establishment into a major national and international research station when it was taken over by Perry in 1868. Fr. Perry himself excelled as the observatory's leader during its most productive decades, with his public profile as a lecturer, publisher and adventurer - very much the Victorian ideal - lending itself to the observatory's reputation. Fr. Sidgreaves, on the other hand, often actively shunned the opportunity to publicise his efforts, which were extensive in a technical capacity. Lacking the formal education of the others, Fr. Sidgreaves' character as a clever, quiet man with a talent for experimental work and photography made him a vital foil for his colleagues, and directly impacted the success of both the observatory and Fr. Perry. This chapter will present these three different characters, and explain their importance as crucial influences on the activity and ultimate success of Stonyhurst's observatory.

Fr. Alfred Weld, the 'Father of Stonyhurst Observatory'[4] was born August 5th, 1823, into a renowned, Catholic English country family that had particularly amicable relations with both the British and French royal families. From their ancestral home of Lulworth Castle, Dorset, the Welds wielded great and charitable influence amongst Catholic orders in England, including the Jesuits, The Order of St. Clare (more commonly known as the Poor Clares), and the Order of the Visitation, a cloistered order of Nuns. This combination of staunch Catholicism (and influence among the Catholic community) and standing in the upper echelons of society would be apparent throughout Alfred's career.

The Weld family's close association with Catholicism in England began long before Alfred was born, with his grandfather, Thomas Weld (1750-1810). It was in fact Thomas who donated Stonyhurst College, along with 30 acres of land, to the Jesuits in 1794.[5] This donation was indicative of Thomas' charity, which was also put towards the founding of a Trappist Monastery and the full support of the Poor Clares in England, a female Franciscan order dating from the 13th century of which his eldest daughter Juliana was a member. A second daughter, Mary, would follow a similar path before ultimately becoming the first English Superior of the Order of the Visitation.[6] The precedent for prominent Weld membership among the Catholic orders was thus already established by Alfred's aunts, while his attendance at Stonyhurst as a schoolboy was well assured thanks to his grandfather's role in its foundation. The family also held a direct connection to the Papacy, via Alfred's uncle, Cardinal Thomas Weld (1773-1837), who continued his father's charity towards Catholic institutions, particularly in the West of England, before joining the clergy in 1821. In 1830 Thomas was elevated to the Sacred College of cardinals, an appointment approved of by those of influence in Britain. His rapid rise reflected Cardinal Weld's popularity, built largely on the back of his charitable influence, primacy amongst English Catholics and powerful connections.[7]

[4] Bommer, J. *Fr. Alfred Weld S.J., the "Father" of Stonyhurst Observatory*. Manuscript, 1992, p. 1.
[5] Pollen, J.H. "Weld" In *The Catholic Encyclopedia*. New York: Robert Appleton Company, 1912.
[6] Gasquet, Francis Aidan. *The Order Of The Visitation*. London: Burns & Oates, 1910.
[7] Wiseman, Nicholas Patrick Stephan. *Recollections Of The Last Four Popes A. Of Rome In Their Times*. London: N.p., 1859, p. 246.

It was through Thomas Sr.'s elder brother, Edward Weld (1740-1775), that the Welds shared a dramatic and controversial connection with English royalty. Edward was killed tragically in a fall from his horse, and his widow, Maria Fitzherbert (1756-1837), would go on to marry George, Prince of Wales, the future King George IV. However, in order to be valid under English civil law, marriages related to the succession required the prior approval of the king, at this time Prince George's father, George III. The king's permission was deliberately not sought, as it is highly unlikely that approval would have been given: marriage to a Catholic, rather than a Protestant, would have removed the Prince from the line of succession, as per the 1689 Bill of Rights and 1701 Act of Settlement. For this reason the marriage was kept secret, a significant gesture of love. Later on, however, the younger Thomas Weld - at this moment not yet Cardinal – persuaded Pope Pius VII, on the behalf of his one-time aunt, to declare the marriage sacramentally valid, thus earning the Welds royal favour by gaining some legitimacy for the now King George IV's earlier marriage to Maria.

Cardinal Weld's brother, Joseph (1777-1863), a celebrated builder and sailor of yachts, connected the Welds to the French royal family, the exiles of which (including Charles X) he received at Lulworth in 1830 (similar hospitality was given by his father to the Bourbons following the French Revolution).

Alongside his influential uncles and grandfather, Alfred also had two notable first cousins: the brothers Charles (1812-1885) and Sir Frederick Aloysius (1823-1891) Weld. Charles was celebrated as being "of service to the Church and his country in supporting the Catholic interests of the day," and further developed the Weld family's catholic roots by playing a role in the founding of the *Tablet*, the Catholic newspaper, and as a painter responsible for copies of since destroyed portraits of English Catholic Martyrs.[8] Frederick, on the other hand, enhanced the political reach of the Welds, playing a formative role in the development of New Zealand as an agricultural leader, Catholic rights activist and eventually Prime Minister, before going on to the various Governorships of Western Australia, Tasmania, and the Straits Settlements (which included Singapore).[9] There is no

[8] The Late Mr. Weld of Chideock. *The Tablet*, 14th February, 1885, p. 21.
[9] The Late Father Weld. *New Zealand Tablet*, Volume XVIII, Issue 21, 19 September 1890, p. 19.

doubt our subject, Alfred, had a family name that carried with it reputation, influence and pedigree.

Alfred Weld's affiliation with the Jesuits began with his education at Stonyhurst, pre-determined on account of the family attachment and, by this time, tradition. Upon graduation, Alfred chose to fully embrace his Catholic heritage. He joined the Society of Jesus as a novice in 1841, at the age of 19. Following the conclusion of his classical studies in Philosophy, Weld undertook a scientific B.A. at the University of London, in what later became known as a period of "special studies" for selected novices - of whom Alfred was something of a pioneer - combining for the first time his standard studies as part of the novitiate with secular studies that went beyond the ability of the Jesuits to teach. By the mid-19th century, mathematics and the sciences, such as physics, had diverged from the traditional 'natural philosophy' still taught as part of the Jesuit training, and developed into the separate disciplines we know today. Weld was gifted enough in these subjects that by 1849, at the age of just 26 and now conducting the bulk of the research at Stonyhurst, he had been elected to the Royal Astronomical Society. He was the second Jesuit fellow of the society, after only Fr. de Vico at the observatory in Rome.[10]

It was during and shortly after the completion of his B.A., in 1846, that Weld began to take on a scientific role at the observatory at Stonyhurst. There is some dispute over precisely when Weld became director: Udías originally claimed that Weld was director from 1846-51, before leaving the post to complete his theological studies and resuming the charge in 1856;[11] a manuscript written around 1878-81 of the history of the observatory, most likely by Fr. Perry,[12] instead lists one Fr. Joseph Howell as director during this first period, with Weld as his chief assistant, a claim also made by de Vrégille;[13] a third claim by an obituary in the *Monthly Notices* of the Royal Astronomical Society that Weld was director in 1848 seems unsubstantiated.[14] Udías has since changed his mind and now places Weld as official director only from

[10] Udías Vallina, Agustín. *Searching The Heavens And The Earth*. Dordrecht: Kluwer Academic Publishers, 2003.
[11] *Ibid*. p. 68.
[12] Perry, Stephen J., 'A History of Stonyhurst Observatory', manuscript, c. 1881.
[13] de Vrégille, P., 'Les observatoires de la Compagnie de Jesus au debut du XXe siécle'. *Rev. Des Questions Scientifiques* 59, 1906.
[14] 'Alfred Weld'. *Monthly Notices of the Royal Astronomical Society* 51.4, 1891: 198-199.

1856, based upon a reference in a manuscript written in the early 20th century.[15] The contention derives from the problem that, despite being easily the most accomplished scientist on the Observatory staff in the late 1840s, Weld was not yet ordained as a priest, making it difficult to supersede Fr. Howell as director. We can safely say, based on Fr. Perry's 1878 history, that Weld was the principal scientific drive at the observatory, regardless of his title - and once he became director, set the precedent for importance of the role.[16]

In 1848, during the Italian Revolution of that year, Angelo Secchi stayed briefly at Stonyhurst during his exile from Rome. At this point Secchi was still a theology student within the Jesuit order, and during his short stay was given a tour of the observatory by Weld, who by all accounts sparked an interest in astronomy in his Italian brother. Secchi immediately abandoned his theological studies and, via the similarly astronomically inclined Jesuit exclave in Georgetown, Pennsylvania, returned to Rome in 1850 and became head of the observatory there. Secchi would go on to become 19th century Italy's preeminent astronomer, specialised, like his colleagues at Stonyhurst, in spectroscopy and solar physics. This story is characteristic of an inspirational trait in Weld's scientific activity, which he would put to further good use in beginning various directions of research at Stonyhurst which would come to full fruition under his successors, long after Weld himself moved on.

In 1851 Weld temporarily left the observatory to study theology and complete his training as a fully ordained member of the Jesuit order. He returned in 1856 as the first truly scientific Director of the observatory, a position for which he had been specifically selected due to his education in the field, a training his predecessors largely lacked.

Weld's directorship was productive, and laid the groundwork for its future success: The newly ordained Fr. Weld quickly put his administrative skills and position to good use, acquiring two new reflecting telescopes to improve the astronomical capabilities of the observatory. The instrumental overhaul continued with the acquisition of improved magnetic measuring equipment, and it was upon Fr.

[15] Cortie, Aloysius. *Stonyhurst College Observatory, Lancashire. A brief sketch of its history and work*. Manuscript, c. 1914.
[16] Perry, Stephen J., 'A History of Stonyhurst Observatory', manuscript, c. 1881.

Weld's request in 1858 that the President of the Royal Society, Sir Edward Sabine, chose Stonyhurst as one of the sites for a coordinated magnetic survey of the British Isles. The link to Sabine and the Royal Society would allow for the growth in stature of Stonyhurst's Observatory on a national and international scale.

In 1860 Fr. Weld resigned his position over to Fr. Perry in order to take on the role of Novice Master. His talents as an administrator well known for his "exceedingly polished manners," and distinguished by "great energy and tact in the conduct of business"[17] meant that Fr. Weld's career within the order quickly blossomed, and in 1864 he was named as the Provincial of the British Province of the Society, essentially the leader of English Jesuits in Britain and certain parts of the British Empire. In 1873 he became the assistant to the Father General – the head of the Jesuit order – and was responsible for all business relating to English speaking provinces. It was in this role, in 1881, that Fr. Weld was sent to Gibraltar to ensure that the chosen Vicar Apostolic, Gonzallo Canilla, ascended to the leadership of the church there. By reporting strong support for Canilla, Fr. Weld managed to maintain strong pressure from London on the Rock's Governor, who was otherwise more inclined to side with a local occupying mob demanding a different candidate.[18] In this role Weld is remembered as having acquitted himself admirably in handling the delicate matter, in spite of the violence he faced,[19] demonstrating once again diplomatic skills that he put to such good use in developing the observatory's connections.

In 1884 a long standing desire of Weld to re-establish the Jesuit mission on the Zambesi was granted, and he was named Superior of a new mission in South-East Africa. By now, Fr. Weld had largely retired from direct scientific work, but returned to it during this time, setting up scientific equipment at the college of St. Aidan, in Grahamstown (in what is now South Africa), including a Stevenson screen and meteorological instruments, and seeking to train new assistants in their use. This proved difficult, however, as assistants were killed and equipment damaged in transit

[17] 'Alfred Weld'. *Monthly Notices of the Royal Astronomical Society* 51.4, 1891: 199.
[18] George Hills (1974). *Rock of Contention. A History of Gibraltar*. London: Robert Hale. pp. 392–396.
[19] 'Alfred Weld'. *Monthly Notices of the Royal Astronomical Society* 51.4, 1891: 199.

to the new observatory, and ultimately the difficulties of colonial life took their toll on Fr. Weld, who died July 24th, 1890 at St. Aidan's..

If Fr. Weld embodied the early Victorian archetype of the talented son of a well-to-do upper class family, Fr. Stephen Joseph Perry's character fit even more readily into the ideal of the charismatic, swashbuckling gentleman-adventurer, barring the slight caveat of his being a "martyr to seasickness."[20]

Born in London on August 26th, 1833, Stephen J. Perry was descended from a middle class English Catholic family; his heritage and the wealth of Perry's father, Stephen Perry Sr., a successful pen-nib manufacturer in London, was enough that the young Stephen received a preparatory education from the Benedictines at Gifford Hall before completing his secondary education in northern France's Douai school, also run be the Benedictine monks. Perry's early bent for Mathematics was apparent, and upon graduation from Douai he was awarded first prize in the subject.[21] It was also there that Perry determined to enter the priesthood. The reasoning behind this, besides his religious-centric education, stems from a serious illness that Perry suffered as a child, meaning his healthier younger brother became the heir to the family business, leaving Perry to pursue the spiritual activity of the priesthood, which was an early wish[22] he shared with his elder sister, who was also a member of the Catholic orders, in a convent.[23] From Douai he proceeded to the English College at Rome, where he read the works of St. Ignatius, the founder of the Society of Jesus, and was suitably impressed so as to decide to join the order, which he did upon returning to England in 1853, at the age of 20.

Perry began his novitiate studies at Stonyhurst in 1856 with the standard Jesuit courses in mental philosophy and natural science. These courses tended towards the old scholastic model, but also included mathematics, astronomy and

[20] 'Obituary: List of Fellows and Associates deceased Perry, S. J.' *Monthly Notices of the Royal Astronomical Society*, Vol. 50, Feb. 1890, pp. 168-175.
[21] *Ibid*.
[22] Turner, H. H. 'Obituary, Father Perry.' *The Observatory*, Vol. 13, 1890 pp. 81-86.
[23] A. M. Clerke, 'Perry, Stephen Joseph (1833–1889)', rev. Anita McConnell, *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [http://www.oxforddnb.com/view/article/21999, accessed 11 May 2015]

science.[24] Perry's strength in mathematics led to him being appointed as assistant to Fr. Weld, and upon completion of his studies in philosophy Perry was sent to London to undertake a similar set of 'special studies' as Fr. Weld. Perry excelled, being awarded 6th position in his class, and continued his studies in mathematics by attending further schooling in London and Paris under the great mathematicians of the day, including de Morgan in London and Liouville, Delaunay, Serrat, Cauchy, and Bertrand in Paris.[25] Perry returned to Stonyhurst in 1860 and was appointed as Weld's replacement as director, though he was at that time still a (very able) student of the order. In 1862 he left to complete his theological studies in Wales, before resuming his post as director in 1868. This illustrates once again the loose nature of the directorship, and thus the importance of Weld's role in establishing it on meritocratic rather than titular grounds.

In the intervening years the telescopes and meteorological equipment were significantly upgraded by Fr. Sidgreaves, and a new underground magnetic observatory built. In 1866, Stonyhurst was named by the Board of Trade as one of the seven principal meteorological stations in Britain. The observatory was chosen by Edward Sabine, the president of the Royal Society, on the strength of Fr. Weld's recommendation and work.[26] This laid the groundwork for the newly ordained Fr. Perry to begin what Udías refers to as "without doubt the most brilliant period of the observatory."[27]

This assertion is based upon Fr. Perry's dedication and excellence as a scientist, as well as his personal skills. Fr. Perry's scientific endeavours encompass two principle elements. The first of these was his scientific practice at Stonyhurst as an exemplary mechanical objectivist, a norm of scientific practice prevalent in the second half of the 19th century characterised by collecting and presenting scientific observations as accurately as possible and with as little influence from the observer as possible, through self-abnegation.[28] His study of sunspots, in which he pioneered

[24] Udías Vallina, Agustín. *Jesuit Contribution To Science*, 2015, pp. 215-216.
[25] 'Obituary: List of Fellows and Associates deceased Perry, S. J.' *Monthly Notices of the Royal Astronomical Society*, Vol. 50, Feb. 1890, pp. 168-175.
[26] Udías Vallina, Agustín. *Searching The Heavens And The Earth*. Dordrecht: Kluwer Academic Publishers, 2003.
[27] *Ibid*. p. 70.
[28] Daston, Lorraine, and Galison, Peter. *Objectivity*. New York: Zone Books, 2007. Print.

(with the specialised support of Fr. Sidgreaves) the use of photography in conjunction with spectroscopic observations, exemplified the approach of simple presentation of the evidence. In this vein, Fr. Perry endeavoured to create simple data in the form of series of results, such as his observations of the satellites of Jupiter between 1872 and 1890. These results were published in the Royal Astronomical Society's *Monthly Notices*.

The second significant element of Fr. Perry's reputation as a scientist was his famed leadership on far-ranging and often peril-fraught expeditions. These expeditions began in 1870 with a trip to Cadiz, Spain, to view an eclipse. In 1874 Perry embarked on his most celebrated expedition, to the Kerguelen Islands in the far south of the Indian Ocean. With Fr. Sidgreaves as his assistant, Fr. Perry was sent by the Royal Society to observe the transit of Venus across the Sun. A place of extreme remoteness, Fr. Perry endeavoured, alongside his solar observations, to determine the exact longitude of the islands. The measurements needed to determine the exact position of the islands required a five month stay in difficult conditions upon a desolate landscape, which by his own and others' accounts Perry bore cheerfully. During his stay, and during the journey there and back, he also conducted a full agenda of meteorological, astronomical and electromagnetic observations. Considering the difficulty of conducting research on the islands even today, there is no doubt as to the hardship encountered by Fr. Perry, and his then assistant, Fr. Sidgreaves.

This self-sacrifice was considered characteristic of both the Jesuit and scientific orders in the 19th century. The unflappable nature exhibited by Fr. Perry also fits the archetypical ideal of the Victorian gentleman. A member of all three cadres, this expedition is indicative of Fr. Perry´s celebrated character.

In 1882 Fr. Perry led another expedition to the Indian Ocean, this time to Madagascar in order to observe the second transit of Venus. In 1886 he observed the eclipse at Carriacou in the Lesser Antilles, and the following year visited Pogost, Russia, on behalf of the Royal Astronomical Society, but failed to observe the eclipse on account of cloudy weather. In 1889 Perry led his last expedition, to the Isle of Salut, French Guyana, to view yet another eclipse. Staying in a room in the military hospital given to him by the commandant, it quickly became clear that the conditions

were rather unsanitary, with dysentery common among the Island's convicts - to whom Fr. Perry dutifully ministered. Refusing to reject the French hospitality by staying on the ship, and not helped by the wet tropical conditions, Fr. Perry soon contracted the disease himself. The dysentery caused gangrene of the bowels, and although well roused by his enthusiasm and duty for the observation itself, his condition deteriorated quickly thereafter. He was taken aboard ship, however Fr. Perry died in transit to the mainland. An obituary in the *Observatory* celebrated his dedication to his ministerial and scientific work: "Like the fighting bishops of old he was always eager to gird on his armour in the sacred name of Science: the discomforts and anxieties, nay the real dangers of the crusade never daunted him for a moment; and we can claim for him all the laurels due to the soldier who pays for victory with his life, and dies bravely, cheerfully, nobly at the moment of success."[29] His stature as a priest-scientist was clearly apparent even to his contemporaries.

Such a eulogy well illustrates Fr. Perry's popularity, which derived not only from his excellent character, but also his strength as a public speaker: He was renowned as an excellent lecturer, in demand as a speaker not only among the learned elite and his fellow members of the Royal Astronomical and Royal Societies, but also to the many and various working men's clubs of the north west of England, his popularity and skill allowing him to transcend the traditional Victorian social boundaries of wealth, class and religion.[30]

Another key legacy of Fr. Perry's time as director is his training of many other directors of Jesuit observatories around the world: Frs. Dechevrens in Zikawei (China), Vines and Gangoiti in Havana (Cuba), Faura and Cirera in Manila (Philippines) Berloty in Lebanon and Goetz in Bulawayo (Zimbabwe).[31] Fr. Perry was also popular with the boys at Stonyhurst, on account of his earnest preaching, teaching of mathematics, and fondness for enthusiastically joining their cricket and football matches.[32] Fr. Perry was elected to the Royal Society in 1874, and named a member of its illustrious council in the month preceding his death. He held an

[29] Turner, H. H. 'Obituary, Father Perry.' *The Observatory*, Vol. 13, 1890 p. 81.
[30] 'Obituary: List of Fellows and Associates deceased Perry, S. J.' *Monthly Notices of the Royal Astronomical Society*, Vol. 50, Feb. 1890, pp. 168-175.
[31] Udías Vallina, Agustín. *Searching The Heavens And The Earth*. Dordrecht: Kluwer Academic Publishers, 2003, p. 70.
[32] Turner, H. H. 'Obituary, Father Perry.' *The Observatory*, Vol. 13, 1890 p. 81.

honorary degree as Doctor of Science from the Royal University of Ireland (1886), and was a member of the Accademia de Nuovi Lincei, the Société Scientifique de Bruxelles and the Société Géographique d'Anvers. He was president of the Liverpool Astronomical Society, as well as a member of the Royal Meteorological, Physical and Royal Astronomical Societies, the lattermost of which he was a long serving councilman, and had been elected as vice president, shortly before his death. The various facets of his popularity and prestige, as a colleague, minister, friend, expeditionary leader, teacher, speaker and academic all contribute to the strength of his lasting memory, which, in the literature at least, far exceeds that of Frs. Weld and Sidgreaves.

Father Walter Sidgreaves shared in the acute aptitude for the terrestrial and celestial physics of his predecessors, but was the polar opposite of them in his social bearing. A modest, quiet and solitary man, Fr. Sidgreaves was nevertheless a meticulous and talented scientist, excelling beyond his colleagues in the operation of experimental equipment, with multiple published papers to his name. Not as celebrated as Fr. Perry, nor as connected as Fr. Weld, Fr. Sidgreaves instead provided the perfect technical foil to their work, providing astute and capable assistance while shunning the spotlight that was so naturally drawn to his peers. Sidgreaves also oversaw much of the material transformation of the Observatory during the transition from Fr. Weld to Fr. Perry's directorship.

Walter Sidgreaves was born October 4th, 1837, into an upper class Catholic country family, like the Welds but of much lower standing. His father, Edward Sidgreaves, *Esq.*, and mother, Mary, were cousins of catholic heritage, and Walter was born at their small estate in Grimsaugh, near Preston, Lancashire – just a few miles down the road from Stonyhurst. His younger brother, Edward (1840-1930), also joined the Society of Jesus, and performed missionary work in British Guyana for 24 years, helping the local population of native Indians, as well as British and Portuguese colonists, to develop the land.[33] This relatively modest background would be reflected in Walter's own character as a devoted Catholic and hard-working

[33] 'Obituary The Rev. E. Sidgreaves, S. J.' *The Tablet*, 4th October 1930, p. 32.

scientist who liked to closely follow the frontier edge of his field while sharing it with the less finely attuned amateurs of his community.

Walter began his education at Stonyhurst at the age of 11. Following his graduation in 1855 Walter immediately joined the Jesuits, and in 1857 returned to Stonyhurst to join the seminary there. Upon completion of his studies of philosophy and literature in 1861, Sidgreaves became a teacher at the school, in chemistry and mathematics. Despite not being afforded the special studies undertaken by Frs. Weld and Perry, Sidgreaves began teaching immediately, indicating some prowess in the fields. The lack of a strict theoretical education, as well as the need to cater to the interests of somewhat less capable young students, likely contributed to Sidgreaves' development into a particularly fine experimental physicist: he was renowned for his skill as a "painstaking, accurate and methodical observer,"[34] producing prize-winning photographs on inferior spectroscopic equipment he had designed himself. He was also known for an extremely skeptical and empirical approach, ideals integral to contemporary conceptions of a scientist in the nineteenth century.[35]

Sidgreaves was acting Director of the observatory in the period 1863-68, when Fr. Perry left to complete his theological studies. Sidgreaves presided over a particularly important time of transition, installing the new meteorological equipment provided by the Royal Society following Stonyhurst's selection as one of Britain's principal meteorological stations. His affinity for experimental and observational equipment shone through again when he himself installed a photographic magnetograph and other equipment for measuring geomagnetic forces in an underground chamber built specifically for this purpose at the observatory; this was done as part of the general renovation needed to bring Stonyhurst up to the top-standard of British observatories required of its selection by the Royal Society. In 1867, Sidgreaves continued his overhaul of the observatory's instruments, and upgraded the telescope to an 8-inch refractor. Following Fr. Perry's death in 1890, Sidgreaves would further upgrade the same telescope with a 15-inch object-lens in honour of his colleague. He had initially sought to raise enough funds for a whole

[34] 'Obituary Notices: Fellows:- Sidgreaves, Rev. Walter' *Monthly Notices of the Royal Astronomical Society*, Vol. 80, Feb. 1920, p. 357.
[35] *Ibid*. p. 357

new telescope, however the attempt fell well short, indicating that Sidgreaves lacked the public awareness and social skills of his predecessor and collaborator.

With Fr. Perry back at the observatory in 1868, Sidgreaves was free to complete his theological studies, and was ordained in 1871 before returning immediately to the observatory. Fr. Sidgreaves' partnership with Fr. Perry was extremely fruitful, and his experience in geomagnetic measurement greatly developed by separate trips to conduct magnetic surveys of the East and West of France, which Sidgreaves completed during his summer breaks from the seminary. He also accompanied Fr. Perry to the desolate Kergeulen Islands, and although the latter received most of the recognition and celebration for the expedition, largely due to his leadership and accessibly written memoirs, Perry attributed to Fr. Sidgreaves the success of the magnetic measurements taken during the expedition, describing him as "magnificent" in his dedication to the cause, having set up and operated the various instruments despite the atrocious conditions of rain, sleet and snow.[36] Fr. Sidgreaves also accompanied Fr. Perry on the follow up expedition sent to Madagascar.

Upon the passing of Fr. Perry, Fr. Sidgreaves assumed the directorship of the observatory alongside his roles as leader of the seminary at Stonyhurst, a position he held from 1881-1893, and professor of experimental physics, which he taught from 1883-1905. Although Fr. Sidgreaves' talents as a meticulous, dedicated observer were most evident in his daily collection of the seismic and meteorological data Stonyhurst was known for, much of his more interesting work was in solar physics, specifically regarding sunspots - an area of interest he largely inherited from Fr. Perry - and solar spectroscopy, in which he was particularly well versed. Regularly published in the *Monthly Notices* of the Royal Astronomical Society, Fr. Sidgreaves had three particularly important works: the first, a series of photographs regarding the violet spectra of the Sun, indicating calcium; the second, also on spectroscopy, concerned the “Spectrum of Nova Aurigae” which was the first new star to have its spectrum photographed, photographs which Fr. Sidgreaves was among the first observers to successfully obtain; and finally, a detailed treatise on the link between sunspots and

[36] *Ibid*. p. 357

terrestrial magnetic activity, proposing links between sunspots and magnetic storms on Earth. He also conducted extensive spectroscopic research into several other stars, always accompanied by details and beautiful drawings, plates and photographs as well as tables describing the wavelengths observed.[37] The sheer volume and accuracy of the work is testament enough to Fr. Sidgreaves' tremendous technical skills and dedication, and his research centred on cutting edge topics within Astronomy, displaying Fr. Sidgreaves' habit of working at the frontier of his field. Furthermore, as a teacher he was remembered for introducing "every new discovery" in order to educate the future priests in the scientific trends of the day.[38] He kept in close contact with other physicists via letters and membership of, particularly local, societies, both professional and amateur, such as the British Astronomy Association (of which he was president of the North-Western branch) and the Royal Astronomy Society, of which he was a council member.[39]

In 1892 Fr. Sidgreaves gained an assistant in Aloysius Cortie, who would go on to succeed him briefly as director, as well as compile a short biography of Fr. Perry. Fr. Sidgreaves' own days as an expeditionary were not quite finished however, and in 1905 he made one last trip to Vinaroz, Spain, to observe a solar eclipse, accompanied by Cortie and in attendance with a number of other Jesuits.[40]

In his later years, Fr. Sidgreaves became deaf, which he used as an excuse to eschew the kinds of public appearances his predecessor had made such free use of. His obituary in the *Monthly Notices* of the Royal Society describes him as finding such publicity distasteful, although a large collection of letters suggest his shyness in front of the public eye did not translate to an anti-social nature; he was simply "happiest when he was working in his observatory."[41] He slowly ceased making astronomical observations during his last decade, however he dutifully continued the magnetic observations he began in 1863 right until the end, a passage of continuance spanning more than 50 years, and a practice that would continue for another 50

[37] *Ibid*. p. 358
[38] *Ibid*. p. 357
[39] *Ibid*. p. 358
[40] Udías Vallina, Agustín. *Searching The Heavens And The Earth*. Dordrecht: Kluwer Academic Publishers, 2003, p. 72.
[41] 'Obituary Notices: Fellows:- Sidgreaves, Rev. Walter' *Monthly Notices of the Royal Astronomical Society*, Vol. 80, Feb. 1920, p. 358.

years after his death.[42] There is no better illustration of his dedicated, indefatigable skill as a scientist and observer, which, combined with his leadership in the education of Jesuit novices, teaching of the boys at the College, and a nature widely remembered as kind and gentle, marks him out as a Jesuit priest of remarkable constitution as well.

Although Professor Udías is right in highlighting Perry's second directorship as Stonyhurst Observatory's most impressive era, his insinuation that this was due primarily to Fr. Perry's brilliance as a scientist is short-sighted: each of the three directors contributed to the success of the observatory during this period. As colleagues they possessed the combination of connections, reputation, skill in public relations and technical capability to power the observatory's success.

Fr. Weld's aristocratic pedigree provided for the connections and legitimacy required to bring Stonyhurst, a Catholic institution in a protestant country, and its observatory, grounded as it was in meteorology, a discipline which was still not well established at that time, to the top table of British science. His relationship with Sabine during Fr. Weld's time as director, and lobbying thereafter, played a key role in linking the observatory with faraway London's Royal Society. This link would provide for the renovation and expansion of the observatory's status and capability in the second half of the 1860s, as well as play an important part in Fr. Perry's election to the Society. Furthermore, this election was initially based on the geomagnetic research conducted in France by Fr. Perry (and Fr. Sidgreaves), which Fr. Weld had so strongly encouraged him to undertake. The Royal Society was also responsible for many of the expeditions Fr. Perry was so famous for undertaking, including the venus-transit observations at the Kergeulen Islands. This all stemmed from the background and foundational work of Fr. Weld prior to Fr. Perry's directorship.

Fr. Perry himself brought immense aptitude for public relations as well as a heavyweight scientific reputation, and was undoubtedly the leader Stonyhurst needed to make the most of Fr. Weld's groundwork prior to its golden years. The demand for him as a public speaker and lecturer no doubt reflected a positive light

[42] *Ibid*.

upon the observatory itself. His success in publishing his memoirs of the Kergeulen expedition, delivered in a much more down to earth style than that favoured by the academic elite, further improved the reputation of himself and the observatory he directed. This allowed Stonyhurst to become the centrepiece observatory that it was, drawing other Jesuits to it to undertake the training required in the establishment and maintenance of Jesuit observatories in missions around the world.

Much of the actual scientific observation on these trips, and the teaching given at Stonyhurst, was in fact conducted by Fr. Sidgreaves, who, though lacking the pedigree and public ease of his predecessors, excelled instead as a practical scientist. Furthermore, it was Fr. Sidgreaves, as acting director, who supervised and conducted the all-important renovations of the 1860s, which enabled Stonyhurst to join the ranks of world-class observatories. Not afforded the scientific recognition of Fr. Perry, and not in possession of the aristocratic or political connections of Fr. Weld, Fr. Sidgreaves is often overlooked, despite his role as perhaps the strongest technician of science of the three.

Although the observatory's golden age certainly coincided with Fr. Perry's directorship, to suggest that its success was based solely on his leadership is jumping to the conclusion without considering the foundations for that success, which were largely attributable to the work of Frs. Weld and Sidgreaves.

Fr. Perry undoubtedly deserves the acclaim attributed to him both at the time and since, however the success of the observatory was not the work of just one man, and a secondary objective for this thesis is to promote understanding and awareness of his colleagues.

The Jesuit tradition 1540-1773

A core support for Udías' understanding of Jesuit scientific motivation is the 'tradition' of scientific research within the Society. This tradition can be characterised as two interlinked parts: education as the central ministry of the order; and the Apostolic- or, for Udías, the Jesuit- Spirituality. The early Jesuits drew together Aristotelian humanism and the early germinations of the new natural philosophy to become an international powerhouse of scientific endeavour. This effort was underlined by the apostolic mission: a desire to save (and influence) souls through truth and learning, to spread the message of God, and conduct charitable work, contributing to the "common good" of society at large. For Udías, it is the combination of these factors that defines the scientific tradition of the Jesuit Order, setting it apart from the other orders of the Catholic Church. In this chapter, we will take a look at the roles education and mathematics played during the first century of the Society of Jesus, before giving an explanation and critique of the modern scholarship on the traditions established at that time.

At the very beginning there was little to suggest the Society itself would evolve into the teaching-centred order that it subsequently became, as when founding the order in 1540 Ignatius and his companions expressly *excluded* teaching as a role for the order. The order would not even teach its own novices, sending them to established universities instead.[43] This is Not particularly surprising, however, as the original ten Jesuits each possessed a first rate education from the University of Paris, where they had gathered around Ignatius during the second half of the 1530s, and they held no ill-feeling toward the university. It was thus well within their world-view, perhaps even crucial to it, to have a university education: Ignatius himself sought a university education in the first place in order to be better equipped to help others.[44] There was also little precedent within the Church for the kind of professional, organised teaching the Jesuits would become so well-known for: at that time the Benedictine

[43] O'Malley, John W. *Saints Or Devils Incarnate?*. Brill, 2013, p. 205.
[44] *Ibid*., p. 215.

and Franciscan teachers of renown tended to be suitably-minded individuals rather than indicative of their respective order's aims or expertise.

Nevertheless, with retrospect it is easy to see that educating others would fit well into the wider basic philosophy of the new Order: Ignatius was always explicit in his desire and motivation to help others, the oft-expressed will to 'help souls.'[45] Also central to his beliefs was the 'interiority' of seeking inward, personal freedom and strength, a goal to which education was vitally important, and one of the motivations that drove Ignatius to join the University of Paris.[46] Ignatius also believed - through his studies of Thomas Aquinas, a theologian central to the works and beliefs of the Jesuits – that: "God could be found in all things in this world."[47] Such an approach attributed spiritual growth to the investigation of the material universe, allowing a theological grounding for the work-to-come in natural philosophy. Finally, the Jesuit founders were first and foremost missionaries, and the apostolic mission provided excellent impetus to grow and develop an educational system aimed at lay students as well as the training of good Jesuit priests. This grounding combination of seeking to help others find inward strength, a belief in investigating the natural world, and the opportunity to minister through teaching, lent itself very well to the establishment of the Society's central ministry of education.

The Jesuit scientific tradition therefore finds its deepest roots and earliest beginnings in the establishment of schools, first founded and run by the order in 1548. It is commonly asserted that there was an element of 'good timing' in the establishment and subsequent success of the Jesuit schools;[48] due to the fortunate coincidence of the founding of the Society of Jesus coinciding with the peak of the revolution in education during the Italian Renaissance. At that time the humanist approach to schooling, the success of which was first demonstrated more than a century before by Vittorino da Fuelte's *La Casa Giocosa*, had firmly established itself as a viable alternative to the traditional medieval universities. This humanist approach was based upon the teaching of a combination of the scholastic trivium – grammar, logic and rhetoric – and the classics, the aim being to develop raw young

[45] *Ibid*., p. 205
[46] *Ibid*., p. 203.
[47] Udías Vallina, Agustín. *Jesuit Contribution To Science*. Cham: Springer, 2015, p. 238.
[48] *Ibid*,.; O'Malley, John W. *Saints Or Devils Incarnate?*. Brill, 2013.

boys into gentlemen in possession of *pietas*. *Pietas* should not be confused with piety – although there is certainly a religious hue to it – instead, a gentleman with *pietas* is fundamentally a man of 'upright character,' including being a good Christian rather than being particularly devout.[49] The humanist ideal that someone could be sculpted into such a fine example of character resonated with the Jesuit pursuit of *Christianitas*, a similar account of well-roundedness, but as a reflection of one's relationship with God. The educational goals, style and ideals of the Jesuits more-or-less lined up with the humanist approach, allowing for plenty of overlap in the eyes of a public that was showing voracious support for education away from the stuffy, elitist universities. Crucially, the humanist education also offered fixed, early training for bright younger boys, aimed at readying them for the rigours they would face as administrators at all levels of the Italian city states' civil service by the time they reached adulthood. This was in stark contrast to the universities, where more well-to-do students could linger for years, and education, graduation and further development did not really figure into the end goals of either the universities or their students. The counter-reformation meant that building a strong association with the Church among young, educated sons and future administrators would play an important role in buttressing Catholicism. *Pietas* striving, influence garnering, Humanist education thus suited the Jesuits well, and happened to be very much in vogue in Renaissance Italy at the time of their foundation.

The Jesuits were also particularly suited to succeed in this environment. Well educated, and dedicated to their mission of saving souls, the individual Jesuits valued schooling. Such a positive core-belief creates good teachers, and, importantly, their humanistic belief in the benefit of education to wider society also gave strong impetus to teach well. Add to this a belief that "ethical and religious formation should not be confined to the pulpit,"[50] and there was a very strong foundation for individual Jesuit priests to become first rate educators. The Jesuits also brought a new approach that differentiated them from the older Italian humanists: the Parisian Method. This method, learned from the University of Paris, was the first step towards a systematic education easily recognised today, featuring classes and a graduated

[49] O'Malley, John W. *Saints Or Devils Incarnate?*. Brill, 2013, p. 202.
[50] *Ibid*., p. 215.

system of complexity. Active learning, such as the deliverance, rather than mere study, of speeches and drama, was also a core feature of the method. This method made the Jesuits more attractive than even the pure-humanists that preceded them.[51] The other major advantage the Jesuits held in this regard was the cost: Ignatius viewed the schools as a charity, a part of the Jesuit duty to the local community and society at large. Not only did this mean the schools were largely free, or at least affordable, it meant that boys from both rich and poor could attend. Although this would not last – the Jesuit schools soon trended towards catering for the rich – it was an important driving factor in the initial establishment and growth of the Jesuit schools.

Thanks to the order's potential aptitude in the field, and combined with a new-found public appreciation for education, the citizenry of Messina – at the insightful suggestion of a local Jesuit, Doménech – requested that the Society open a humanistic school in the city. In return, the city would provide for five teachers and five Jesuit students, a crucial boon to the fledgling order. This mutual benefit made the decision to acquiesce to the request an easy one, and with the precedent now set, Messina's Sicilian neighbour, Palermo, requested a similar school the following year. With the success of the schools came further expansion, including in Rome at the Collegio Romano. This school, founded in 1551, was testament to the success and popularity of the Jesuit schools: forced to expand to larger premises within its first year, it counted more than 250 alumni after just two years. It would shortly become the first Jesuit University, as in, institute of tertiary education, in 1556, when given the power to award degrees in Theology and Philosophy by Pope Paul IV. This expansion into university education is the founding moment of the Jesuit tradition in science in particular, rather than just education, as at this time the core of any undergraduate programme was Philosophy, including Natural Philosophy, the forerunner of the sciences as we know them today.

There are two other reasons often given for the inspiration and driving force behind the Jesuit foray – and subsequent dominance – in education: counter-reformation ideals and, more importantly, the deliberate development of the wider order's influence and stature. The first of these should gain little traction, as

[51] *Ibid*., p. 206.

the schools that began during the reformation period were all in areas safe from Protestant encroachment. The value to the Jesuits at this time was on a more practical and personal basis: the schools provided income, lodging, a stream of capable novices (and missionaries, trained as they were in *Christianitas* and rhetoric), and above all a purpose to the order; it also allowed the individual Jesuits to develop themselves and their relationship with God in line with St. Ignatius' teachings. There was also significant organic growth, due to the natural fit between Jesuit pedagogy and the wave of humanism that spread across Europe before them. The latter point, however, though not of initial significance, certainly took on a great deal of importance in the latter decades of the 16th Century and thereafter, as the Jesuits realised the boon teaching mathematics could be in gaining the connections and civic influence of the nobility.

Mathematics always stood apart from the other subjects in the Jesuit curriculum, to both the benefit and detriment of the subject. Even in the beginning, Ignatius recommended its teaching only as a cautious afterthought: "there must be taught logic, physics, metaphysics and moral theology and also mathematics, with the due moderation for the end that is intended."[52] 'Mathematics' also included astronomy, optics and mechanics: the *scientiae mediae*, or middle sciences. The separation of mathematics from philosophy is explained by the growing tension between the subjects at this time, considering the publication of Copernicus' heliocentric theories in 1543, and the first waves of the scientific revolution beginning to lap against the scholastic foundations of knowledge. Somewhat ironically, this separation actually worked in favour of the subjects' development, as mathematics would allow for 'new science' - mathematical sciences derived from the *scientiae mediae* - to be taught by particular teachers and Jesuits within the order who happened to be so inclined. This created a sub-culture of mathematical and scientific teachers within the order, whose work would establish the subsequent tradition in the field.

The first of these was Jeronimo Nadal (1507-1580), a compatriot and collaborator of St. Ignatius, who wanted to include the teaching of mathematics and astronomy at the first school, in Messina. Most interesting of all, he proposed the use

[52] Saint Ignatius of Loyola, *Obras Completas*. (Constitutions), Part IV, Chap. 12, C (451).

of both classical and contemporary authors on the subject, including Copernicus, showing a clear interest in the subject from a modern perspective, rather than a 'complete' classical form of knowledge. The first professor of mathematics at the Roman College was Baltasar Torres (1481-1561), who similarly introduced contemporary literature alongside the classical works of Ptolemy and Euclid. Towards the end of the 1560s, Torres established the first rules governing the teaching of mathematical subjects, however the subjects' separate status would become apparent once again as, five years later, the theologian Ledesma's publication of a complete set of rules at the college (*De ratione et ordine studiorum Collegii Romani*) contained no mention of Mathematics.[53] These modest early beginnings would be just enough to lead to the appointment in 1567 of a new professor to the chair of mathematics at the Roman College, who, over the next 45 [54] years, would endow the order with its first truly solid foundations for a scientific tradition.

Christoph Clavius (1537-1612) joined the society in 1555, at the age of 18, presumably upon completion of studies at the Jesuit Ccollege in his home town of Bamberg. In 1564 he became a priest, and his ability was already clear: by 1567 the still fairly recently ordained Fr. Clavius became professor of Mathematics at the Roman College, already the preeminent Jesuit educational establishment. Clavius was, by all accounts, an excellent teacher as well as a prolific publisher of works on the various topics of mathematics. These characteristics, alongside the prominence conferred upon him by a chair at the College, naturally grew his influence within the order, the Church and the lay scientific community; his renown demonstrated most clearly when he was selected by Pope Gregory XIII as a member of the commission tasked with reforming the Julian Calendar, in 1582. His stature among other practitioners of mathematics and astronomy is made clear by his being requested, first by Gregory and then by Pope Clement VIII, to publish defences of the then controversial reform.

Clavius was particularly well suited to introducing mathematics, and its scientific applications, to the Jesuits, and he can be seen as the archetypical

[53] Udías Vallina, Agustín. *Jesuit Contribution To Science*. Cham: Springer, 2015, p. 9.
[54] *Ibid*., p.5.

embodiment of the Order's stance on science in the subsequent centuries, even though ultimately his proposals were not adopted in their entirety. Clavius took a balanced approach to his field, in some parts the conservative and other parts the reformer. This is best illustrated by his appreciation of Copernicus: Clavius celebrates the observations and formulations of Copernicus, and goes so far as to – rather astutely – name him "the outstanding renovator of astronomy in our times whom posterity will celebrate and admire like a second Ptolemy."[55] Yet, despite his use and admiration of Copernicus' work, Clavius never accepted his system, favouring instead that a reform of the Ptolemaic system was necessary. He stuck to this line until his death, characteristically becoming gradually more open to wider reform beyond Ptolomy, though never offering any insight to the controversy that would follow his tenure, giving no indication of a stance in favour of Brahe's system or strict opposition to Copernicus' heliocentric one, which he characterised simply as being a set of valuable pragmatic inventions.[56] Clavius also seemed to have a more developed understanding and appreciation for the relationship between mathematics and natural phenomena than his Aristotelian brothers. This is made most apparent in the introduction of his commentary on Euclid, in which he connects geometry with the understanding of natural phenomena. Clavius' mixture of traditional focus and openness towards cutting edge contemporary mathematics, both applied and abstract, is reflected in subsequent Jesuit activity in the area, largely due to his influence on the production of the *Ratio Studiorum*, the central Jesuit curriculum adopted at the end of the 16th century.

Udías describes Clavius as "belligerently in favour of his discipline," a professor who actively promoted the proliferation of the teaching of mathematics. He made strict proposals that teachers in the subject should earn respect for mathematics among the students by maintaining an informed and authoritative method, and by never writing against it. This was necessary to establish and protect the authority of mathematics, against vulnerability at a time of humanistic and theological dominance of the curriculum. He also pushed for the inclusion of mathematical questions in philosophical examinations, further emphasising his

[55] Clavius, Christoph. *In sphaeram Joannis de Sacrobosco commentaries* (1581), trans. Udías, 2015, p. 7.
[56] *Ibid*.

modern approach in using mathematics in the pursuit of natural philosophy.[57] Although undoubtedly driven by his love for his subject, he also presented an expertise in the subject as a necessity for the wider Order. Clavius believed that it was very important for the Jesuits to remain in touch with the new science, and was aware of the benefits in social situations a knowledge of mathematics brought.[58] Though he himself seemed to shun such cynical promotion, the generation of Jesuit mathematicians which immediately followed him, including Christoph Scheiner, was well aware of the benefit of mathematics as a way to capture "noblemen and magnates and bring them to God's service." This was because it was fashionable for the rich and powerful offered patronage to mathematicians, providing the Jesuits with a voice and influence at court.

Clavius certainly completed Nadal's aims of making mathematics part of the broader Jesuit curriculum, and established a strategy for its tuition. Ultimately, however, the traditionalist Fifth General congregation of 1593-1594 established that the unified doctrine of the Jesuits would be that of Aristotle, leaving mathematics largely separate from philosophy, a position which was still being confirmed centuries later by the congregations of 1731 and 1751. Clavius tried to enshrine mathematics in the *Ratio Studiorum*, however he faced growing opposition, with the definitive version of 1599 reducing the role of mathematics and omitting Clavius from it. Despite a smaller role for mathematics than Clavius had envisioned - allowing colleges to take diverse paths, both near and far from the subject he held in such high regard - by leaving mathematics apart from natural philosophy, those sciences which were traditionally mathematical in nature, such as astronomy, could continue to grow and develop rather than be controlled by the *Ratio*, and it is for this reason the Jesuits ended up building such a strong tradition in the subject. This tradition nevertheless relied on the passions of individuals for mathematics.

The General Congregation of 1593-1594 also marked the end of another important factor: the Jesuit order's relative youth. Although mathematics was always treated as somewhat outside of the core Jesuit activity, individuals convinced of its importance had, prior to 1593, found little opposition in their promotion of its study.

[57] *Ibid.*, p. 10.
[58] *Ibid.*

This allowed for at least some gradual adoption of their ideas into the establishment itself, ideas which would form the basis of later work within the order by individuals with interest in the subjects. Clavius and his forbears may not have succeeded in making mathematics a central part of the maturing Jesuit education system, however they did establish a tradition and a place for it within the order.

The diversity of opinion, and tension between modern mathematics and the ultimate supremacy of scholastic philosophy, within the order, is best illustrated by the controversy surrounding Galileo and the Jesuits in the first half of the 17th century. The relationship began well enough: Clavius and Galileo were friends, and he was very well received at the Roman College during a visit in 1611.[59] The following year, however, things began to sour, as Galileo accused the Jesuit professor Christoph Scheiner (1575-1650) of plagiarising his work on sunspots. Galileo's ego had been offended by Scheiner's work and he refused to let the issue go, still publishing against Scheiner in 1623 – despite the fact that Galileo was in no way the first or only observer of the sunspot phenomenon. The problem worsened in 1616, when the Inquisition, under some consultation from the Jesuit theologian Melchior Inchofer – a geocentrist fully committed to the traditional, literal interpretation of the Bible – censored Copernicus' work, and forbade Galileo from teaching or defending it. The feud, and Galileo's reputation within the order for arrogance, was cemented in 1618, when he criticised the work of the Jesuit Orazio Grassi, beginning another prolonged spate of publication and counter-publication.

These three incidents display the tensions between scholastic philosophy, theology and mathematics. The first thing to note is that Galileo had - at first - a strong relationship with the mathematicians of the Jesuits, indicating their position at the cutting edge of the field; upon Galileo's discovery of various phenomena with his new telescope, it was the Jesuits who largely confirmed their authenticity in consultancy with the Church. The questions raised by such state-of-the-art research become apparent, however, with Scheiner's work on sunspots. In his book, *Rosa Orsina sive de Sole*, Scheiner postulates that the spots are clouds or objects rotating around the Sun, rather than on its surface, which must be immaculate in accordance

[59] *Ibid*., p. 17.

with its status under Aristotelian physics as a heavenly body. The extent to which the inherent tension between Church dogma and better understanding of the natural world blurred the line that bounded Jesuit belief is brought into even sharper relief by the work of Grassi. Grassi was willing to dispute Aristotle's belief that comets - like meteorites - were atmospheric phenomena, theorising instead that they were much more distant objects; a theory dismissed, for all the wisdom attributed to him, by Galileo. The ultimate supremacy within the order of Aristotelian doctrine over empirical research, however, is shown by Inchofer's strong critique of Copernicus: it is revealing of where the power lay that a Jesuit theologian with such traditional views was chosen to consult with the Inquisition on matters of the cosmos, rather than one of the Society's astronomers.

The 1633 trial of Galileo was much less of a staged show-trial than is often portrayed. The Church went to great pains to build a secure legal case against Galileo, the one major flaw of which was its disregard for Bellarmino's 1616 note clarifying that Galileo had not been accused of heresy. Of more relevance to this paper, the Church also brought in neutral consultants to examine Galileo's arguments for heliocentrism. This was vital because, should Galileo's arguments be unconvincing on a rational, evidential basis, he would be in opposition to the Church on simple theological grounds, a clear case of heresy. The ultimate veracity of Galileo's claims clouds modern judgement of the facts, however Galileo himself could not offer conclusive evidence for the motion of the Earth. The facts he presented, such as the phases of Venus, were undermined by counter evidence, such as there being two tides in a day, rather than the single tide Galileo's theory entailed. Crucially, the lack of a stellar parallax – made all the more serious by the false assumption that the stars were much closer than they in fact are – offered apparently conclusive evidence against Galileo's theory.[60]

Galileo, convinced of his heliocentric beliefs, blamed his defeat and condemnation instead on his poor relationship with the Jesuits. There is some evidence for this on the Jesuit side too, with Grienberger suggesting that a better relationship with the Jesuits of the Roman College would have at least allowed

[60] Finocchiaro, Maurice A. *Retrying Galileo, 1633-1992*. Berkeley: University of California Press, 2005.

Galileo to continue his work. For their part, Jesuit mathematicians such as Grassi and Grienberger were much more open to Galileo's beliefs.[61]

The point to take from the controversy surrounding heliocentrism is not simply that there was a broad difference of opinion among the Society's members, but that in regards to this conflict of opinion it was the scholastic theologians and philosophers, rather than the Order's specialists in mathematics, who came out on top. The price of this is clear in the most important outcome of Galileo's trial: a precedent was set that the Church, and therefore the Jesuits, considered heliocentrism heresy. This precedent would last well into the 18th century, long after Newton's description of gravity and broad acceptance of Copernicus' system, and therefore placed a lid on the capability of Jesuit researchers, explaining the sharply reduced output of Jesuit scientific work, and teaching of mathematics in the second half of the 17th century.[62] This limit was reflected by a wider slowdown in Italian science in the subsequent century, as practitioners were forced to focus instead on purely empirical work, shying away from challenging the Church's authority over theory.[63]

Alongside the contribution of particular historical factors and actors to the development of a scientific tradition in the Order, Udías' takes the position that the Jesuits had a specific stream of Apostolic Spirituality that made them particularly well adapted to working in the sciences. Udias draws the concept of Apostolic Spirituality from Harris' 1989 paper, *Transposing the Merton Thesis: Apostolic Spirituality and the Establishment of the Jesuit Scientific Tradition*.

In this paper, Harris sought to apply a similar study as that conducted by Merton in his research of English Puritans to the Jesuit order, as a manner of testing the merits of Merton's thesis that the core tenets and characteristics of the Puritans and their beliefs were an important factor in the Scientific Revolution occurring predominantly in England rather than somewhere else. Harris did this as he, as well as Merton himself, felt that too many of the paper's critics misunderstood the

[61] Udías Vallina, Agustín. *Jesuit Contribution To Science*. Cham: Springer, 2015, p. 22.
[62] Steven J. Harris, Transposing Merton's thesis: Apostolic spirituality and the establishment of the Jesuit scientific tradition. Science in Context , 3 (1989), 29–65.
[63] Cohen, H. Floris. *How Modern Science Came Into The World*. Amsterdam: Amsterdam University Press, 2010.

conclusion, wrongly assuming that Merton claimed that Puritanism in early modern England was a sufficient, or even necessary cause, for the scientific revolution there. This is not the case, as Puritanism was neither necessary nor sufficient, but was instead a major contributor thanks to its conduciveness to such a development sparked by other, non-disclosed sufficient factors.[64] Because of this, Harris believed a comparative study would offer better critique of Merton's thesis, and he carries this study off with aplomb. His method is a mixture of quantitative research, in which he compiled a database of bibliographic information regarding around 6,000 scientific papers published by Jesuits from 1540-1800, cross referenced with biographical information of the various authors; and qualitative research of the order's normative texts, involving study of the central foundations and administrative practices and principles of the Society.

His research developed and agreed with the work of Rivka Feldhay, working from a basis of 'Jesuit Ideology',[65] the core of which is the idea that knowledge, and the pursuit thereof, can be equated with salvation. In his research, Harris identifies several other values central to the Jesuit Ideology: universality, rationality, individuality and adaptability. These values, particularly at a time of rising humanism and the 'new sciences', made the Jesuits particularly suited to education, and by extent, learning. Moreover, this Jesuit Ideology is so deeply imprinted upon new members of the order during the extensive training period between joining the order and being ordained as a priest, that it combines with the central tenet presented by Feldhay to create a closely-felt esteem and even "sanctity" of learning.[66]

Harris considers this core ideology, as well as other characteristics of the order, such as diligence and a practical approach, as all together aimed towards the Jesuit goal of saving souls. This is the "Apostolic Spirituality", which is channelled towards what he terms the three main apostolates of the Society: in education, at court, and in the overseas missions. Harris takes the angle that the Jesuits actively tried to grow their influence along these lines, a task aided by the aptitude for- and

[64] Merton, Robert K., [1938] 1970. *Science, Technology and Society in Seventeenth-Century England*. New York: Howard Fertig.
[65] Feldhay, Rivka. "Knowledge and Salvation in Jesuit Culture," *Science in Context* 1(2), 1987, pp. 195-213.
[66] Steven J. Harris, Transposing Merton's thesis: Apostolic spirituality and the establishment of the Jesuit scientific tradition. *Science in Context*, Vol. 3, 1989, pp. 29–65.

expertise in- the sciences. In education, this is demonstrated by the importance, alongside Aristotelian philosophy and theology, of using the mathematical sciences to attract influential students, such as the sons of nobles and administrators. In the missions, the conduct of scientific research ranged from gaining access to the local seats of power, such as the Zikawei observatory in China and the privileged position of the Jesuits at the Imperial Court, to finding ways to support the indigenous people, thereby ingratiating the Jesuits – and Catholicism – within their societies. Betraying his somewhat cynical approach, Harris places most emphasis in the employment of technical expertise in the royal courts of Europe. This occurred for practical reasons in the interests of the monarch's holdings, such as practicing cartography or the development of defensive architecture. However, Harris also highlights the widespread 'application' of Jesuit scientific expertise in the 'virtuoso sciences': astronomy and mathematics conducted at the behest of the lord for their entertainment or because it was in vogue, rather than for the purpose of discovery, experimentation or refinement of theory. Harris discusses Kircher as an example of this, a brilliant scientist whose plethora of talents was put to use in service of the entertainment and fashionable enlightenment of the court, rather than scientific advancement, with the payoff being greater renown and influence for the Jesuits among contemporary powerbrokers. Harris supports his conclusion that the needs of the Society's apostolic aims outweighed any scientific ends with the examples of Christopher Scheiner and Gregoire de St. Vincent, who each gave up their positions as professors to join the courts of Archduke Maximilian and Ferdinand II respectively.

To summarise, Harris' characterisation of the Jesuit scientific tradition is as follows: the sciences were initially established in the Jesuit spectrum due to their esteem for general learning and education, a product of their belief that God could be found in all things, and a practical, active engagement with the world around them. Once a part of the Jesuits' normative structure, the sciences were put to use in the pursuit of the Society's apostolic aims: namely in education, the foreign missions, and most importantly, the Royal courts of Europe. Astronomy was particularly useful in each of these regards, and so formed the backbone of the Jesuit tradition. The shortcoming of Harris' method is that it doesn't allow consideration of the historical

context, a weakness shown most clearly by his repeated mention of a drop off in the publication of papers in the middle of the 17th century without any mention or consideration of the trial and censorship of Galileo and heliocentrism. This would have added support to his argument that the Order's apostolic goals, loyalty to the Church and philosophical uniformity outweighed cutting-edge scientific research, however Harris ultimately pays little attention to the context or actors involved.

This is an area in which Udias excels. Alongside the central tenets of the Society of Jesus, reaching back to St. Ignatius himself, Udías considers the historical context and development of the Order. He also pays great attention to the testimony and activity of individual Jesuit scientists. This allows him to develop a much better understanding of how sciences such as astronomy were, via mathematics, incorporated into the Jesuit tradition, as we have seen above. Udias also reaches similar conclusions to Feldhay and Harris: that the religious fundamentals of the Order both catered for an appreciation of learning and took precedence over any reform in philosophy that derived from scientific practice. He also generally agrees with Harris on the three apostolates of education, royal courts and foreign missions as conduits for Jesuit scientific output, although he pays less special attention to the garnering of influence at court.

Udias is, however, less satisfied than Harris with this picture, believing that such an Apostolic Spirituality is shared by other orders, subsequent to the Jesuits, and does not, therefore, explain the Society's unique history of extensive and sustained success in the sciences.[67] It is here that he makes, I think, the error Harris seeks to overcome with his approach to Merton's original thesis. Udias is searching for an exclusive, sufficient cause of the Jesuit scientific tradition, and looks to their spirituality to find it. He builds upon Harris' Apostolic Spirituality by introducing what he terms "Ignatian Spirituality". In this characterisation, Udías determines that the service element is dedicated particularly towards serving the Church and its interests by engaging with the rest of the world, especially in places the gospel found it hard to reach: be this geographic, dogmatic or in a philosophical sense. This

[67] Udías Vallina, Agustín. 'Jesuit Scientific Tradition and Ignatian Spirituality', *Revista di Filasofia*, Vol. 3 No. 10, 2012, pp. 207-219.

missionary practice bred an instinct among the Jesuits for seeking out 'frontier work', exploring, preaching and investigating at the boundaries of the European and ecclesiastical domain. Furthermore, the 'active' facet of service is, under the 'Jesuit Way', combined with prayer to form the tenet that contemplation of God and activity are one and the same. Udías writes that this motivates the Jesuits to conduct science as part of their spiritual activity, and that this motivation is automatically included in the basis for all Jesuit activity.[68] Despite this close link between scientific practice and religious spirituality, however, Udías makes it clear that religion always comes first, and that a Jesuit's duty as a priest and minister override his duties as a scientist.[69]

Service to the Church, and the idea of scientific activity being equivalent to contemplation with regards to finding salvation, chime more or less in time with the work of Feldhay and Harris. Udias makes a particularly strong point regarding his presentation of an instinct for 'frontier work' that is particular to the Jesuits. The evidence for such a description is overwhelming, particularly in terms of the apostolates of education and foreign missions – the two apostolates Harris pays less attention to. In terms of foreign missions, the Jesuits are famous not only for being among the first to travel as missionaries to the East and the lands of the New World during the early modern period, but also to Africa and Australasia in the 19th and 20th centuries. Mass has even been conducted by Jesuits in the Arctic (1954) and Antarctic (1958) circles.[70] In education, this instinct was equally productive, pushing Jesuit practitioners of mathematics and its applied derivatives to the boundaries of their fields and thereby advancing the subject.

Problems with Udias' characterization of Ignatian Spirituality being the cause of the Jesuit scientific tradition arise, however, because he treats this as a sufficient cause. By claiming that such Ignatian spirituality "automatically" includes a motivation for scientific activity, Udias disregards the tensions between the philosophical/theological beliefs of the order and the scientific practice conducted by a minority of its members. The mistake Udias makes with this assertion, I believe, is

[68] Udías Vallina, Agustín. *Jesuit Contribution to Science*. Cham: Springer, 2015, pp. 236-238.
[69] *Ibid*., p. 239.
[70] Charlotte B. Harvey. 'The voyage of the Monte Carlo'. *Boston College Magazine*, (Fall 2000).

that he seems to equate the 'learning' discussed by Feldhay and Harris with 'science', without offering any justification. To elaborate, Feldhay and Harris discuss 'learning' as a key component of the Jesuit spirituality, citing its practice as a form of prayer; this, however, encompasses the entire world of knowledge, including theological, social, humanistic and every other form, a definition which is much broader than just science. It is therefore possible for 'learning' to be central to every Jesuit's sacrament, while science will only be a part of *some* Jesuits' activity, making it hard to justify the claim that scientific investigation forms a central part of wider Jesuit spirituality, an argument Feldhay and Harris make convincingly in the case of 'learning'.

A second issue is that Udías, despite using Harris' work covering 1540-1800 as a basis, attempts to apply his characterization across the Society's entire history, including the periods both before and after the suppression. This is difficult to swallow, as the apostolic character of Jesuit spirituality cannot be considered equally on both sides of the divide: Harris anchors his emphasis on apostolic drive in the Jesuit activity within the preeminent European royal courts of the 17th and 18th centuries, many of which either no longer existed or held much diminished influence following the Society's restoration. This removed one of the key apostolic applications of scientific expertise, and therefore this spirituality cannot be taken as such an important driving factor in the redevelopment of science within the order at places like Stonyhurst, far from the centre of power in London. What's more, upon the Order's restoration, science itself had changed, maturing and professionalizing as economic and political forces sought to harness it. Although there was a strong scientific tradition among the Jesuits, established in the order's first two centuries via education, apostolic spirituality and a conducive set of historical circumstances, by the time of the Order's 'return' in the 19th century the world was very different: science itself, and the practice thereof, had changed – and continued changing - dramatically.

In this chapter we have seen that the roots of the Jesuit tradition of education allowed for an early adoption of mathematics, driven principally by the work of impassioned individuals such as Christoph Clavius. The benefits of this work to the Jesuits' apostolic cause in garnering influence for the Society were quickly realized,

however, the traditionalist Aristotelian beliefs of the wider order and Church ultimately secured primacy – as shown most famously by the Gallieo affair - which meant that mathematical subjects continued only as a niche, a tradition honoured by a specialized minority. This undermines Udías theory that scientific investigation is a facet of spirituality shared by all Jesuits. However, he successfully introduces the concept of 'frontier work' to the original characterization of Apostolic Spirituality by Feldhay and Harris, who successfully define 'learning' as a core part of the Jesuit Way. These two entwined passions, for learning (and teaching) and seeking out places where none have gone before, nevertheless proved sufficient to consistently push a minority of individual Jesuits to the study of science, more often than not in Astronomy, thanks to the tradition started so long before by Clavius. A new theory combining these ideas should give a better picture of Jesuit spirituality and its connection with education and the sciences throughout the Order's history, prior to the suppression and after it, when changes in the scientific landscape would be much more pronounced.

A Changing Context: Science in 19th Century Britain

The world in which the Jesuits re-established themselves following the 1814 restoration was much changed from the one the order dominated prior to 1773. The turmoil of the Napoleonic wars had shifted the European balance of power away from the Catholics in the South and West and towards the Protestants of the North. The dissipation of the Catholic Church's authority was further compounded by the beginnings of the modern secular nation-state, while improvements in navigation and shipbuilding as well as a period of relative peace and stability on the continent meant that Europe's powers turned their eyes more fixedly upon the rest of the world.

Nowhere was this more keenly felt than in Great Britain, which the battles of Trafalgar and Waterloo had left as the unchallenged naval and military power of the world. The ascendency of their Empire gave the British a reach that encompassed the length and breadth of the globe, and the trade supremacy this entailed made the country extremely wealthy. As the world briefly centred upon the British Isles, so too will this chapter, focusing on the development of science there during the Victorian period, and Stonyhurst's position within that context.

The sciences matured rapidly at this time, diversifying from Natural Philosophy into separate disciplines and specialisations. This development also engendered a more pronounced diversion from religion, with which Natural Philosophy was heretofore well entwined. It began with geological discoveries that undermined the Bible, directly contradicting Genesis. Although it was not much of a stretch to reconcile faith with this more informed world-view, extremists started to appear at either end of the spectrum. As the century progressed, broader evidence appeared which demonstrated the fallibility of Holy Scripture, leading a growing number of academics to believe that science should be given a greater say in the running of society - at the expense of religion. These newly coined 'scientists' appealed to their national governments, promoting the economic benefits (in the form of innovation) and political impact (military improvement, exploration and the prestige of discovery) of science. Their attempt to usurp authority from the Church was perceived as a much more public 'conflict' following the publication of Darwin's *Origin of Species* in 1859: his ideas further decentered the role of Humanity in the

universe, countering the social ego and the Church's position that Man was God's custodian – and master – of the Earth. The shift lent more weight to the scientists' argument, and their attempts to professionalise the sciences bore fruit, leading to a true separation of the professional scientists from their ecclesiastical and amateur colleagues.

This chapter will focus first on the process of professionalization, explaining the goals of the scientists driving the change and how, by around 1875, they succeeded in removing the authority of the clergy and establishing their own. It will then look at the scientific playing field after 1875, characterizing the positions of professional and amateur scientists, showing in what ways they cooperated and came into conflict. The final part of the chapter will place Stonyhurst and the work of Frs. Weld, Perry and Sidgreaves within this changing context, highlighting the apparent contradictions and explaining the conflations of purpose before offering insights into what made Stonyhurst's observatory so successful at this time, in spite of the significant social changes whirling around the college.

One of the most interesting and more well known topics within History of Science is the oft-characterised 'conflict' between science and religion. Although the current received wisdom among scholars – if not necessarily the public – is that this conflict is, and was, often grossly overstated, some arguments from the last forty years or so have posited that, at least as far as contemporary scientists and clergy are concerned, there was some perception of a conflict during the latter half of the 19th century. At the very least, those trying to professionalise science sought advantage by attacking their perceived adversaries in the clergy, thereby playing the conflict up.

These aggressors had two major springboards from which to launch their assault: Dogmatic adherence to scripture in the Church, and turmoil in the church following the publication of Darwin's *On the Origins of Species*. To clarify: although by the 19th century theology encompassed more than just revelatory arguments for the existence of God, organised religions nevertheless possess certain dogmas - the Catholic Church certainly not least of all – which could be attacked as incompatible with scientific enquiry. Church Doctrine was also vulnerable in the 1860s, due to internal strife: Darwin's *Origins* is usually seen as having brought the differences

between Church traditions and modern scientific theory into sharp - and public - relief, the apparent beginning of the first battle between science and religion; however, it was most important in the short term for its role as a catalyst for the far bloodier affair concerning the much more widely sold *Essays and Reviews*, a collection of seven works produced by six Oxford theologians and one lay fellow of Cambridge which attempted to promote a rational approach to religion. *Essays and Reviews* instead provoked a major controversy within the Anglican Church and the wider public, as traditionalists and reformers clashed in a series of petitions and committee decisions that spanned the social spectrum. Seeing dissension, doubt and weakness in their opponents, those wishing to remove the Church from a position of influence in the sciences now had the fundamental motivation and opportunity to provoke a conflict.

Where conflict does arise, it is usually initiated and perpetuated at the hands of individuals, rather than a broader population, and the conflict which spawned professionalization was no different: indeed, it should be characterized as scien-*tists* versus religion, rather than science itself.[71] In the ascendency thanks to the debate surrounding *Origins* and *Essays and Reviews*, it was the 'scientific' extremists that promulgated the idea of a broader conflict, in order to further their aim of removing priestly influence among the sciences. Such personal conflict, tied to the individuals involved, drives the debate to be characterized by polemics, ignoring the faults within each camp: even as early as 1873, Maxwell lamented the decline of original research even as the numbers of students and professors increased. Such a fault was not dissimilar from one often pointed out in the clergy – that many priests lacked the moral fortitude and scholarly excellence celebrated by their respective orders.

In order to describe the social context of Victorian Science it is thus sensible to better understand the individuals behind the drive towards professional science. The group that contributed most to the success of professionalism in science consisted of the nine men that made up London's "X-Club", founded in 1864 out of an already established social network of friends and colleagues. The club united a group of men upon which Turner bases his characterization of the 'Young Guard' of professional

[71] W. D. Niven, ed., *The Scientific Papers of James Clerk Maxwell* (New York: Dover, 1965), Vol. II, p. 356.

science: they were researching and publishing scientists of some stripe; they partook in scientific societies and gave popular lectures or published works aimed at a variety of audiences; and they were respected well enough to be consulted by the government of the day.[72] Of most interest, however, is that they came largely from the 'edges' of society. The group was by no means the progeny of the working class, however only John Lubbock (the son of a banker and baronet) and Joseph Dalton Hooker (a close friend of Darwin and a botanist like his father, William Jackson Hooker) had anything like a tangible pedigree. More typical is the story of Thomas Henry Huxley (1825-1895), the group's *de facto* organizing founder, who was self-taught in the sciences. Several members of the society came from the provincial towns and counties of the North, including Lancashire, and the father of one, Herbert Spencer, was a well-known religious dissenter. Huxley, of course, is most famed for his role in the 1860 Oxford evolution debate, where he battled Bishop Wilberforce on the topic of Darwin's recently published *Origins of Species*. Although a confidant of Darwin and a champion of evolution, Huxley was motivated primarily by his belief in academic liberalism, free from the shackles of clerical influence and religious dogma, a point made most clear by his famous disappointment in Wilberforce's use of his rhetorical gifts to cloud the reasoned pursuit of truth in the matter.[73] This event is often referenced as one of the major skirmishes of the supposed conflict between science and religion, however from the 'religion' side there was much greater concern for the controversy surrounding the publication of *Essays and Reviews* in March of 1860. This controversy was between the traditional Anglicans, such as Wilberforce, and the liberal Anglicans who were using theological arguments in their acceptance and promotion of Darwin's ideas relating to the

[72] Turner, Frank M., 'The Victorian Conflict between Science and Religion: A Professional Dimension' *Isis* Vol. 69, No. 3 (1978), pp. 356-376.

[73] "[Bp. Wilberforce's question] gave Huxley the opportunity of saying that he would sooner claim kindred with an Ape than with a man like the Bp. who made so ill a use of his wonderful speaking powers to try and burke, by a display of authority, a free discussion on what was, or was not, a matter of truth, and reminded him that on questions of physical science 'authority' had always been bowled out by investigation, as witness astronomy and geology." Wollaston, A. F. R. (1921). *Life of Alfred Newton: late Professor of Comparative Anatomy, Cambridge University 1866–1907, with a Preface by Sir Archibald Geikie OM*. New York: Dutton. pp. 118–120.

transmutation of species. Given the context of Huxley's motivation and the Church's focus on its internal controversy, it is clear that the supposed conflict was being 'fought' mainly by Huxley and those others trying to professionalise science, rather than from both sides.

To understand why the professionals were working under the pretense of a conflict, we should understand their aims beyond simply the professionalism of science, which is a rather broad-stroked description. Huxley himself decried the term 'scientist' as a horrid Americanism, preferring the term 'Naturalist' which more pointedly discarded the supernatural. Therefore a more precise statement would be to describe their activity as in pursuit of the complete autonomy of science from supernatural religious authority, which they saw as counter to the scientific principle of inquiry – an ambition directly related to their professed ideology of academic liberalism. The 'professional' characterization is introduced because, in pursuit of their aim of autonomy, the X-Club felt that both the clergy and, to a lesser extent, amateur practitioners, should be excluded from science, leaving only 'professionals' such as themselves. Professionalism was also a useful term to explain the supplanting of Church affiliated practitioners as the norm: At this point, priests of all stripes, from parish vicars to leading bishops, were involved to some degree in learning and especially education, as the majority of the British education system from schools such as Stonyhurst right up to Oxford University were run along Church lines. Naturally, a percentage of these learned clergy were interested in the natural sciences, and these priest-scientists, bolstered by a combination of social and academic influence, dominated major national scientific institutions, the Royal Society especially so. Usurping this position of power under the description of professionalism was a goal that the X-Club achieved during the subsequent two decades. Compounding the problem, as far as the new professionals were concerned, was the influence of religious 'authority' over these priest-scientists: in the middle of the 19th century scientific research was seen as subordinate to the study of moral and religious concepts, and 'natural theology' still formed a major part of scientific research during the middle of the 19th century.[74] In order to remedy this perceived

[74] Turner, Frank M., 'The Victorian Conflict between Science and Religion: A Professional Dimension' *Isis* Vol. 69, No. 3 (1978), p. 361.

problem, the X-Club's members and colleagues sought a separation of science from such religious influences by exorcising the clergy from education and 'professional' science. They promoted the idea that the clergy were not suited to the practice of 'real' science, not only because of religious dogma clouding their impartial judgement, but because such practice also brought religious character into disrepute: Galton declared in 1872 that "the pursuit of science is uncongenial to priestly character".[75] This point illustrates the core belief of the X-Club: that science and organized religion were incompatible, and must be separated for the good of scientific advancement.

The X-Club's formation in 1864 was not as rebellious as Turner (and perhaps my own exposition thus far) makes out. It reflected a growing movement among the British political classes to afford science a greater role in education, which at this time was run predominantly by voluntary schools of variously religious character. As society shifted towards a nationalist, rather than Godly, state, it was viewed that a state-run, scientifically leaning education system would bring greater benefit to Britain, at the expense of religious influence. In 1870 Parliament passed the Education Act, making provision for state schools throughout Britain to be run alongside the already established Church schools. In the key 'battlefield' of education, this was a powerful blow that truly represented the turning tides against ecclesiastic dominance of science and education, and by 1875 it was all over, the Devonshire Commission declaring that: "considering the increasing importance of Science to the Material Interests of the Country, we cannot but regard its almost total exclusion from the training of the upper and middle classes as little less than a national misfortune."[76] This incident reflects in particular the swing of wider public opinion towards a nationalist, secular agenda, and it was widely (and urgently) understood that the German victory during the Franco-Prussian war was in part due to the superior education of German officers in comparison with their French counterparts: "[the French education system] was almost completely effective in excluding the army's brain power from the staff and high command. To the resulting

[75] *Ibid*. p. 365.
[76] Sixth Report of the Royal Commission on Scientific Instruction and the Advancement of Science (1875), British Parliamentary Papers, Education: Science and Technical, Vol. IV, p. 24., quoted by Turner, *Victorian Conflict*.

lack of intelligence at the top can be ascribed all the inexcusable defects of French military policy."[77] In both of these points it is the wealthy and powerful upper and middle classes of society for whom education is a concern, classes known for their dominance of the clergy, emphasizing the blow dealt to the Church by the Devonshire Commission's secularization of the education system.

It is no coincidence that Huxley and Lockyear, another member of the X-Club, sat on this commission. Much of the debate since Turner's seminal essay has raged around whether the X-Club was a social gathering or a dedicated conspiracy geared towards furthering the aims and careers of its members.[78] For the purposes of this essay it is sufficient to say that if they began as a conspiracy they became friends, and if they were friends then those bonds allowed them to support each other's careers and organically garner the influence needed to successfully promote their ideas: what is important for us is that they were indeed influential, and they were indeed successful in their promotion of Academic liberalism instead of ecclesiastic authority. By 1875 the X-Club had played a key role in usurping educational and epistemological authority from the Church, a position they consolidated in the subsequent decade. No fewer than three members of the club served as President of the Royal Society, and they played a pivotal role in the nomination and election of several more.[79] The X-Club's most important contribution was its specific drive against religious influence in scientific endeavor, however that says little for the other major historical class of scientific practitioner, the amateur gentleman scientists, whose place in the social context following 1875 this paper now considers.

By the final few decades of the 19th century, the professional scientists had successfully overthrown the traditional aristocratic-clergy based authority in the sciences, and established their own supremacy along the lines of academic universities and secular state funding. While the senior clergy had been largely confined to their 'proper' practices of theology and pastoral duty, at least in the

[77] Irvine, Dallas. 'The French and Prussian Staff Systems before 1870' *Journal of the American Military History Foundation*, vol. 2, no. 4 (1938), pp. 192-203.
[78] Barton, Ruth. '"Huxley, Lubbock, And Half A Dozen Others": Professionals And Gentlemen In The Formation Of The X Club, 1851-1864'. *ISIS* 89.3 (1998): 410.
[79] Jensen, J. Vernon. 'The X Club: Fraternity Of Victorian Scientists'. *The British Journal for the History of Science* 5.01 (1970): 63.

collective ideal of society, the wealthy 'gentleman practitioners' who had done so much for the development of science had been relegated to the position of amateurs. The amateurs, including many of the lower level clergy, nevertheless continued to pursue their interests – after all, it wouldn't do to neglect to use a telescope built with the family money – and carved out for themselves minor roles across a range of sciences. They were particularly well installed within astronomy, and its rapidly developing sister-science astrophysics, and to explain Stonyhurst's place in the Victorian scientific scheme of things it is important to understand the amateur counterpoint to professional dominance of the star-gazing playing field.

The most important unifying feature of the 19th century amateur astronomer, besides a passionate interest in the subject, was wealth.[80] Firstly, this allowed them to purchase and install the telescopes needed for their research, which – even the small refractors favoured by such amateurs – could be extremely costly. More importantly, at least with regards to their research, their wealth allowed the amateurs to be free from patronage, and thus able to study whatever project caught their fancy. This contributed to a major difference between amateur and professional astronomers: whereas professionals depended upon government support, amateurs actively eschewed funding, preferring to retain their freedom.[81] Although their wealth allowed them this liberated position, some analysts argue that the amateurs' reasons for wanting freedom in the first place are egotistical in nature: they were individuals looking to make discoveries for their own pleasure, self-esteem and fame, rather than as part of a unified scientific research programme.[82] Nevertheless, there were also amateurs whose limited equipment and membership of the British Astronomical Association encouraged them to organize and focus on specific objects and areas, enabling them to specialise as "steady and persistent" observers.[83] There were of

[80] Lankford, J. 'Amateurs And Astrophysics: A Neglected Aspect In The Development Of A Scientific Specialty'. *Social Studies of Science* 11.3 (1981): 275-303. Web.
[81] Lankford, John. 'Amateurs Versus Professionals: The Controversy Over Telescope Size In Late Victorian Science'. *ISIS* 72.1 (1981): 11-28.
[82] Berman, M. '"Hegemony" And The Amateur Tradition In British Science'. *Journal of Social History* 8.2 (1975): 30-50. Web
[83] Captain Noble's Presidential Address, *British Astronomical Association*, 1890, quoted by Lankford, John. In 'Amateurs Versus Professionals: The Controversy Over Telescope Size In Late Victorian Science'. *ISIS* 72.1 (1981): 11-28.

course a number of defining characteristics of amateur astronomers that were not beneficial to the subject: foremost of which was their lack of a 'professional' education. This caused problems at all levels of amateur practice. For those steady observers providing data for professional use, it meant their methodological practice was not necessarily up to par; for those eager to claim fame and glory via new discoveries, it meant they had to rely on no small amount of luck in finding success; and even when they did find something, their deficiency in the realm of theory meant they may not understand what they were looking at, a problem further compounded by the limited equipment they operated (predominantly 6-12 inch refractors, as opposed to the 20+ inch reflectors used at the major professional observatories).

It was from such limitations that conflicts between the amateur and professional astronomers would arise. Lankford illustrates one such contention, sparked by William Frederick Denning, who presented a thesis that larger telescopes provided, at best, no improvement over their smaller cousins.[84] The conflict provides an example of the various difficulties presented by amateur astronomers: firstly, Mr. Denning was an extremely successful astronomer with a proven record and reputation for discovery, credited with four comets, a score of faint nebulae and a Nova (Cygni 1920).[85] Secondly, he had absolutely no scientific background, and was an accountant by profession – though he retired from this career and focused on Astronomy, subsisting on his own wealth and that inherited from his father, also an accountant.[86] Denning held a deep, lifelong passion for astronomy, and epitomized the amateur astronomer with which we are concerned thanks to his independent wealth, indifferent scientific education, and record of interesting discovery. Furthermore, he was a regular publisher in magazines and journals, and encouraged others to follow up their interesting discoveries with systematic study. He also kept a wide correspondence, further cementing his reputation as a very good practitioner of science, despite his belief that smaller refractors were the match of large, professional telescopes. Respected as he was, however, he by no means fit the

[84] Lankford, John. 'Amateurs Versus Professionals: The Controversy Over Telescope Size In Late Victorian Science'. *ISIS* 72.1 (1981): 11-28.
[85] 'William Frederick Denning' *The Observatory*, Vol. 54, (1931), pp. 276-283.
[86] Beech, Martin. 'W. F. Denning – the Doyen of Amateur Astronomers' *IMO* 26 (1), (1998): pp. 19-24.

developing criteria of a professional scientist, as demonstrated by the conflict over telescope size: the conflict presented a problem, as Denning's lack of education in accurate experimentation and practical ignorance of the advantages afforded by the large reflecting telescopes of professional observatories conflicted with his good standing (and correspondingly respected voice) to cause friction within the astronomical community. Ultimately, his rhetoric and repeated appeals to the non-technical advantages of smaller telescopes could not overcome the standing and authority of the professionals, and the conflict demonstrates that, no matter how successful the amateur astronomer – and, as Denning showed, there was indeed plenty of room for success and recognition as an amateur – they would always operate on a level lower than- and often subservient to- their professional colleagues.

But operate in tandem they nevertheless did, with amateurs providing much of the 'manual labour' of astronomy, such as tracking objects and other movements, and generally collecting the vast amount of data the sky threw at them each night. One area in which amateurs really excelled was in combining astrophysics and photography, both of which were relatively new areas of expertise in the late 19th and early 20th centuries, and both of which attracted that certain kind of hobbyist that many of these amateur astronomers were. Astrophotography also was an area where great success could be found without an in depth understanding of celestial mechanics or an up-to-date engagement with the academic community, while also providing real benefit to professional astronomers.

These traditions, of an institutionalized role for amateurs within the astronomical community and a specialization in astronomical photography, continue today. Programmes such as SETI (Search for Extra-Terrestrial Intelligence) and Planet Hunters employ amateur astronomers on a mass scale to help explore and classify the observable universe. Photography also remains a favoured pastime of amateur astronomers: one example being Navaneeth Unnikrishnan, who uses simple techniques such as long-exposure to capture images of the stars above us, as well as telescopic productions of galaxies and planets.[87] These pictures inspire not only other

[87] http://www.bbc.com/earth/story/20150822-incredible-india-by-night

amateurs, but also the youngsters that will develop into the professional astronomers of the future.

With all this in mind, it is easy to assume that Stonyhurst was at a disadvantage: operating during a time of change that featured the simultaneous declines of religion's public predominance, amateurism in science, and Church-led education, the Jesuits were also coming from a much weaker position than that prior to their suppression. Nevertheless, just as these major trends were coming to their peak in the 1870s and 80s, Stonyhurst found its greatest success.[88] The cause of this success lies partly in Stonyhurst's special sense of standing apart, even within the Jesuit order, while also being deeply involved in the contemporary scientific playground, and partly in the individual characters of each of the directors upon whom this work is focused.

Stonyhurst's immunity from much of the more dramatic changes, particularly during the 1860s, came firstly from its status as a Catholic entity. Catholics were by now generally accepted as being equal in mainland Britain, emancipated by the Roman Catholic Relief Act of 1829, and the Pope had restored Catholic hierarchy in England in 1850. A wave of several hundred thousand Irish Catholics following the Great Famine of the late 1840s combined with established French Catholic refugees from the Napoleonic Wars to form a significant Catholic minority in England by the 1860s. With a secure place in wider society, being Catholic was no longer a significant disadvantage to Stonyhurst. Furthermore, the conflict promulgated by the X Club was a national struggle against a divided and incoherent Anglican Church, rather than the international Catholic Church. Secondly, the college's principal scientific activity centered on the observatory, specialising in astronomy, meteorology, magnetism and to a lesser extent seismology, instead of the naturalist (geology and biology) focus upon which the primary 'conflict' was founded. Finally, its location offered respite from the swirling politics of London, while its position in distant, protestant Britain kept it low on the Pope's agenda as well.[89] Its location also,

[88] Udías Vallina, Agustín. *Searching The Heavens And The Earth*. Dordrecht: Kluwer Academic Publishers, 2003.
[89] Sidgreaves, Walter, Letter to Fr. Hagen, 1908.

however, allowed Stonyhurst to apply the research it conducted in a practical sense; this is most clearly seen by the work conducted at the observatory researching how changes in atmospheric pressure could predict gas explosions in Industrial Britain's all important coal mines.[90] Furthermore, north-western England was at that time a vibrant, prosperous and innovative part of the country with the wealth and attitude to support research into meteorology in order to better manage the maritime trading concerns run out of nearby Liverpool. This drew national interests to the college, allowing for the further development of magnetism and meteorology at the society, developments upon which much of the observatory's success was built.[91] Here we can see how Stonyhurst itself possessed several unique features that protected it from social strife while also allowing it to prosper as a scientific institution.

The three directors also had a somewhat convoluted relationship with the contemporary social spectrum of scientists, being simultaneously representative of- and dissimilar to various archetypes of the time, while also being educators in the more traditional sense as teachers at the college. Fr. Weld, of course, neatly fits the bill for the kind of priest-scientist Huxley was so determined to remove from the scientific community: he was aristocratic, he was a member of the clergy – and thanks to his rapid rise within the Order, a rather influential one at that – and he had the ear of other influential men within the community, having sat on government commissions while also enjoying a strong working relationship with Edward Sabine, who was President of the Royal Society during the first decade of the X-Club. However, it was precisely these factors that enabled Weld to lay the all-important foundations for the observatory's subsequent success in terms of establishing Stonyhurst as a prominent and reliable source of observations off the back of his own work in the 1850s, in the building of a role for Stonyhurst in the national scientific programme – via his relationship with Sabine – during the 1860s, and the literal installation of high-quality equipment that this effort required. Weld found success as a scientist because he received excellent training providing by the Church and he was able to cultivate a relationship with Sabine due to his connections within the upper classes. The Church also provided him with the space, and crucially the

[90] Perry, Stephen J., 'A History of Stonyhurst Observatory', manuscript, c. 1881.
[91] *Ibid*.

freedom, to install the necessary equipment. This last point is what differentiated Weld – as well as Frs. Perry and Sidgreaves – from the ecclesiastical villains portrayed and pursued by Huxley and the other professionals: instead of being a co-conspirator in the Church's attempted dictatorship of natural philosophy, as Huxley would have it, Weld was instead given great freedom to study and act as he saw fit. Furthermore, he made no overt attempts to reconcile Church authority using scientific theory. While without a doubt an example of the traditional 'old guard' of religiously minded scientific practioners and educators, Weld's position was utterly crucial in the successful development of Stonyhurst's scientific activity, and he was a special case in that Weld was afforded a much greater degree of freedom than other priest-scientists could or would indulge in.

Fr. Perry is perhaps the most interesting of the three in terms of how he fitted into the Victorian scientific world. With the exception of his being a member of the clergy, Fr. Perry shared in many of the characteristics that defined the 'young guard' of professional science: he was a prolific publisher (and excellent writer) of scientific papers both professional and popular; he was renowned for his public lectures, delivered to audiences as diverse as fellows of the Royal Society and working men's clubs in Blackburn; and he was encouraged and funded by both the government and that venerable Society to conduct research expeditions to the farthest corners of the Earth; as a Catholic, he even fitted the bill as something of a minor social outsider. Finally, shortly before his untimely death off French Guyana, Perry was elected to serve on the Royal Society's council for 1890. The obvious response to this information is to declare it evidence contrary to the X-Club's supposed success in deposing the clergy from positions of influence, however, this is not the case, and an alternative explanation can be found: firstly, Perry was engaged in fields with which the X-Club was less concerned, namely Stonyhursdt's specialist topics of magnetism, meteorology and astronomy. Secondly, it should be understood that while the X-Club's members and their colleagues were successful in removing the Church's authority and establishing their own, the change would take the deaths of several influential men and more than a couple of decades to be complete. Finally, like Weld, Perry did not seek to reconcile his scientific work with wider theological concerns; although science was part of his vocation as a Jesuit, I would rather characterize him

as a scientist as well as a priest, rather than as the kind of priest-scientist the X-Club sought to remove, as there was little direct crossover between his priestly and scientific duties, both of which were carried out to the highest standards of their respective creeds. Perry, then, is an example that suggests that the professionalizing elements of Victorian science went too far in their exclusion of the Church from science, as he exemplifies both the Godly priest (his determination to attend to the spiritual needs of Ile de Salut's prison colony cost him his life) and the professional man of science. The dissuasion, or alienation, of the religiously inclined from science is perhaps likely to have cost the scientific world other men of Perry's stature. His record adds weight to the widely held thesis that, to reference Secchi in particular: [some kinds of] science and religion were perfectly compatible in practice.

Much as his predecessor at Stonyhurst exemplified many aspects of the professional scientist, Fr. Sidgreaves was almost the quintessential post-1875 amateur scientist: he was specialized in photography and astronomy, with excellent technical skill in both thanks to his expertise in the operation of equipment; his background was that of a self-taught scientist, having lacked the advanced theoretical tuition afforded to Perry and Weld. This deficiency in theory was most apparent in his book on the relationship between sunspots and terrestrial magnetism, in which he incorrectly postulated that sunspots and magnetic storms on Earth were at best loosely related; a deficiency shared by many other amateurs at the time. Similar again to those amateurs, Sidgreaves was heavily involved in organisations and societies, and excelled at the kind of labour intensive data collection for which such groups were responsible: Sidgreaves continued to record the observatory's meteorological data until his dying day. He was also a very successful astronomer, commended with a pair of Gold Medals at the 1908 Franco-British Exhibition[92] for his work on spectroscopy and solar photography. However, there were also two significant differences between Sidgreaves and the archetypal amateur scientist. Firstly, he was a shy and quiet man, unconcerned with the bravado and prestige of men such as Denning – he instead conducted his research out of a love for his subject

[92] The exhibition, attracting around eight million visitors, celebrated the 1904 entente cordiale between the United Kingdom and France, and coincided with the London Olympics, marking it as a major socio-cultural event.

and a duty to his work and the Church, a trait much more common among Jesuits than Gentleman astronomers.[93] This was his other dissimilarity: Sidgreaves was not an independent Gentleman; he was instead supported by the Church, yet retained his academic freedom thanks to Stonyhurst's unique position within the Jesuit order. Finally, Sidgreaves was also an excellent teacher, and leading member of the college, due to his responsibility for the seminary there. Fr. Sidgreaves, like Fr. Perry, stood both within and without the characterization of a typical kind of scientist in his day; furthermore, he is another example of a perfectly good (amateur) scientist who was also a well-regarded priest.

In this chapter we have seen how the X-Club played a central role in professionalising science in England, a goal they achieved in part by promoting the idea of a conflict between science and religion. Regardless of whether such a conflict was actively fought by both 'sides', there was certainly a sea-change in the scientific establishment in the latter half of the 19th century, from strong religious dominance to a more secular, professional group of practitioners and leaders. This change culminated with the Devonshire Commission in 1875; however, this is also the time that Stonyhurst, a religious institution, was at the height of its scientific stature. Reconciling these two facts provides the greatest insight into what allowed the Stonyhurst Jesuits to find success in their work. Firstly, as Catholics, the Jesuits were apart from the much more tangible conflict between traditionalist and reformist Anglicans at the time, allowing them to maintain their distance when the professionals hijacked that controversy. Secondly, the Stonyhurst Jesuits were able to straddle the two major splits in characterization, between secular/religious scientists and professional/amateur scientists. This happened in the first because the fathers at Stonyhurst were under no direction from the Church in their research, free to act as they saw fit, thereby keeping their religious and scientific duties from influencing each other; in the second, because they held both advantages usually only afforded to either a professional (an education and network of colleagues) or an amateur (the independent wealth to pursue their research agendas). Finally, the individual characters of Frs. Weld, Perry and Sidgreaves allowed them to be both

[93] Sidgreaves, Walter, Letter to Fr. Hagen, 1908.

scientists and priests, being as they were meticulous, professional researchers as well as dutiful priests. The limited direct impact of one role on the other, considered in light of the benefits being part of the Jesuit order provided to them as scientists in terms of education, network and funding, adds further weight to the refined thesis that the Society of Jesus' 'spirituality' was conducive to good scientific work, rather than a logical precursor. Therefore, the Stonyhurst Directors' ability to excel was down to macro factors keeping them out of the cultural strife as well as micro factors such as their own personality and the unique character of the Jesuit order allowing them the freedom, wealth and education required by their endeavours.

In Their Own Words: Histories, Accounts and Other Materials by the Observatory's Directors

Despite the quality of Stonyhurst's archive and its curators, one of the difficulties in scholarship on the observatory is the lack of a complete or consistent (or published) history by the hand of one of its staff. This is not to say there is nothing; I have a variety of unfinished, unpublished and otherwise unpolished manuscripts written by staff at the observatory during the period. But it is this variety from which the difficulty arises, and so this chapter will analyse in turn four different histories of the observatory, including two contemporary manuscripts (1868 and 1880 respectively), the latter of which is accompanied by a rather exhaustive set of notes; a written report of a lecture given by Fr. Perry on the history of the observatory (1876); and a history written following 1914 by an unknown hand (of whom there is plenty to discuss). I'm also fortunate to have a set of four letters written by Fr. Sidgreaves to Fr. Hagen, then director of the Vatican observatory. By conducting analysis of each of these primary sources, this chapter will gather direct insights into the observatory's practice and the activities of its directors, allowing us to relate those insights back to the work done in previous chapters regarding the directors themselves, Jesuit spirituality and the scientific social context of the time. The analyses will proceed in chronological order, treating each source in turn, discussing the nature of the evidence itself as well as the content.

1868 Notes

The first item to be examined is a basic manuscript covering the period from the observatory's founding in 1838 until the end of 1868, just after the return of Sidgreaves and Perry from their magnetic survey of Western France and Perry's resumption of the post of director. It then provides detailed descriptions of the observatory's buildings and equipment, before describing the proper utilization of measuring equipment and known photographic processes, featuring Sidgreaves' innovation in the development of photographs, the publishing of which appears to be one of the aims of the work. Although the historical section begins as a fairly rough draft written in prose, it quickly takes the form of notation, becoming more and more

reliant on shorthand as it progresses. The descriptions of buildings, equipment and processes return to a more prosaic style, however the detail discussed, and lack of colour which accompanies it, suggests a more technical purpose; a typical passage, describing the construction of the magnetic pavilion, reads as such:

> "There is not the least Fe [iron] in the construction. The center stone pier is entirely free from the floor of the building. This pavilion replaces the stone pillar whi [which] stood at the entrance of the botanical garden: the removal of this pillar was rendered nec.y [necessary] on account of the proximity of the new garden nails, whi [which] are of Fe [iron]."

As a combination of notes and technical detail, the manuscript appears to be intended as either the foundation of a more complete work or a purely informative record. Another possibility is that the history was written as a follow up to an inspection of Stonyhurst Observatory by Mr. Stewart of Kew Observatory, which is listed in July of 1868. The purpose of this inspection is not made clear, however it is very likely to be linked with Stonyhurst's newly acquired status as one of Britain's seven major magnetic stations. The author is difficult to determine: although the style is similar to the 1880 notes, due to the nature of shorthand the conclusions we are able to draw from this are limited as the handwriting differs, indicating a different author. The script also differs from that contained within the other sources available. The latter notes specify a staff at the time of 1869 as: Fr. Perry, Br. Hostage and Jos. Mason; Fr. Sidgreaves having been replaced by Fr. Perry, and it could have easily been any one of these three. The staff lists also often include laymen brought in to build and install equipment and facilities.

What the manuscript lacks in diverting reading and clear authorship it more than makes up for in interesting content. Firstly, it declares that "The meteorological department has all along received the principal attention, & been supplied with the best instr.ts [instruments]," showing a clear focus on meteorological measurements rather than the astronomical observations for which it was also intended. The observatory's capabilities in the field were quickly recognised, being declared by James Glaisher (Fellow of the Royal Society, founding member and later president of

the Meteorological Society, among others) whom the manuscript quotes in 1849 as saying "the standard by whi [which] to judge of other meteorology observatories." This success follows the arrival of Fr. Weld, whom the manuscript claims as having taken charge in 1846; although this further clouds the debate over precisely when Weld became 'director' and what this title exactly entails, Weld's impact is clearly shown: prior to his arrival 1846 there is extremely limited activity at the observatory, while following this date, various reports are made and experiments are carried out. Furthermore, following Weld's departure in 1851, the activity at the observatory under Mr. Clare is non-existent – the only significant entry, in 1853, also discusses Weld and his being asked to give evidence to the House of Commons regarding water supply in the country. Upon his return in 1856 the observatory's activity once again increases significantly, and the growing prestige of Stonyhurst in this period is shown again when, in July 1858, a pair of the observatory's magnetic instruments were purchased by the Vatican for Secchi's use, indicating that Stonyhurst was, within the Church's network, a leader in this field.

The manuscript also documents the beginning of the relationship between Stonyhurst and General Sabine. In 1849, then a colonel, Sabine recommended a new anemometer for measuring velocity. Nearly a decade later, the general returned to Stonyhurst to attempt some measurements as part of a magnetic survey, but was unsuccessful due to inclement weather. A couple of months later the observatory forwarded its monthly magnetic observations to him, and these must have proved useful as the manuscript notes that Gen. Sabine pressed Weld to take a set of self-registering magnetic instruments, offering £225 to help with expenses. Although this initial grant fell through, the diary shows that the following year saw the Royal Society recommended Stonyhurst to the Board of Trade as a meteorological station, which granted the observatory £200 per annum, in addition to which the Royal Society fulfilled the original proposal of £225.

The notes also give some insight into the impact of Sidgreaves at the observatory. Shown as taking charge from December 1862 until the end of 1868, Sidgreaves oversaw the installation of the equipment needed for the work funded by the board of trade, as well as the beginning and perfection of the monthly observations for which Stonyhurst would become famous for. There is also a detailed

description of his innovation to the method of photographic processing used at Kew Observatory, provided at the end of the manuscript. This highlights his technical expertise in astro-photography, an area central to the role amateurs would play in the scientific landscape of the late 19th and early 20th centuries.[94]

There are two elements of the manuscript relating to the social context of science in the Victorian age. The first is the 1868 declaration by Archbishop of Westminster (and shortly thereafter, Cardinal) Manning that Stonyhurst was the link between religion and science in England. This demonstrates clearly the Catholic Church's view that there need be no conflict between science and religion, while also describing them as somehow separate entities. The second is that, just as the X-Club was rising in the 1860s, so too was Stonyhurst, improving its position within Great Britain's scientific hierarchy while the professionalists did the same by undermining religious influence in the scientific establishment.

1879 Lecture Report

The second item for study is the report on a lecture given by Fr. Perry on site at the observatory. It appears to have been written around 1879-81, as it references a magnetic series begun in 1867, of which "the first twelve years are now in process of reduction," and the latest event referenced prior to this is the 1874-5 expedition to the Kerguelen Islands. It seems strange that a lecture would so readily ignore the more general work of what would have been the last five years, however it is possible that the discussed magnetic studies completed in conjunction with Kew, Rome, Florence and Zikawei took place at this time, and were not specifically dated precisely because of their recent occurrence. The author is most likely Sidgreaves, as it discusses Fr. Perry (the other likely author) in the third person, and lacks the colourful style for which Perry was known – his book on the Kerguelen expedition was a well sold tale of adventure, while the reference to the expedition in the text in question is rather dull and lifeless. It is likely to be one of the two, rather than an uninitiated assistant, as the piece begins with the customary Jesuit motto A. M. D. G., *Ad maiorum Dei gloriam*, 'For the Greater Glory of God'. The handwriting also

[94] Lankford, J. 'Amateurs And Astrophysics: A Neglected Aspect In The Development Of A Scientific Specialty'. *Social Studies of Science* 11.3 (1981): 275-303.

matches quite well to Sidgreaves' letters to Hagen in the early 20th century, featuring the characteristically long crossing of 't's and q-like tails on 'y'; the small differences being accounted for by the nearly four decades years between writing and difference of styles between prose and letter writing scripts. Furthermore, the writing is most impassioned when discussing photography, an area in which Sidgreaves had particular expertise. Based on this analysis, it is both quite likely to have been written by Fr. Sidgreaves and quite unlikely to have been written by the other possible candidate, Fr. Perry (it being Perry who gave the lecture in question). This set up would also reflect the hierarchical structure of Perry as director and Sidgreaves his chief assistant. In terms of style, the piece is fairly general in its discussion of meteorological and astronomical work, while taking a much more technical angle in its description and explanation of magnetic observations. A sample will make this clear:

> "The mean secular variation of the magnetic elements during the whole period of observation has been -6'23" yearly for the declination, -1'57" for the Dip, & 0.0012 of the value of the Horizontal Component of the Intensity."

This level of detail is far beyond that given when discussing meteorological and astronomical observations, and suggests that the audience had a good level of familiarity with the study of magnetism, although it is difficult to say any more about them.

The content of this report nevertheless takes a broad, introductory tone when discussing the observatory as a whole. The author describes the facility as a "complete physical observatory" with each of the "branches" of astronomy, meteorology and magnetism receiving "considerable attention at Stonyhurst." It is followed with a brief overview of the observatory's history, which specifically states that the original intention of the observatory was for both meteorological and astronomical observations; however, it is pointed out that the original building became reserved entirely for meteorological observations while a purpose-built astronomical observatory was constructed later. This shows the limitations faced by Stonyhurst in conducting its astronomical work, leading to the early focus on more

easily conducted meteorological observations. Magnetic observations came later, when the 1858 magnetic survey of England - and Stonyhurst's selection as a station for that survey - necessitated the construction of a subterranean magnetic observatory. This hierarchy is reflected in the author's (and presumably Perry's) treatment of the observatory's work within the three branches in order, beginning with meteorology before turning attention to astronomy and finally magnetism. For convenience, our analysis will follow suit.

The discussion of meteorological observations begins with a brief breakdown of the equipment, which included: Barograph, Thermograph, Anemograph, Plunograph [sic] and Sunshine recorder, all of which were self-recording. An explanation of how these instruments work or what they do is forgone in favour of an outline of what is done with their results: Attention is drawn to two papers, described as 'very important & interesting,' published in the early 1870s and discussing the link between Stonyhurst's meteorological findings and gas explosions at English coal mines. These papers were written by prominent scientists Sir William Galloway and Robert H. Scott FRS, and show, using data-series obtained by Stonyhurst's instruments, how a change in atmospheric pressure forewarns of gas explosions in the mines. Scott was, alongside his fellowship of the Royal Society, director of the Met Office, indicating close ties between the Office and Stonyhurst, as well as Stonyhurst's prominent position within meteorological research. The second point of interest is that the lecture presents the results of those papers thusly:

> "…of 550 fatal explosions 55 per cent were indicated by the Stonyhurst Barograph, & 19 per cent by the thermograph, which suggests a lesson of prudence [regarding meteorological research] to any coal producing country."

This presentation sounds almost as if the lecturer is trying to convince his audience of the worth of the observatory's research.

Discussion of Stonyhurst's astronomical observations offers three main nuggets of information. The observatory's activities are listed as "a long series of observations of Jupiter's satellites, of occulations of stars by the Moon, of positions of double stars, & of the daily record of number & extent of the solar prominences." The

observatory's work centres on the kind of long, repetitive observations vital to astronomy and which priest-scientists are historically known for. The report goes on to mention a hope to introduce a camera with which to record spectroscopic observations, an early indication into its future success in the field of solar spectroscopic photography. The discussion concludes with a mention of the expeditions to Spain for the total solar eclipse of December 1870 and to the Kerguelen Islands[95] in 1874, specifying that both expeditions were placed by the government under the direction of Stonyhurst astronomers, and made use also of Stonyhurst's equipment.

By far the most attention is given to the observatory's work in magnetism, and by the late 1870s Stonyhurst had developed a history of success in the field – the first survey of France by Sidgreaves and Perry was approximately a decade before this lecture – which was itself down to Perry's particular expertise. As director, then, it is unsurprising that this remained a feature both of the observatory's work and of the lecture in question. It being featured for the benefit of a specialized audience is also probable, given the detail and technical explanations given for various facets of the work.

The lecture gives an overview of the history of the study of magnetism at Stonyhurst, noting that it was not established until 1858, two decades after the beginning of the observatory itself, and was thus not a part of the observatory's original intentions. This is understandable, as although magnetism as a phenomenon had been known for millennia and applied to navigation since St. Thomas Aquinas' time, its connection to electricity and first introduction into mainstream scientific study did not come about until the early 19th century: 1858 was still four years prior to the first tentative formulation of Maxwell's equations. Magnetism, then, was another example of a cutting edge physical field in which the Jesuits were quick to engage with. Stonyhurst was once again active at a high level, shown both by its

[95] The Kerguelen Islands are a French Archipelago – though dominated by one much, much larger Island, Grand Terre – in the Southern Indian Ocean, noted for being one of the most remote places on earth, located more than 3,300 km away from the nearest inhabited place. Alongside this isolation, the Islands also have the nickname 'Desolation Islands', due to a tough, cool, windy climate on the land that denies easy survival to most life forms not directly reliant on the sea for their sustenance.

selection for the survey in England and its participation in international surveys; the report refers to the importance of international cooperation in the field in order to make "comparisons of synchronous, & also of mean, results obtained at distant observatories." Stonyhurst's support in this endeavor is demonstrated by its collusion firstly with Kew Observatory, in London, and also with observatories accessed directly via the Jesuit Order, at Florence, Rome and Zi-Ka-Wei in China. Stonyhurst's observers were also involved in surveys of both the East and West of France, as well as Belgium. The Jesuit network was thus a direct benefit in conducting effective scientific research in this field.

Once again, photography was used in order to record "every movement of the Declination & Intensity magnets," showing the general adoption of photographic technology by the observatory, and reinforcing the point made earlier that the Observatory was quick and comprehensive in its adoption of photography as a technique. The report in fact ends with a characteristically understated British salute to the quality of those photographs: "The lecture was concluded by a well merited tribute of praise for the very efficient way in which the photographs had been exhibited." The inclusion of this sentence suggests the author's pride in the observatory's budding photographic work.

1881 Notes

The next item is a set of notes covering the observatory's activity since its foundation until 1881. The notes themselves are likely to be from Perry's hand, due to the particularly comprehensive record of Perry's work and publications, the ADGM title, and his position as director and only ordained observatory staff member at the time. The style is purely notational, featuring shorthand notation throughout, and proceeds chronologically. It reveals several different insights into Stonyhurst's development and stature, including the impact of Fr. Weld, the often disappearing and reappearing act of Fr. Sidgreaves' early time at the observatory, Perry's own rise to prominence, Stonyhurst's international reach and its position within the wider network of Jesuit observatories.

The paper begins with a comprehensive presentation of the work done during Weld's directorship. Once again we see that, prior to Weld's arrival there is extremely

limited activity, which picks up following his joining the Observatory staff and drops off again during his time away in the early 1850s. These notes also reveal that there was developing engagement with the wider scientific community during his tenure, beginning with the visit of Secchi and De Vico and the granting of Greenwich publications to Stonyhurst in 1848. This was followed in 1849 with visits from prominent researchers Richard Sheepshanks, James Glaisher and John Hartnup Sr., demonstrating the increasing importance and prominence of Stonyhurst's budding observatory under Weld. Weld added real influence to this growing stature by becoming a founder member of the British Meteorological society while still in his twenties, in 1850. The notes bring two other points of interest in 1849 to light, namely the 'contemplation' of a magnetic & electric tower and the first observations made of sunspots. The interest in these topics pre-dates the directorships of Perry and Sidgreaves, showing Weld's important role in setting the tone and direction of Stonyhurst's later success in these fields.

Sidgreaves' early stint as director in the 1860s, his latter of course yet to occur at the time of writing, was marked by lower activity, as he was clearly neither the publisher nor engager that Perry was. Nevertheless, he did publish one paper on magnetism, indicating both the shift in focus to include magnetism among the observatory's core specialties, and his own academic credentials: while not as prolific as Perry or Weld, he was indeed in possession of a talented mind. Where Sidgreaves really shines in the notes, however, is in his clear skills as an administrator: under his supervision, the observatory upgraded its instruments significantly, using grants from the Board of Trade and the Royal Society, the spending and acquisition of which were both overseen by Sidgreaves. Following this, Sidgreaves published work in connection with Kew observatory, again demonstrating the Observatory's stature as well as his own scientific prowess. It is also noted that he accompanied Perry on trips to France and the Kerguelen islands, where his strong organizational skills would have proved a good pairing with Perry's leadership on these expeditions.

Beginning in September 1868, Fr. Perry takes over as director. The notes here become somewhat confused, alternating seemingly at random between 1869 and 1870, and we can thus speculate Perry was drawing the notes rather haphazardly from multiple (most likely two) sources. This suggests that a clean 'handover' was not

conducted, illustrating further the confusion seen in previous research into Stonyhurst regarding the beginning and ending of specific 'directorships;' but the notes do nevertheless confirm the positions of Weld, Perry and Sidgreaves as the observatory's most noteworthy individuals, whether they were officially titled 'director' at the time or not. Following the commencement of Perry's leadership, there is a surge in activity: of initial note is the visits of prominent scientists, such as Professor Joseph Henry of the USA's Smithsonian Institute in the May of 1870. The next major change in comparison with the notes prior to 1868 is the sheer volume of publications that began to pour forth from Stonyhurst, the vast majority of which were of Perry's authorship. No doubt the observatory's stature, as well as the new status acquired from working in partnership with the Royal Society and the Board of Trade - and the research conducted under those partnerships - contributed to Perry's incredible publishing prolificacy, which was to the tune of 7-10 papers per year between 1870 and 1880. This prominence quickly led to his being appointed to lead the government expeditions to Spain and India to observe solar eclipses there. This was followed by his taking charge of the expedition to the Kerguelen Islands, where they would observe the transition of Venus across the Sun. The return from this trip featured measurements at every port along the way, including in South Africa, India and Italy, where Perry also gave lectures on his scientific research to the local communities. The final and clearest measure of his stature is listed in 1879, when Perry was called upon to write an obituary for Fr. Secchi, by then a world famous Jesuit astronomer.

Unpublished 1881 History

This unpublished history, authored at about the same time as the notes - as they discuss the same events - draws from both the notes and the lecture report discussed earlier. Its relationship to the lecture report is clear, in that its opening is nearly identical, and refers to the same lecture. It nevertheless covers much more ground than the predominant focus on magnetism of the earlier report, discussing astronomy and meteorology within the context of the observatory's historical activity and with relation to each other. One likely scenario is that the lecture and its report inspired Perry to write a more conclusive historical description of the observatory

itself, the physical dimensions and operation of which he covers in extreme detail, while offering little insight into the foreign expeditions undertaken by himself and others at Stonyhurst. The report also pays close attention to the observatory's equipment, to which Perry attributes Stonyhurst's importance. The greatest volume of page space is given over to detailed descriptions of the nature and operation of the observatory's equipment, interspersed with small passages discussing interesting research and insights gleaned from the observational data.

The manuscript is very clear in explaining that Stonyhurst's contemporary importance in the early 1880s rested on two major features: the government's favour and the 'complete' collection of meteorological equipment in its possession, which we shall return to shortly. Government attention and support was garnered due to a combination of efforts and perseverance (as well as the quality of equipment), specifically on behalf of Fr. Weld, whom the paper highlights as the defining factor in building the observatory's reputation:

> "The zeal and energy displayed by the R. P. Weld soon made the observatory well known through the Country, & has ever since shown the liveliest interest in its welfare & materially aided its progress."

The paper also draws attention to Sabine's personal interest in Stonyhurst, which played a key role in both the positive relationship with the government (via the Royal Society) and the direction of it, towards magnetism. The paper indicates that government support was so important to the observatory because it provided money for new equipment, and allowed Stonyhurst's researchers to take part in (and often lead, in Perry's case) a great variety of foreign expeditions. These expeditions (and, once again, the equipment provided), allowed in turn for better research, further increasing the observatory's renown. Another point of pride is the attendance of Angelo Secchi in 1848, when the year of revolutions overcame Rome, who came as a student of theology to the college. The fledgling work in meteorology and astronomy "attracted his attention, & exercised a fascinating effect on his active mind," and led to his later success in America and Italy; adding another feather of significant historical influence to the cap of Fr. Weld.

Perry also celebrates Fr. Secchi for having "laboured for the advance of science & religion until his death." This comment referring to the Jesuit roles in both science and religion – a hot topic at the time at to the X-Club – is a rare one, for Perry is otherwise meticulous in presenting only the detail, data and the facts of the observatory's measurements, and rarely alludes to his role as a priest within his scientific writing. In this piece, however, he also makes notes of the observatory's connection to the college at Stonyhurst, giving brief detail of its founding and growth.

The vast majority of the history concerns incredibly detailed description of the facilities, instruments, and their operation. Perry determines the "complete nature of its equipment for physical research" as the leading driver of interest in the observatory, comparing it to other observatories which, though in possession more advanced particular instruments, could not match Stonyhurst for its complete suite of observational equipment. This reveals his understanding of the relationship between the importance of an observatory and the equipment in its possession, and mentions several times that gaining one leads to the other. He goes into particular detail when outlining the self-recording mechanisms of each individual instrument, despite promising only a short description avoiding any 'unnecessary detail;' clearly, Perry found there to be little that would fall under 'unnecessary'. Perry is unhesitant here in acknowledging that, by the time of writing between 1879 and 1881, the observatory's astronomical facilities lagged behind those of the meteorological and magnetism sections. There are several reasons for this: firstly, astronomy was a much more mature subject, and the developments in telescope technology far outstripped Stonyhurst's capability for expenditure upon them. Secondly, Stonyhurst's day-to-day research strengths lay in magnetic and meteorological observations at this time, though it should be understood that a part of this strength would derive from the budget-enforced shift in attention away from astronomy. Finally, the work the observatory undertook in partnership with the government and the Royal Society, which ranked as the observatory's most important endeavours according to Perry, necessitated top of the line equipment, indicating the seriousness with which the observatory took its work on the scientific frontiers.

Discussion of the observatory's research, especially when juxtaposed with his exhaustive description of its facilities and equipment, comes across as almost

reluctant, as if Perry is hesitant to declare anything. Nevertheless, Perry briefly discusses several areas of scientific 'produce' in the form of insights drawn from their observations. The first is the research of Scott and Galloway into the relationship between meteorological readings and gas explosions in coal mines, repeated nearly verbatim from the earlier lecture report. The second is his report of a "very satisfying" confirmation of General Sabine's statement that the Sun has a greater effect upon Earth's magnetism during the winter. The third insight is barely more than a sentence, explaining that 13 years of records show there to be a link between magnetic storms and the Aurora Borealis, though Perry only claims that this provides for interesting discussion in the monthly bulletins, rather than being willing to take any theoretical positions on the matter. This non-committal approach is repeated when discussing several other minor, yet "striking" observations, maintaining only that they provide excellent fodder for discourse, and not giving any theoretical detail. This limited presentation of the various outcomes of Stonyhurst's research is illustrative of the more 'amateur' elements to the observatory's activity. Finally, throughout the history, Perry is keen to assert the importance of international cooperation in meteorological and magnetic research, discussing throughout the partnerships and research undertaken with colleagues in Italy, China and the wider world, as well as over greater distances within the British Isles.

Sidgreaves' letters to Hagen

These letters, in Sidgreaves' own hand, to Fr. Hagen in Rome are dated from 1908 and 1914, and they give a clear, though brief, view of Sidgreaves' character and motivations, illustrated by Sidgreaves' request for the Pope's blessing for the observatory.

The letter dated October 20th 1908 enclosed the official vouchers Sidgreaves had received in conjunction with his winning gold medals in two sections of the grand prix during the Franco-British exhibition, in Scientific Applications of Photography, and the Educational Sections. He asked that they be presented to the Father General, the leader of the Jesuits, and, if appropriate, to be laid "at the feet of our Holy Father Pio X- begging his Blessing for the observatory and the college." Though the general tone of Sidgreaves' writing through the collection of letters is one

of a very humble man, this request demonstrates his pride in having achieved "the highest award that can be given". Of particular interest to this study, however, is his explanation for the request:

> "I am venturing upon this because my chief consideration in the work of the observatory is in my belief that His Holiness holds it to be to the honour of the Church."

This demonstrates quite clearly that Sidgreaves' motivation for his work at the observatory is closely aligned to its being beneficial to the reputation of the Church, and that he therefore feels his scientific work to be an honourable pursuit in the name of God. This is very interesting, as it shows Sidgreaves to believe that science is not only not 'against' the Church, but in fact to its benefit – so long as the Pope agrees, it seems. In the letter dated November 20th 1908, Sidgreaves makes clear his disappointment that the Pope sent his blessings to the wider College, rather than primarily the Observatory as Sidgreaves had requested (and to which the College was 'indebted' for its presence at the exhibition). This suggests the observatory was, to some extent, considered as a separate entity from the College by observatory staff – especially considering that Sidgreaves also played an important role as a teacher at the College. Such a separation suggests that the observatory was indeed an almost professionally scientific endeavour, apart from the educational and religious role of the college itself.

The final letter, dated March 13th 1914, discusses the expense of new equipment, and how the intended instruments to be acquired from Brown's, a prominent telescope maker, were likely to prove too great a pull on Fr. Sidgreaves resources. At less than £70, this shows that the days of budgets from the Royal Society and Board of Trade were long past, which would have been a major contributor to the loss of stature suffered by the Observatory in the 20th century; especially considering the importance Fr. Perry placed on the acquisition of instruments in his history of thirty years prior.

Stonyhurst College Observatory, Lancashire. A brief sketch of its history and work.

The final paper to be examined stands out most of all for the question of its authorship, which we will discuss initially. Professor Udías believes the paper to most probably have been authored by Fr. Sidgreaves; however, I feel there is compelling evidence that this cannot be not the case.

The paper, *Stonyhurst College Observatory, Lancashire. A brief sketch of its history and work* lives up to its title: it is very brief, at just 9 pages, a third of which are concerned once again with a description of the observatory's equipment. The latest event it covers is the 1908 Grand Prix in which Sidgreaves won his medals; this dates the paper as between 1908 and 1919, the time of Fr. Sidgreaves' death, which is not noted. The paper pays Fr. Sidgreaves significant attention compared with other works, and it is for these reasons – date and subject – that Professor Udías believed Sidgreaves to be the author, writing shortly after 1908. There are four reasons to disagree with this thesis: firstly, the paper is not titled with AMDG, the Jesuit motto with which all Jesuit papers are signed. Secondly, it is written on lined, loose-leaf paper, which was not in common use until at least 1914. Thirdly, when compared with Sidgreaves' letters of 1908 and 1914 (written about the same time), the handwriting is clearly different, particularly evident in the style of capital Ts and Fs, and the tails on small Ys. Finally, the paper has a touch of gallows humour , referring to the Ile du Salut ("Isle of Health"), where Fr. Perry fell ill, as "much mis-named," a reference that seems unlikely given Fr. Sidgreaves' highly respectful nature and close relationship with Fr. Perry. In accordance with this evidence, and considering the use of secondary literature within the paper, a more likely author would in fact be an outside researcher, working prior to 1919 and having access to Fr. Sidgreaves and his diaries as primary research material. This would make the paper interesting as a first hand, outside account of the Observatory, adding a different shade to its account of the observatory and its directors.

With this in mind, it is even more noteworthy that the importance of Weld is clearly highlighted by the author: "It was not until Father Alfred Weld was appointed director in 1856 that really important work began to be undertaken." This demonstrates firstly Weld's role as the instigator of work at the observatory, and it

also shows that his work itself was of importance. The history notes that of greatest significance during Weld's directorship was the commencement of Sabine's relationship with the Observatory, as he advised to begin the series of magnetic observation; this was important as it was not only the Observatory's first foray into magnetic research, but also led to the procurement of instruments of magnetic study which would allow for the further research, which, we've already seen, would provide the basis for Stonyhurst's latter success.

Considering the evidence we've seen of Fr. Perry receiving the lion's share of attention, particularly in secondary accounts, it is somewhat surprising that coverage of Perry's achievements and activities is largely limited to brief descriptions of his expeditions. The reason for doing this appears to be to demonstrate Perry's prominence as a public figure, as the focus is on his selection and direction by the Government to serve with, and later lead, the expeditions. This does not, however, explain why his mammoth catalogue of publications are not given mention; perhaps such activity is simply unworthy of a 'brief sketch.'

Of the three, it is Fr. Sidgreaves who receives the most space in this history. A long quotation – more of an extract, in fact – from Chicago Professor Hale's work *Astronomy and Astro-Physics* (Vol XIII, 1894) forms the bulk of this attention. In it, the influential Professor Hale discusses Sidgreaves' quality as a spectroscopic researcher, and draws particular attention to his innovations in spectroscopic photography. This specialization is further celebrated by the author in his discussion of Fr. Sidgreaves's award at the Grand Prix of 1908. Sidgreaves is also given mention as accompanying Fr. Perry to France and Kerguelen, the latter of which is referred to as 'that delectable spot', highlighting the author's sense of humour, and suggesting a personal account given by Sidgreaves due to the informal style of the description – it is unlikely in the extreme that the author had also visited the remote archipelago.

Conclusions from the Material

The first major point to draw from the bulk of the sources is the extreme focus on the observatory's equipment, both in volume and detail. The Perry manuscript clearly shows the importance placed upon the quality, diversity and range of equipment at the observatory, and attributes much of the observatory's renown to its collection. Of

particular interest is Perry's highlighting of the observatory's "complete suite" of instruments across meteorology, astronomy and magnetism, and the liberal use of innovative self-recording equipment, in contrast to the observatory's inability to afford specialist, high-end equipment. This is an excellent example of the Jesuits deriving the most value possible from a limited budget, which is a habit reflective of their 'frontier work' approach.

The bent towards frontier work is also seen in the observatory's initial focus on meteorology, a science very much in its infancy at the time. Alongside its status as a young science, meteorological study was also of direct benefit to the coal mining operations of Great Britain, which was highlighted by Perry specifically, further backing up Udias' theory that Jesuits would actively engage in frontier work as a means of supporting their local community.

Magnetism falls into this same bracket, being a young science with applications in the coal mining industry, and is also indicative of the benefit to the Church's honour of the observatory's work: Stonyhurst was able to gain international prestige in the field of magnetism through Perry's specialization in the field, and, most importantly, its utilization of the global Jesuit network to conduct the kind of long distance geomagnetic experimentation the subject relies upon. This shows that the observatory's work in magnetism not only reflects the Jesuit frontier 'spirituality', but also that the Jesuits were especially well suited to the topic thanks to the global reach this spirituality engendered – demonstrating an obvious disadvantage to the exclusion of religious groups from science that the X Club strived for.

The contemporary works also clearly and repeatedly show Weld, both during his own time and half a century thereafter, to have been hugely influential in the establishment of the observatory as a national and then international institution. The examples above are numerous, however special attention is drawn to his connection and cultivation of the relationship with Sabine and his proactive scientific work in the observatory's early years. The manuscripts explicitly celebrate and honour his influence and impact, and so I think it can be conclusively said that Fr. Weld played a crucial role that, although less prominent than that of Perry during the Observatory's hey-day, directly laid the foundations of the Observatory as an important institution, as well as planting the seeds of research (for example in sunspots and magnetism)

that his more famous successor would harvest. He is thus worthy of higher regard than that given to him by modern scholars, and his story must be more readily included when telling that of Fr. Perry.

Perry himself is responsible for a large part of the source material, which comes as no surprise considering his propensity to publish and produce: just as much as Weld was crucial in providing avenues to work down, Perry was adept at raising the observatory's profile through his lectures, works and expeditions. The works that he himself has produced reveal a scientific man very much in the mold of the 19th century concept of an ideal scientist: meticulous and detail oriented, focused on retrieving data from the world around him, and willing to put his comfort and his life at risk to do so. Those that write about him highlight his role leading expeditions all over the world, and pay particular praise to his doing so on behalf of the government and major organisations, which emphasizes his prominence within the scientific community beyond the Church. Most interestingly, neither he nor his colleagues pay much attention to one another's priestly duties and values; the one reference being Perry's obituary of Fr. Secchi, in which he applauds Secchi's commitment to both religion and science – as equals – until his death. This strongly suggests that there was no natural conflict between the theological and physical in these Jesuits' view, nor much crossover – at least on a practical basis – worth mention.

Father Sidgreaves, in his letters, does mention religious motivation for his work, namely that Stonyhurst's research is valuable in that it should bring honour to the Church. This no doubt indicates where Sidgreaves' loyalty lies; however, despite being a very skilled scientist – particularly proficient in the technical operation of the instruments – Sidgreaves did not receive the same education in mathematics and science as his predecessors. This meant that he was much more of an amateur scientist, and the sources bare this characterization out, as he is celebrated mostly for his photographic innovations and skills. Overall, Sidgreaves comes across as a humble, but very fine administrator, and a technically gifted and reliable scientist, though not the publishing scientist that Perry was. This is indicative of how the different researchers at Stonyhurst straddled not only the religion/science debate, but also the professional/amateur split. The final paper, *A Brief Sketch*, tempers this

modesty by highlighting Fr. Sidgreaves skill in observation and his good standing within the field: Hale's praise is no small courtesy, and offers a strong argument that Fr. Sidgreaves, too, is worthy of greater standing in consideration of Stonyhurst's history. The fact that Fr. Sidgreaves is not remembered – the current master attributes the relative dearth of information on he and Fr. Weld to their being "lesser scientists" – disregards both their own worth as researchers and their broader contributions to the observatory's, and Fr. Perry's, more noted success.

In all, these primary, contemporary sources relate to our previous chapters in three important ways: firstly, that Frs. Weld and Sidgreaves, celebrated by their contemporaries, deserve much greater attention and credit for their role in the development of the observatory than is currently given him by scholars. Secondly, that the observatory's engagement in research in the fields of meteorology and magnetism, as well as its leadership in research and expeditions that literally visited the frontiers of the inhabitable planet, give strong evidence to Udias' argument that Jesuits have a unique streak of seeking out 'frontier work.' Furthermore, it was understood by the three directors in question that such work brought both prestige to the wider Church and supported the Jesuits' wider community. Finally, that, considering the quality of its equipment, its national prestige and its international activity, Stonyhurst had many of the hallmarks of a serious professional scientific institution during the latter half of the 19th century. However, its link to religion, via its operation by the Jesuits, and its conduct of both amateur and professional research on the frontiers of science, show that the observatory succeeded in straddling divides between religion and science, professionalism and amateurism, just as such boundaries were being drawn up by their professional, secular colleagues in London. The one caveat to this being Stonyhurst's apparent unwillingness to present conclusions from its research: a good example of this being Fr. Perry's research on coal, highlighting how the magnetic observations varied around the huge coal deposits of Belgium's southern region and contrasting them with a measurement in the North-West of the country, which produced the exact opposite effect to that in the coal-rich South, although no theories or any speculation at all are given for this. A link between the phenomena of magnetic storms and Aurora Borealis is also discussed without speculation as to its nature. It is also worth noting from

Sidgreaves' letters that, despite Stonyhurst's success, and the prominence within the wider Jesuit scientific community that entailed, the observatory's achievements were not celebrated by the Church with the gusto he desired. These two points suggest that Stonyhurst were aware of - and perhaps disappointed by - the broader exclusion of the Church from the 'professional' scientific domain, and the Church's reticence in combatting th

Final Conclusions

The first question to tackle, as to whether Frs. Weld and Sidgreaves are overlooked and underestimated by modern scholarship, has a conclusive answer in the affirmative. Dismissing them as 'lesser scientists' than Perry disregards their crucial contributions to the successes of the Observatory and Fr. Perry himself. Further investigation into their activities and backgrounds reveals the role they played in helping the observatory gain prominence during a time of declining influence and presence of religious groups within the scientific community.

To break this down further, we saw that Fr. Weld was integral, and in reality almost solely responsible, for the development of Stonyhurst's observatory into a world class institution. Not only did he lead the observatory's initial research and set the direction towards and within the meteorological, astronomical and magnetic sciences, he also used his high standing in society to promote the observatory, principally by cultivating a crucial relationship with General Sabine.

The contemporary evidence backs this up very strongly, as Fr. Weld's successors repeatedly lauded his contributions, leadership and zeal for the observatory's work. The hard evidence, of experiments conducted, observations made, and projects initiated also demonstrate Weld's single-handed development of a small outhouse into a national and then international observatory. The sheer lack of activity without him during the 1840s and 50s, and the vast wealth during his tenure and thereafter, speaks loudly to his input and influence.

Weld's hard work, and utilisation of his social pedigree, made the most of the last period in which ordained priests formed the bulk of the scientific hierarchy, and laid the groundwork for Fr. Perry to flourish even as the Church played a smaller role in the sciences.

Fr. Sidgreaves, on the other hand, became director well after the completion of this exclusion at the end of the 19th century. He was nevertheless well suited to continue Stonyhurst's success, thanks to his technical prowess and modest character, culminating in the award of two gold medals at the 1908 Anglo-French Exhibition. These same qualities also made him the ideal administrator to oversee the extensive upgrades to Stonyhurst's observatory during the 1860s, which also provided Fr.

Perry with the tools he needed to take Stonyhurst onto the global scientific stage in the 1870s and 80s; they also allowed him to play an important role in assisting Fr. Perry's work - particularly on their expeditions to France and the Kerguelen islands.

Once again, the contemporary evidence comes down strongly in favour of this view, with nearly all of the various resources highlighting the vital importance of the diversity of equipment installed at the university, and the role played by photography in relation to those instruments - two areas that Fr. Sidgreaves was particularly responsible for and specialised in. The later work, particularly the final piece, also notes the reputation among the upper echelons of the field Sidgreaves had developed as a skilled technical scientist. I would surmise that the underappreciation of Fr. Sidgreaves' contributions to the Observatory come down to his general modesty and shyness, as evidenced by anecdotal evidence from contemporaries, and the disregard of his scientific abilities as an 'amateur' scientist, regardless of his achievements. This amateurism is in fact one of the key factors in his continued success, as it allowed him to garner renown for the Observatory without coming into conflict with the newly secular scientific hierarchy.

Fr. Perry was undoubtedly the Observatory's brightest star, the sheer volume of his published work, his membership in the Royal Society, and his selection and successes in leading major international expeditions all highlight this. The important thing to understand is that this success was built upon the work of Weld initially and supported by that of Sidgreaves, rather than simply a result of Perry's individual brilliance. One area in which Fr. Perry may earn special credit would be his leadership in the training of Jesuit priest-scientists that would run similar observatories all around the world, in Africa, the Phillipines and China. While Fr. Sidgreaves also played a key role as the leader of the priest-training seminary at Stonyhurst, Fr. Perry's international reputation was likely to have been important in the development of these institutions, and the reason as to why their first leaders were sent to Stonyhurst for training. The extent to which such a Jesuit 'school' of observer priests was developed, and the role Frs. Weld, Perry and Sidgreaves played in it, would be a fertile ground for further research.

The second question we must answer is whether or not the Jesuit order has a particular attunement to scientific study, and to what extent this aided the priest-scientists at Stonyhurst. To answer, we've taken a look at modern scholarship on the nature of the order, and focused on the particular Jesuit Apostolic Spirituality. Feldhay and Harris highlighted the role played by learning in the 'Jesuit way', as a path towards self-realisation and communion with God, making learning a form of prayer for Jesuits; when combined with a strong tradition in education and mathematics, the study of the sciences forms a small, but not disreputable, corner of the Jesuit Spirituality. However, the spirituality of 'learning' can be applied to all things, rather than just mathematical sciences in particular, which is the point where Udías takes a different track, asserting instead that the Jesuits have a particular bent towards the mathematical sciences thanks to their drive towards 'frontier work'.

While I think that the concept of 'frontier work' is an important and valuable characterisation of the Jesuit Spirituality, Professor Udías goes too far in claiming that the entirety of the Jesuit order is thus suited to scientific study; this conclusion ignores the wider Society's disregard for Clavius' suggestions for the Jesuit curriculum, and plays down Jesuit activity following in the Galileo affair. Instead, I would argue that apostolic frontier work characterises the Jesuits in a number of fields, of which the mathematical sciences are but one. Nevertheless, this part of the wider Jesuit Spirituality is crucial in encouraging those inclined to conduct scientific research: exploring the reaches of science and the solar system is an endeavour the Jesuits condone, rather than condemn, for the benefits it brings to the wider Church and the Jesuit mission.

This background, of a tradition - particularly in astronomy - and a drive towards the frontier work, provides a strong explanation of why Stonyhurst developed an Observatory in the first place. It also goes some way to explaining the choice of studying meteorology and magnetism, alongside astronomy, as these were young sciences, right on the frontier of new research. Combined with the aptitude and passion of the observer priests at Stonyhurst, the element of 'frontier work' in their spirituality played a definite role in their success.

The primary research certainly provides evidence that Stonyhurst's priests sought out the boundaries of their fields and reaped the rewards in renown that

doing so provided, highlighting in particular: Fr. Weld's initial forays into meteorology and the prominent position on the national stage he secured for Stonyhurst via his work with Sabine; Fr. Perry's international prestige in magnetism and astronomy, and his involvement in the great multinational expeditions (there were also American and German teams battling the elements at the Kerguelen Islands); and Fr. Sidgreaves' recognition in both top-tier awards and plaudits from the most prominent of scientists in Professor Hale, as well as his insistence on teaching classes about the latest advancements in the sciences. All of this contributed to the Observatory's renown, which in turn brought honour upon the Church - as celebrated in Fr. Sidgreaves' letters to Fr. Hagen - that continued a the long established Apostolic value in the Jesuit conduct in Science.

The final question is with regards to the broader exclusion of the clergy from the scientific establishment in Great Britain during the 19th Century. What drove these changes, and how were the observer priests at Stonyhurst able to prosper despite them?

The reasons for this sea-change were both macro- and micro-thematic; the macro-developments centred on the broader growth and development of largely secular nation states guided by social contracts, economic gain and political point scoring rather than religious or monarchical control. The upheaval in Church doctrine following the publication of the *Essays and Reviews* and Darwin's *Origins* also left it vulnerable. On the micro-level, professionalists such as the X Club were able to seize these changes in ideology to expel the clergy from the Scientific hierarchy, succeeding particularly well in usurping control of the Royal Society following 1875.

This same period, however, saw Stonyhurst's rise to becoming a premier observatory on the national and international stage. The Jesuits at Stonyhurst were able to avoid the wider exclusion due to a number of factors: firstly, as Catholics, they were already considered somewhat outside the system as an established minority in Protestant Britain, and so not a worthy target for the professionalists struggling for control - the religious establishment in the UK was the Church of England, rather than the Catholic Church or its orders. This meant they were separate from the

controversy gripping the Anglican church following the publishing of *Essays and Reviews*. Nevertheless, they were part of a significant (and wealthy) community, as Britain had provided refuge for those escaping the chaos brought to the continent by the French Revolutionary wars. Stonyhurst was in fact one of the least affected of all the Jesuit institutions suppressed in the 18th century; discounting its physical relocation from Belgium, the institution's geographical separation from the turmoil elsewhere meant that it retained a large amount of continuity. These two combining factors put the college in a fairly strong position (relative to other such Jesuit institutions around the world) during the 19th century.

This translated into direct advantages for the priest-scientists at Stonyhurst's observatory, providing them with the education and professional networks as well as the economic independence necessary to conduct research as they saw fit (though rarely an especially well funded programme, Frs. Weld, Perry and Sidgreaves had time, equipment and the college to lean on for their broader needs). In contrast with their lay contemporaries, who were usually afforded only one or the other: amateur scientists had wealth and freedom, but limited training, while the burgeoning class of professional scientists boasted first rate education and networks, but were forced to meet the demands of their nations and universities in exchange for funding and support.

The characters of the directors themselves, and more importantly their relationship with each other, also contributed to their success during the broader decline of scientific influence among the clergy: by combining popular lectures with high quality research while refusing to hypothesise, Fr. Perry made a difficult target for the Professionalists. Without the groundwork laid by Fr. Weld prior to the ascensions of the X-Club, or Fr. Sidgreaves support, it would have been much harder for Fr. Perry to achieve that bar, reliant more on his rhetoric than anything else, much as Bishop Wilberforce did.

As the various histories show, there was also nearly no crossover between the religious and scientific capacities of the priests at Stonyhurst; though there was internal and external awareness of their providing a 'link' between science and religion, there was very little to mark their discussion of scientific matters that would reveal their religious vocation. This, of course, also had rather a lot to do with the

subjects at hand: while controversy surrounded the geological and biological fields, contradicting Scripture on matters of creation, the mathematical sciences traditional to the Jesuit order offered little beyond plain facts, and the apparent reluctance of the priests to speculate on theory kept it this way.

The first conclusion to draw from answering these three questions is that not only were Frs. Weld, Perry and Sidgreaves excellent scientists thanks to their individual abilities, but that they were boosted in their scientific endeavour by their position as priest-scientists: they were provided with first-rate education and training, given the resources they needed and the freedom to conduct their research as they saw fit. They also benefitted from a strong tradition among the Jesuit order in particular for seeking out 'frontier work', allowing them to push the boundaries of scientific understanding by engaging with new fields of study. Finally, their Catholic status kept them apart from the broader changes within the scientific hierarchy, thereby allowing them to find success and in doing so demonstrate that there was no inherent limitation in being both a priest and a scientist, at a time when this was a very real question.

With this in mind, we can draw a second conclusion that the exclusion of clergy from the sciences that was initiated by professionalists during the latter half of the 19th century perhaps went too far, and removed valuable, educated and resourceful practitioners from the sciences on grounds that had more to do with political maneuvering and broader social trends than specific, practical issues with their ability to conduct science on account of their religious calling. The damage this may have done to overall scientific progress cannot be precisely known.

These conclusions leave us with two questions worthy of further consideration. Firstly, is it still the case today that priest-scientists hold certain advantages over their lay brethren? The Jesuits are certainly still active, operating schools and universities all over the world (including Stonyhurst, though the observatory has fallen into minimal use) as well as being responsible for the Vatican Observatory at the Papal Summer Residence outside Rome and its major Advanced Technology Telescope at the Mount Graham International Observatory in Arizona. There are also

plenty of examples of Jesuits at the pinnacle of their fields, most notably Timothy Toohig in the realm of particle accelerators. Uncovering the advantages and disadvantages faced by modern Jesuit scholars such as Dr. Toohig and others, as well as the staff of the Vatican Observatory, and answering this question would be an interesting topic for further research.

The second question is a little more abstract, and applies to the broader history of science: was the short-term or 'tactical' disadvantage of excluding clergy from the sciences, as evidenced here, also a disadvantage in the longer, 'strategic' term? In light of its history on the matter, it is easy to consider that the ultimate reduction of the role of religious dogma in the broader scientific endeavour might be a boon, however there are clearly certain areas in which priest-scientists have contributed - and still contribute - much. There is also something to be said for conducting research for its own sake; certainly, there are few parts of academic life more frustrating than the oft-bemoaned cantrip of 'Publish or Die'. Against this seemingly worsening plight, Churches would be well placed to provide for research funding as charity.

While only a hardcore few within the scientific community would hold a researcher's religion against him or her, there are certainly broader social questions with regards to the relationship between religion, morality, technology and science to consider, as well as a widespread belief among the general public that religion and science retain a fundamental incompatibility. I would hope that my research here, on a small corner of the Victorian world, provides some food for thought among those critics.

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