James Gregory, inventor of the reflecting telescope and Fellow of the Royal Society, was the first Regius Professor of Mathematics of the University of St Andrews, 1668–74. He attempted to establish in St Andrews what would, if completed, have been the first purpose-built observatory in the British Isles. He travelled to London in 1673 to purchase instruments for equipping the observatory and improving the teaching and study of natural philosophy and mathematics in the university, seeking the advice of John Flamsteed, later the first Astronomer Royal. This paper considers the observatory initiative and the early acquisition of instruments at the University of St Andrews, with reference to Gregory’s correspondence, inventories made ca. 1699–ca. 1718 and extant instruments themselves, some of which predate Gregory’s time. It examines the structure and fate of the university observatory, the legacy of Gregory’s teaching and endeavours, and the meridian line laid down in 1748 in the University Library.

**Keywords:** James Gregory; scientific instruments; observatory; meridian line; St Andrews; astronomy

On 8 June 1677, Thomas Kirk of Cookridge, Yorkshire, who was spending several nights in St Andrews during a tour of Scotland, was shown around the three colleges of the University of St Andrews by the masters. He inspected the tomb of Bishop Kennedy, founder of St Salvator’s College, the three medieval ceremonial maces and the ‘blackstone’, on which students sat during formal oral examinations. Visiting the St Mary’s College area, he found that ‘in a room here are kept some mathematical instruments; the mathematical professor, Mr ———, did show them to us. Upon the outside of the College Walk near the sea is a new observatory erected but it is not yet finished.’

Given the date of Kirk’s visit, it is likely that these instruments were primarily those acquired by James Gregory, the university’s first Regius Professor of Mathematics 1668–74, who attempted to establish in St Andrews what would, if completed, have been the first purpose-built observatory in the British Isles. The university had issued a commission, dated 10 June 1673, for Gregory to travel to London and there purchase instruments.
‘such instruments and utensils as he, with advice of other skilful persons, shall judge most 
necessary and usefull’ for improving the teaching and study of natural philosophy and the 
mathematical sciences and equipping the planned university observatory. The room Kirk 
describes was almost certainly in the ‘University building’ adjacent to St Mary’s College. 
This contained the University Library, where Gregory worked and where later university 
 tweaked inventories confirm that instruments were held.

The author of *Theatrum Scotiæ* and the writer Daniel Defoe also knew of the existence of 
the university’s instruments. *Theatrum Scotiæ*, a volume of descriptions and engravings of 
Scottish towns and monuments first published in 1693, records that Gregory ‘erected a 
 commodius Observatory for Mathematical Observations in the College-Garden [of St 
Mary’s], having caused a Contribution to be made for that purpose. He also furnished it 
with many Mathematical Instruments much better than it had been before his Time.’

Defoe, who visited St Andrews in the early eighteenth century, notes in *A Tour Through 
the Whole Island of Great Britain*: ‘Dr Gregory, obtain’d an observatory to be erected, and 
gave them abundance of mathematical and astronomical instruments: But it is not now made 
use of, for what reason I know not.’

Other visitors who left accounts of their experiences in the town, including John Macky 
(visited ca. 1723), John Loveday (1732) and Richard Pococke, Bishop of Meath (1760), were 
aware of the observatory building, which stood at the south end of the St Mary’s College 
gardens. Macky, observing that it was a ‘fine [building] of Free-stone’, comments: ‘it is 
neither finish’d, nor ever made use of, which is a pity, considering the Expense the 
building cost.’ Although it was almost certainly never brought into use for its intended 
purpose, and became increasingly dilapidated during the course of the eighteenth century, 
 its size and associations meant that the observatory building became something of a local 
landmark. It featured on a map of St Andrews as late as 1802, by which time it had been 
partly demolished.

This paper examines the attempt to establish an observatory at the University of St 
Andrews under James Gregory, and the acquisition of instruments in this period. It 
considers the structure and fate of the observatory building, the impact of Gregory’s 
teaching and endeavours, and the meridian line in the University Library, laid down by 
Thomas Short in 1748 but commonly misassociated with Gregory.

### MATHEMATICAL TEACHING BEFORE GREGORY’S APPOINTMENT

Mathematics had been taught in the university long before Gregory’s time. Natural 
philosophy was a core part of the Arts curriculum from the fifteenth century. The 
teaching at St Andrews was admired by Jaspar Laet de Borchloen, who in 1491 issued an 
address to Archbishop William Schevez, University Chancellor from 1478 to 1497:

In particular you have brought from the blind darkness of oblivion to the brightness of 
daylight the geometrical studies which, possibly through the supineness of the Scots, 
had been almost lost from this ecclesiastical cradle of learning. You collected a 
number of books with a view to the revival of astronomy.

In the temporary statutes of 7 January 1561/62 (issued following the Scottish 
Reformation) it was stated that after a preliminary study of verse or rhetoric, students 
should progress to the logic of Aristotle and the books of Ethics, proceeding to Natural
Philosophy, Metaphysics and Mathematics over the traditional course of three and a half years. Soon afterwards, in 1564, John Napier (1550–1617), later the inventor of logarithms, entered St Salvator’s College at the age of 13 years.

The records of the Earl of Morton’s Visitation of the university on 16 April 1574 dictate that ‘the third maister of the New College [St Mary’s] sall reid, within the same, four lessinis oullkie [weekly] in the Mathematic Sciences’: this seems to have been the first creation of a specialist mathematical post at St Andrews. Under the terms of the ‘New Foundation’ of the university in 1579, when St Salvator’s and St Leonard’s Colleges were re-founded as colleges of Arts and Philosophy and St Mary’s as a school of Theology, the teachers of Law and Mathematics formerly at St Mary’s were transferred to St Salvator’s College, as extraordinary professors. The reports of the 1588 Visitation record that the ‘Mathematician, Mr Homer Blair, sayis he teachis the Arithmetique of Ramus Mononday at viii houris, at 10 houris on Tysday and viii houris on Frayday.’ William Welwood, who had taught mathematics from 1575 to 1587 before being transferred to the post of lawyer, informed the Visitors:

I professit ye mathematiques as I did their x [ten] yeiris and mair yrof I not onlief often tymes redd arithmetik geometre geographie and astronomie the mechanisms of Aristotol also adjoint therto all sortis practik arithmetic and geometrie togidder with ye makking of ye cartis universall and particular ye uss of ye astrolabe ye calendairis and summe chronologes.

This reference to ‘ye astrolabe’ is the first distinct mention of a scientific instrument that I can locate in the university’s records, yet it is unclear whether Welwood taught the use of the astrolabe practically, with an actual instrument, or just theoretically. After the death of the mathematician in 1600 the specialist ‘profession’ of mathematics lapsed. There was an unsuccessful attempt to establish a chair of mathematics at St Salvator’s College in 1649. However, not until 1668 was a Regius Chair of Mathematics established, for the university as a whole, with James Gregory as its first incumbent. Although continuous provision had been made for instruction in the subject of natural philosophy since the fifteenth century, chairs of Natural Philosophy were not established at St Salvator’s and St Leonard’s colleges until 1724–27.

JAMES GREGORY, THE UNIVERSITY OBSERVATORY AND THE ACQUISITION OF SCIENTIFIC INSTRUMENTS

James Gregory (1638–75) was born at Drumoak, near Aberdeen, and educated at Marischal College, Aberdeen, graduating MA in 1657. In Optica Promota (1663) he gave the first description of a reflecting telescope, an instrument that, through a combination of lenses and mirrors, would allow greater magnification to be obtained with barrels of shorter length than was possible with a refracting telescope, hitherto the standard model. He spent time in London in 1662–63, where he attempted to have an effective working model of his telescope constructed by Richard Reeve, an instrument maker specializing in optics; Reeve’s experiments failed, but the process was later perfected by Robert Hooke, and in the eighteenth century the ‘Gregorian’ telescope became the standard form. While in London Gregory came into contact with a group of scientists and instrument makers, many of whom were associated with the Royal Society. Among them was John Collins
(1625–83), a government accountant and a mathematician who was an enthusiastic correspondent of several principal mathematicians in Britain and Europe and had a key role in encouraging the interchange of mathematical news and promoting mathematical publishing. Gregory then travelled to Italy, spending about three years at the renowned university of Padua, where he studied geometry, mechanics and astronomy under Stefano degli Angeli. He published two further mathematical works, which secured his election to the Royal Society on his return to London in 1668 and influenced his appointment to the new Chair of Mathematics at St Andrews. He married Mary Jamesone, daughter of the artist George Jamesone of Aberdeen in 1669.

Gregory has been credited with giving ‘the first introduction to a Scottish university of the work of Kepler, Galileo and Descartes’. He continued his researches while at St Andrews, remaining in touch with mathematical thought despite his remote location, chiefly through a detailed correspondence with Collins. Without it, he said, he would have been ‘dead to all the world’. Fifty-seven letters, mainly from Collins to Gregory, survive in the Special Collections of St Andrews University Library (SAUL). In 1932 it was realized that the blank spaces on some letters had been used by Gregory to work out mathematical problems. These notes shed light on his advances and methodology, and, according to Herbert Westren Turnbull, confirm his ‘right to take his place with Barrow, Newton and Leibniz as a principal discoverer of the differential calculus’. The manuscripts have been published, together with other correspondence and material relating to Gregory drawn from various sources, by Herbert Westren Turnbull in James Gregory tercentenary memorial volume (London, 1939).

Gregory’s novel teachings were not always welcomed by his less progressive colleagues at St Andrews, as he revealed in a letter dated 13 July 1675 to James Frazer in Paris:

The affairs of the Observatory of St Andrews were in such a bad condition; the reason of which was, a prejudice which the masters of the University did take at the mathematics, because some of their scholars, finding their courses and dictats opposed by what they had studied in the mathematics, did mock at their masters, and deride some of them publicly. After this, the servants of the Colleges got orders not to wait on me at my observations; my salary was also kept back from me; and scholars of the most eminent rank were violently kept from me, contrary to their own and their parents’ wills, the masters persuading them that their brains were not able to endure it. These, and many other discouragements, obliged me to accept of a call here to the College of Edinburgh, where my salary is near double, and my encouragements otherwise much greater.

Gregory was to spend just one year as the first holder of the Chair of Mathematics at Edinburgh before he was seized with blindness and died in late October 1675, aged 36 years.

Gregory ordered mathematical books and instruments through Collins, his conduit to the outside world. A ‘Catalogue of books bought by Mr Gregorie for the Observatorie’, which appears in a catalogue of the University Library at St Andrews compiled between ca. 1687 and 1695, lists dozens of works, mainly relating to natural philosophy, astronomy or mathematics. Even before the scheme to construct and equip the observatory was mooted, Gregory asked Collins to purchase instruments and apparatus on his behalf, for use in his teaching or research, sometimes to very detailed specifications, as on 15 February 1669, when he wrote:

I would have a quadrant after the enclosed fashion [diagram provided in original letter], made of jointed wood, with a brazen limb, and a ball and socket (or something else to turn
upon) in the centre of gravity, three feet in the radius (1.08 ball and three-footed staff) exactly, and as minutely divided as the quantity can suffer. I do not desire any other scales and divisions on it, save only a needle of a considerable length, for observing the declination of the same upon one of the radiuses or middle, as ye think most convenient. I would also have a chain, two good compasses, and a brazen sector. I desire to know the price of every one of these by themselves.

Collins responded on 15 March 1668/9 that the quadrant would cost £4 0s 0d, a ball and socket with a three-footed staff £1 8s 0d, a needle a foot long £1 0s 0d, two pairs of compasses £0 10s 0d, and a brass sector £1 5s 0d. It is not known whether Gregory confirmed the order for these particular instruments, although a sector, surveying chain and compasses appear on an inventory of ca. 1699. A letter from Collins detailing the route taken by a parcel containing various books and two glass prisms in 1672 shows that sending items from London to St Andrews was not a straightforward matter:

About the beginning of August last I sent by Bethel Broaderick a Carrier of Newcastle a Box directed to you, to be left with Mr Robert Kar a Merchant in Newcastle to be by him sent to Mr David Thompson Merchant in Edenburgh at the back of the Maine Guard to be by him transmitted to you . . .

Letters took about three weeks to travel between St Andrews and London. Sometimes a sea route was preferred for goods: in December 1672 Collins, hearing that the Earl of Kincardine was returning from London to Scotland and sending his own goods by sea, passed into his care a box containing a parallelogram, a ‘Dioptrick Lanthorne’ and yet more books, to be landed at Leith and again left for Gregory with David Thompson in Edinburgh.

There were obvious complications in obtaining instruments via a third party in London, especially to particular specifications. Yet as the manufacture of scientific instruments was not really established in Scotland until the early decades of the eighteenth century, Gregory had little choice. Bryden attributes this to the ‘poverty of scientific achievement in 17th century Scotland. The instrument maker’s trade could not become economically viable, except within an established framework of scientific endeavour which would provide a market for his goods and skills.’

Although Bryden recognized that Scotland had produced mathematicians with ‘international reputations’, namely Napier and Gregory, and ‘men of less standing’, such as the scholar Duncan Liddel (1561–1613) and the cartographers Timothy Pont (ca. 1565–ca. 1617) and Robert Gordon (1580–1661), who would have required instruments, there simply was not enough activity in scientific fields to support a native manufacturing industry in this period. In London, the mathematical instrument trade had been established in the mid sixteenth century. It was therefore to London that Gregory travelled in the summer of 1673 to select instruments and apparatus personally for the planned university observatory.

The scheme to construct the observatory may have been considered as early as July or August 1672. On 6 August 1672 Gregory wrote to Collins: ‘since my last to you, several gentlemen have fallen upon a method to gather contributions for mathematical instruments to the university of St Andrews, which may probably take effect. It is like upon this account that I may see you within a twelvemonth.’

On 13 May 1673 he told Collins: ‘I thought to have seen you before now, but some affairs of the university have delayed my journey for some weeks.’ On 10 June 1673 the university
formally issued the official commission cited above, confirming that an observatory should be built at St Andrews and instructing Gregory 'to goe for London, and there to provide, so far as the money already received from our Benefactors will reach, such instruments and utensils as he, with advice of other skilful persons, shall judge most necessary and usefull.'

It is clear from the terms of the commission that significant fundraising had already taken place towards the construction of the observatory and the acquisition of the instruments: ‘this our laudable designe hath already met with such considerable encouragement from persons of all ranks’ as to allow Gregory to begin his purchases. However, yet more funds were needed: ‘we ar not able to accomplish [the intended work] with the contributions of these only who have already listed themselves encouragers of it’, and Gregory was empowered to make ‘application unto all whom he knows to be favourers of learning, for their concurrence unto the advancement of the forsd. work.’

Though the names of the observatory’s benefactors do not survive, it is known from the Council Register of the Burgh of Aberdeen that as Gregory ‘wes ane touns man heir’, permission was granted on 15 October 1673 for ‘ane collection’ to be taken ‘at the Kirk dores’.

The commission of 10 June 1673 was signed by the most eminent figures in the university in this period: Walter Comrie and James Wemyss, Principals of St Mary’s and St Leonard’s Colleges, respectively; George Wemyss, Provost (equivalent to Principal) of St Salvator’s College; the Rector, Andrew Bruce; and masters including Alexander Skene, Provost of St Salvator’s College from 1680 to 1690, and William Saunders, Gregory’s successor in the Regis Chair. It sets out the reasons why the university considered it desirable to purchase instruments and establish an observatory:

For as much as we having formerly taken to our serious consideration the great detriment and losse this ancient seminary hath been at in times past, and doeth yet sustain by the want of such proper and necessary instruments and utensils as may serve and conduce for the better, more solemn, and famous profession, teaching, and improving of naturall philosophy and the Mathematicall sciences, and especially for making such observations on the heavens and other bodys of this universe ... whereby we may be enabled to keep correspondence with learned and inquisitive persones in solid philosophy every where ... And having purposed ... to set as effectuall as may be about this laudable and necessary work, for providing the forsaids instruments of all kynds, ane observatory, and all other accoutrements requisite for the improvement of the forsaid sciences, the benefite, advantage, and delight of youth to be trained up here, the honour of the kingdom, the reputation of our benefactors, and the lustre and splendour of the University ...

From this, various points can be ascertained. The university has not owned many, if any, scientific instruments before Gregory’s time. It declares that it is keen to improve its standing, both in teaching and contributing to progress in (‘improving of’) ‘naturall philosophy and the Mathematicall sciences’. It also desires the status that such improvements will bring, adding to its ‘lustre and splendour’, confirming its important and powerful position within the kingdom as an upholder of the ‘honour’ of Scotland and asserting its international standing, as an institution that can correspond with ‘learned and inquisitive persones in solid philosophy every where’. The developments will not only prove advantageous to the university’s students, but also ‘delight’ them, and will be sufficiently splendid and successful as to enhance the reputation of the university’s benefactors; that this might attract more students to St Andrews and encourage more benefactions cannot have escaped the university’s notice. The university was, it seems,
well aware of the potential power of the instruments and observatory as visible symbols of its learning, status, and interest and influence in the rapidly developing scientific fields. Its observatory was to be not only the first in the British Isles (that at Greenwich was not founded until 1675) but also a model of the best in the world, being based on close observation ‘of the fabrick and forme of the most competent observatorye, that ours here intended may be builded with al its advantages.’

Through Collins, Gregory sought the advice of John Flamsteed (1646–1719), later the first Astronomer Royal at Greenwich, regarding equipment for the St Andrews observatory. Flamsteed recommended that he purchase a metal wall quadrant, 8 feet in radius, and two sextants of the same radius, all with ‘telescopes and threeds’; telescopes of 2, 3, 7, 14, 30, 40 and 50 feet in length, to be fitted with micrometers for measuring distances; an ‘Armilla ’ as described by Tycho Brahe (1546–1601); and

two pendulum Clocks which may shew the houres minutes and seconds therei swinges so long as to vibrate no more then seconds. I thinke it were more convenient to have them onely of the watch part to shew the hower, least the strikeing part disturbe the equall motion.

In Gregory’s response to Flamsteed, dated London, 19 July 1673, he explains that, although he would indeed like to acquire an 8-foot wall quadrant, ‘the walls of our Observatorye being already built in the top of one of our Colledges can admit none such; seeinge they decline considerably from the meridian; the mater of 9 or 10 degrees.’ He goes on to describe the structure of the observatory building in great detail:

We have alreadye a Room 3 Storeys high, declininge in the length of it some degrees from the meridian. The rest of the Colledge is betwixt it and the North, it hath the Horizon free upon the South; East and West, onelye some little Mountains at some Miles distance. Of this (beinge as we all judge the fittest Place and least Expence) we are resolved to make our observatorye. It is length 59 Feet, in Breadth 26. We were judging ourselves, that the roof should be Taken of; and the walls heighted above the Floor 13 foot; and then a Platforme to be put on. And then toward the North part of it A Chamber should be taken of 20 foot Square; Leavinge by the one side a Entrance 6 foot broad and 20 Longe to Enter the observatory which at this rule, is 39 foot longe and 26 broad. We would have it have 6 Windows, 2 on Each Wall, at aequall distances from the Corners of the observatory, and from each other. Each Window should be 4 foot from the floor, 3 foot broad and 9 high to the Platform.

This description indicates that the observatory is to be established through the conversion of an existing building. The account of the walls of the observatory as being already built ‘in the top of one of our Colledges’ may imply that just the top floor of the building ‘3 Storeys high’ is to be used for the observatory, or may refer to the position of the building in the college grounds, ‘in the top’ of the College meaning ‘at the far end’ of the grounds of St Mary’s College, where the observatory is known to have stood. Certainly, Gregory’s description of the position of the observatory, ‘The rest of the Colledge is betwixt it and the North, it hath the Horizon free upon the South; East and West’, accords with a position within or just outside the south boundary of St Mary’s College. The building is described by Kirk in 1677 as ‘Upon the outside of the [St Mary’s] College Walk’, by Macky as ‘at the bottom of the Garden’ of St Mary’s College, and by Pococke as ‘beyond this College [St Mary’s]’, and is marked in this area on a map of 1802 published in Grierson’s Delineations (1823). A tall square building three storeys high with a flat roof
is shown at this location in an engraving of St Andrews in Slezer’s *Theatrum Scotiæ* (1693 and 1718) (figures 1 and 2). Although the engraving records three, not two, windows on each storey on the south side and two on each floor on the east side, there can be little doubt that the building depicted is the university observatory.³⁹

Gregory’s letter to Flamsteed does reveal that he is having a quadrant made in London of 4 feet radius, and has been given one by the Duke of Lauderdale (John Maitland, 1st Duke of Lauderdale, 1616–82) of 2 feet radius. Gregory tells Flamsteed that he is interested in purchasing a telescope of 100 feet and another of 50 feet made by ‘Mr Cock’ (Christopher Cock of London, fl. 1660–96). He is concerned that he may not have sufficient funds for ‘Tychos-Armillae’, and worries that it would not be easy to carry one to Scotland ‘unspoyled’. In deference to Flamsteed’s advice, he wrote:

> I have 2 Pendulum Clocks makinge, with longe Swinges, Vibratinge Seconds; and Pointinge Hours, Minits and Seconds, without Strikinge; And also one little Pendulum Clock, with a Short Pendulum, vibratinge 4 times in a Second, alseoe without Strikinge; for discerninge small Intervalls; when there may be a pointe of a Seconde in Question.⁴⁰

These clocks, made by the renowned clockmaker Joseph Knibb of London (1640–1711) less than two decades after Christiaan Huygens had completed the first working pendulum clock in 1656, remain in working order in the university to this day. The two larger clocks are a pair of long-case regulators, used to monitor time accurately. The little clock (figure 3) may be the earliest split-seconds pendulum clock in existence: it beats three times a second, not four. It was originally a bracket wall timepiece; a narrow-waisted trunk was added some years after its construction but was removed in the second half of the twentieth century.⁴¹ Flamsteed wrote back to Gregory: ‘Your Pendulums you will...
finde exceedeing usefull, but not for Measureing small distances, in which I am confident they will not performe neare soe exactly as the Micrometer.\textsuperscript{42}

Some documentary evidence survives of what other instruments Gregory purchased for the University of St Andrews; however, it is frustratingly sparse. He apparently enquired about obtaining a parallelogram in 1672; on 16 July Collins wrote to inform him that Mr Bedford (Hilkiah Bedford, \textit{fl.} 1660–80) ‘a Mathematicall Instrument Maker’ had made one priced £3; on 6 August Gregory revoked the order in anticipation of his visit to London. On 23 September he asked Collins to ‘send to me the lantern for projecting the species’. Also on 23 September Collins wrote to Gregory:

You may expect another Box containing a very good ordinary Parallelogram which Mr Sinclair bought for 40 shillings whereas they are commonly sold for £3, so you shall not feare to loose by it, if upon your bringing or sending it up you are minded to part with it, and the Diopticall Lanthorne and figures you writt for, which will cost about £3 more, I have them of Cox [Christopher Cock] the glasse grinder . . .

On 8 November 1672 the ‘Parallelogram and Diopticall Lanthorne’ had still not been dispatched, because neither ‘Cox’ nor Collins had been able to procure any glass figures for the lantern: ‘Dutton [Richard Dutton of London, \textit{fl.} 1663?–82] the sole Glasses Painter we have, hath promised to furnish such as shall be bespoke’ a month after Christmas. The instruments were received by Gregory via the Earl of Kincardine’s shipment by 7 March 1673, when he declared himself ‘well pleased’ with them; the glass figures arrived by 13 May.\textsuperscript{43}

Regarding his instrument purchases in London during the summer of 1673, Gregory wrote to the Reverend Colin Campbell:
Figure 3. Split-seconds clock by Joseph Knibb, London, 1673. PH208, Museum Collections, University of St Andrews. (Copyright © University of St Andrews.) (Online version in colour.)
It were tedious to write down particularlie all the instruments I have brought home, yea a larger letter wold not contain all ther names & sizes, for I have all sort: our largest quadrant is of oak, covered with brasse, 4 foote in radius and actually divided in minutes, of which we can judge $\frac{1}{3}$ or $\frac{1}{4}$: we have two semisextans all of brasse, 6 foot in radius, diagonally divided, in which we can judge $\frac{1}{6}$ or $\frac{1}{7}$ of a minut. our largest telescope is 24 foot longe; which magnifies one dimension of the object 100 times.

Letters from Collins on 12 January and 5 March 1673/74 reveal the acquisition of a dipping needle, possibly made by Henry Wynne (fl. 1654–1709), and that Mr Shortgrave (probably Richard Shortgrave, fl. 1658–76, or his son Thomas, fl. 1674–80) had been commissioned to produce ‘glasses’ for Gregory, for what purpose is not known. It is unfortunate for the study of scientific instrument manufacture and exchange that Gregory was not more forthcoming to Campbell regarding his acquisitions. Frustratingly, both Gregory and Collins apparently failed to respond to Flamsteed’s repeated requests, of 20 August, October/November and 27 December 1673, to list what ‘instruments and bookes’ Gregory ‘tooke into Scotland’.

In addition to the Knibb clocks, various instruments survive in the University of St Andrews that are now generally assumed to be associated with James Gregory and the fitting out of the observatory. These include an astrolabe by Humphrey Cole, 1575, now widely known as the ‘Great Astrolabe’ (figure 4); a universal instrument by Humphrey Cole, 1582 (figure 5); a mariner’s astrolabe by Elias Allen, 1616; and an early-seventeenth-century Dutch circumferentor, all of which were manufactured a considerable time before the observatory was conceived. There are also some roughly contemporary instruments: a sundial, in the form of Oughtred’s double horizontal dial, by Hilkiah...
Bedford; an horary quadrant, of the form described by William Leybourn in *Panorganon, or a Universal Instrument* (London, 1672); and a parchment refracting telescope, stylistically of this period, now without its lenses and mountings.

Three of the earlier instruments are prestige pieces. Humphrey Cole (ca. 1530–1591) was the pre-eminent instrument maker of the Elizabethan period.\(^{47}\) In 1576 he provided instruments for Martin Frobisher’s first voyage in search of the northwest passage to China. The ‘Great Astrolabe’ has been widely hailed as his ‘masterpiece’.\(^{48}\) Only one of its three original plates survives, for a latitude of 52° 0’ (central England), together with another inscribed ‘John Marke fecit’ for a latitude of 56° 25’, close to that accepted for St Andrews in this period. Given that John Marke was active as an instrument maker in London ca. 1665–79, it is highly likely that Gregory commissioned him to make this second plate.\(^{49}\) A miniature version of the ‘Great Astrolabe’ made by Cole in 1574 seems later to have belonged to Henry, Prince of Wales (1594–1612).\(^{50}\) The universal instrument is an unusual piece that allows the celestial coordinates of a heavenly body to be determined in both horizontal and equatorial coordinate systems.\(^{51}\) It is thought to be an extremely rare surviving example of a type of instrument described by Martín Cortés in *Breve Compendio de la Sfera y la Arte de Navegar* (1551).\(^{52}\) The mariner’s astrolabe is a relatively rare extant example of a navigational instrument ‘Employed on every ship from the fifteenth to the seventeenth century for the determination of latitude’.\(^{53}\) This example made by Elias Allen (fl. 1606–54) is of particular interest, being of exceptional weight (7.7 kg). These three instruments are described in various publications and exhibition catalogues.\(^{54}\)
It may be that all the instruments noted above, including the non-contemporary Cole and Allen pieces and the circumferentor, were purchased by Gregory in London, because the second-hand instrument trade was well established by this period. The universal instrument is similar, although not identical, to the ‘Armillae Aliae Aequatorial’ as described by Brahe in his *Astronomiae instauratae mechanica* (Wandsbeck, 1598): perhaps Gregory decided to take Flamsteed’s advice on obtaining ‘Tychoes-Armillae’, and this was the best option available. However, like Lauderdale’s quadrant, the older instruments may have been presented to the university by a wealthy patron keen to support the observatory initiative. Although there is no documentary evidence to support their acquisition by the university in the 1670s, the balance of probabilities is that this is the earliest, and most likely, period in which they were obtained, the drive to equip the observatory providing the impetus for significant purchases and donations. An extant undated seventeenth-century dip circle, inscribed ‘Ex dono Archebaldi Areskine Armigeri Londini’, indicating that it was presented by Archibald Erskine, Esquire, may likewise have come to the university at this time. Certainly it does not seem that the university was actively acquiring pieces as fine and expensive as the Cole instruments at the time of their manufacture. In 2006 Allen Simpson (retired curator of science and technology, National Museums of Scotland) made the suggestion to me that the Cole and Allen instruments and the circumferentor may have come to the university as a group at the time of the visit of James VI to Scotland in 1617, through Sir Archibald Napier (son of the mathematician John Napier), who coordinated the tour; this idea is particularly intriguing in view of the connection of the miniature of the ‘Great Astrolabe’ to James VI’s son, Prince Henry. However, although James VI certainly visited St Andrews, on 11 July 1617, and was ceremonially greeted by the university Rector and presented with a volume of poems lauding his reign, there is no evidence that a reciprocal gift of instruments was made. The university had carefully catalogued a gift of 228 books sent by James VI and his family in 1612 to establish the University Library. Although information may have been lost from the university’s records, which are incomplete for this period, it seems likely, if the university had obtained such magnificent instruments from such a source, that this would have been mentioned in the commission of 1673, to encourage other benefactors to align themselves with this royal munificence.

Gregory’s correspondence from his time at St Andrews provides evidence of his dealings with the London instrument makers Christopher Cock, Hilkiah Bedford, Richard Dutton, Henry Wynne and Richard Shortgrave while Professor of Mathematics at St Andrews, while the extant clocks attest to his relationship with Joseph Knibb. Once removed to Edinburgh, he ordered, via Collins, a microscope from ‘Yarvill’ [John Yarwell, 1648–1712], and a ‘plaine table from ‘Mr Marke’ costing £3 10s 0d. This last establishes Gregory’s connection with Marke, as already suggested by the new plate for the astrolabe.

**INVENTORIES OF INSTRUMENTS, CA. 1699–CA. 1718**

Four extant manuscript inventories of scientific instruments, made between *ca.* 1699 and *ca.* 1718, provide further hints of Gregory’s acquisitions, although because these are not differentiated from material acquired later it is impossible to be categorical about which items he purchased, except where other evidence survives. Given their importance as indicators of the range and scale of instruments owned by the university in this period,
these previously unpublished inventories are given in the Appendix.\textsuperscript{59} The earliest inventory, ‘A note of things wanting in of Instruments as received by Mr Henry’, probably dates from 1699. A second document, ‘The Instruments that are wanting or broke in Mr Henrys time’, must date from 1699 to \textit{ca.} 1702. To the same sheet of paper bearing the earliest inventory there has been added, in another hand, a list of ‘The Instruments that are wanting or broke in Mr Crie’s time’, produced in \textit{ca.} 1702–1718.\textsuperscript{60} James Henry and John Crie were the University Librarians from 1699 to 1702 and from 1702 to 1718, respectively; these inventories indicate that the instruments remained in the Library, as they had in Gregory’s time.\textsuperscript{61} They note only pieces that have been lost or damaged. From the earliest inventory we learn that ‘The Images of ye Magick Lanthorn [are] altogether wanting’, ‘The broken Prism [is] awanting’, and ‘the frame of ye dipping needle is as formerly, but ye needle is awanting’. This may relate to the dipping needle, a prism and the figures for the ‘Dioptrick Lanthorne’ bought by Gregory. Losses have occurred to compasses and a surveying chain, perhaps those for which Gregory requested prices on 15 February 1669. A ‘gilded [past]board telescope [possibly the extant parchment telescope] wants all ye glasses save ye eye glass and a plain glass put in for ye object glass.’ On the inventory of ‘The Instruments that are wanting or broke in Mr Henrys time’ is recorded ‘The Large Astrolabe broke’ and ‘the glasses of the dipping needle broke’.\textsuperscript{62} Various instruments known or thought to have been purchased by Gregory appear on the more comprehensive ‘Catalogue of ye Clocks, mathematical instruments & others in ye publick Library’ pasted into the back of a catalogue of the books of the University Library produced in \textit{ca.} 1714–16; it is probably to be associated with the catalogue of instruments for carrying on a course in Experimental Philosophy given in to the Senate on 18 February 1715.\textsuperscript{63} Like the University Library catalogue of \textit{ca.} 1687–95, this Library catalogue contains a ‘Catalogue of Books bought by Mr Gregorie for the Observatorie’; unfortunately no such distinction is made for Gregory’s instruments, which are simply subsumed into the list of all scientific apparatus in the Library by this date. This inventory is torn down the left side, with some loss of text. The three pendulum clocks are recorded, together with the ‘[Diopti]ck Lanthorne with the Glasses that goe into it whereof three are wanting’; a ‘large Quadrant and another [lost]’ (perhaps that of 4 feet radius purchased by Gregory and the other of 2 feet radius given by Lauderdale); and ‘A large Astrolabe’. This is presumably either the Cole or Allen astrolabe; it is curious that only one astrolabe is mentioned, and this may indicate that, in fact, the Allen astrolabe had not yet been obtained. The universal instrument is perhaps indicated by the word ‘Sphere’ preceded by missing text due to a tear, possibly ‘Armillary Sphere’ was intended; or alternatively, perhaps a ‘Copernican sphere’, which the university attempted, possibly unsuccessfully, to obtain between 1710 and 1714.\textsuperscript{64} Four telescopes are listed. One of ‘24 foot with its case’ presumably indicates ‘our largest telescope … 24 foot longe’ described by Gregory to Campbell. The others are of ‘kane’, ‘hazel’ and ‘parchment’, the latter probably the one extant. The Hilkiah Bedford sundial would not have appeared on this list: it stood in St Mary’s College garden until knocked off its plinth by a bomb blast on 25 October 1940.

\textbf{Gregory’s departure from St Andrews and the fate of the observatory}

Although a comprehensive list of the instruments obtained for the observatory cannot now be established, clearly the venture involved significant expenditure. Malet’s research shows that
in 1670 Reeve was charging £45 for a 50-foot telescope, and a good pendulum clock could cost more than £100.\textsuperscript{65} It seems perverse that although the improvement of the subjects of natural philosophy and mathematics had received such evident support from the university, Gregory felt his work so slighted by his colleagues as to force him to resign his chair and move to Edinburgh. Undoubtedly his time in St Andrews involved frustrations. His observations of the eclipse of 9 April 1670 were prevented by ‘a great fall of snow’\textsuperscript{66}. He told Collins on 17 May 1671 that he was troubled ‘with great impertinences’, being forced to resolve ‘doubts which some gentlemen and scholars propose to me … all persons here being ignorant of these things [his work] to admiration’. This prevented him from spending time on his own researches, yet in the same letter he declared his determination to ‘rest contented’ with his situation.\textsuperscript{67} However, hindrances continued to annoy him: on 30 April 1674 he wrote to Colin Campbell:

> As for observations or experiments, I dar hardlie promise anie considerable, befor the observatorie be builded: seing (whill the instruments ar keeped in the bibliothec, wher I cannot be alon or with my own companie and convenience) it is hard if it be at all practicable to doe anie thing seriously & with exactness.\textsuperscript{68}

Unfortunately there is little extant evidence, beyond Gregory’s vitriolic letter to Frazer, to explain why his relations with the university’s other masters suddenly broke down so irrevocably.

It is clear that with Gregory’s departure the observatory initiative foundered. Indeed it is likely that the creation of the observatory, with its opportunities for research and the exchange of ideas with learned persons, was primarily Gregory’s scheme, with the university tempted along by the prospect of glory and eminence. On 19 July 1673 Gregory had written to Flamsteed: ‘There are none understandinge of these things here, of whom I have yet heard, that Ever did see an Observatoire Compleat in their life.’\textsuperscript{69} Gregory’s successor, William Saunders (1674–88), whom he referred to as ‘very knowing in the mathematics’, obviously took some pride in the recently acquired instruments, showing them to Kirk.\textsuperscript{70} However, the observatory seems never to have been brought into working use. Loveday, who visited St Andrews in 1732 and was shown round the university by the librarian, recorded ‘As I can understand, ye Mathematical Observatory built for Gregory … was never compleated, as he left ’em.’\textsuperscript{71} The disintegration of the observatory building can be traced through the Senate Minutes of the eighteenth century. In June 1705 and again in June 1713, orders were given for the ‘iron stenchers’ to be removed from the windows of the lower storey and the windows built up with stone and lime. The work, which was to have been funded by the three colleges equally, does not seem to have been done, because on 10 June 1729 it was minuted that ‘the lower windows of the observatory, being all open, Children have access to go in to it, and are in danger of being hurt, by reason of the rottenness of the floors.’

Orders were again given, carried out by 1736, for the windows to be closed up with stone and lime. On 22 November 1736 it was recorded that the lead and timber from the observatory had been sold at roup (public auction), fetching £586 10s 0d Scots. By 1751 the observatory building had become so alienated from the university that the Senate had to check whether the university even owned title to it. Finally, on 17 October 1761 it was decided that, with widening cracks in the west and south walls, all faulty parts of the building should be taken down.\textsuperscript{72} Some remains seem to have survived until 1846, when the road by which it stood, now Queen’s Terrace, was widened under Provost Playfair.\textsuperscript{73}
TEACHING AND INSTRUMENT ACQUISITIONS AFTER GREGORY’S TIME

Gregory’s teaching of the new mathematical ideas did leave a legacy. They are apparent in the 1674 graduation theses of students, and through his successor Saunders they were passed to the next generation of scholars, such as Alexander Cockburn, whose theses of 1679 demonstrate a knowledge of Newton’s work. Records of the Chair of Mathematics are patchy from 1690 until 1707, when the Professorship was given to Gregory’s nephew Charles Gregory (1707–39). In 1695, when the Commissioners visiting the university laid down ‘That every year the regents of the said several classes be obliged to teach to their students some Rudiments of the Mathematics’, St Salvator’s and St Leonard’s colleges were able to confirm that this, at least, occurred.75

There are few records of instrument acquisitions in the 40 years after Gregory’s departure. In 1710 the university purchased a celestial and a terrestrial globe, each 16 inches in diameter, to be held in the University Library with the Knibb clocks and other scientific instruments, as the apparatus of intellectual enquiry. The next great impetus for the acquisition of instruments seems to have come in February 1714 when the Senate approved ‘the proposals for purchasing Instruments for carrying on a course of Experimental Philosophy’, taught by Charles Gregory. The Senate Minutes record that an annual course is to be established to reflect ‘the great Improvements that have been made of last years in natural philosophy & ye mixt parts of Mathematics chiefly by means of Experiments’, and so requires the acquisition of new ‘Instruments and Machines’. Some of Gregory’s instruments had, of course, been damaged, and others may have been regarded as old-fashioned or obsolete by this period. The appeal to contribute to the instrument fund was issued to ‘all Noblemen and Gentlemen to whose Patronage Learning belongs’; subscribers were to be allowed to attend the course free of charge. The St Andrews scheme was probably inspired by the ‘course of experiments’ initiated at Glasgow in 1712–13, for which an appeal to purchase instruments by voluntary subscription had also been launched. Like the Glasgow course, it was ‘extra-mural’ in that it was aimed at people beyond the student ranks. It may not have been immediately successful, and possibly only a few instruments were obtained: the proposal was effectively reissued, with the same appeal for instruments, by St Salvator’s College in the mid 1720s, the period in which fixed professorships in Natural Philosophy were established at both St Salvator’s and St Leonard’s colleges. Resolutions passed by St Leonard’s College on 23 May 1726 concerning the teaching of ‘Natural Philosophy in all its parts, particularly Mechanics, or, the Laws of Motion, Hydrostatics, Optics and Astronomy’ to the Magistrand (final-year or masters) class note that the lack of a dedicated master and few ‘Instruments for making Improvements in Natural Philosophy, and demonstrating it by experiments’ had suppressed class numbers. It was agreed that David Young would from 1 November 1727 be appointed to teach the course, while attempts would be made to secure subscriptions for an instrument fund.80

The acquisition of instruments continued sporadically throughout the eighteenth century. In 1736 David Young sought advice from Colin Maclaurin, Professor of Mathematics at Edinburgh University, over the purchase of a reflecting telescope. Maclaurin recommended James Short of Edinburgh (1710–68), who was to become the outstanding telescope maker of the eighteenth century. The extant telescope arrived by June 1737. Short made improving modifications to it in 1741 (at his own expense) and 1749–50. The purchase was funded by money from the sale of the lead from the observatory.81 An
extant orrery made by Benjamin Cole of London in ca. 1750 was probably also obtained during Young’s tenure.

**THE MERIDIAN LINE IN THE UNIVERSITY LIBRARY**

On 14 September 1748, David and John Young represented to the University that they had taken the opportunity of bringing along with them from Edin’ one Mr Thos. Short Instrument maker to fix a meridian line for this place & had caused him make Some Instruments for the University to be kept for that purpose.82

It seems to have been in this year that the meridian line that runs through the University Library, and is marked on its floor, was laid down. From at least 1823 onwards, this line, and the extant bracket for supporting a telescope or other instrument that is mounted on the exterior wall of the south-facing library window through which the line runs, has often been said to have been associated with James Gregory, but there is no evidence that this was so.83 Thomas Short, who practised as an instrument maker in Edinburgh and Leith from about 1737, was the brother of James Short and in 1776 founded Edinburgh’s Calton Hill Observatory.84 The Senate Minutes of 28 September 1750 reveal that Thomas Short was also responsible for ‘the supporters to the transit Telescope in the north [sic] Window of the Library’, which cost £2 2s 0d:

As to the supporters of the transit instrument, they are a part of the work which the university by their Act of 14 September 1748 had approved of being done, not being finished when Mr Short was called home these supporters were sent from Edinburgh about three months after.85

Short seems also to have set up two poles marking the meridian line on Scoonie Hill, to the south of St Andrews. The Senate Minutes of 17 March 1755 record:

It being represented to the meeting that the two poles that were set up on the top of the hill South from the town for the meridian of the telescope and transit instrument are fail’d and frequently beat down by the Wind, and that it would be proper two Stone pillars should be set up in their place.

One of these pillars survives, although possibly not in its original position.

**CONCLUSION**

Although the plan to establish an observatory in St Andrews under James Gregory ultimately did not come to fruition, the ambition of the scheme, as demonstrated by the instruments and particularly the observatory building, was noted by visitors to St Andrews in the late seventeenth and early eighteenth centuries and featured in their accounts of the town. In the eighteenth century it was to be the University Library, of which Gregory had complained that while the instruments were kept there ‘it is hard if it be at all practicable to doe anie thing seriouslie & with exactness’, that became the centre of mathematical and astronomical work in the university. The instruments remained in the Library, with other valuables of the university also held there for security, and by the 1730s the Senate
Minutes show that the Knibb clocks had become generally known as 'the Library clocks'.\textsuperscript{86} The clocks retained a scientific function: they were used by David Young and Charles Gregory during their observations of the solar eclipse on 18 February 1737.\textsuperscript{87} St Andrews is not the only university in Scotland to have built up collections of instruments from a relatively early period. It is, however, unusual for the number of early pieces that remain extant.\textsuperscript{88} Gregory’s reputation, the university’s pride in its association with him, the magnificence of the extant early instruments and their expense may all have influenced their retention, long after they became obsolete for teaching purposes. The inventories preserved in the university archives provide important documentary evidence of what instruments the university held in particular periods, and their condition. The fate of some of the earlier instruments can be traced through later inventories, which themselves provide key information on the development of the instrument holdings, in particular that prepared by George Rotherham, Professor of Natural Philosophy from 1795 to 1804 ‘in the week after his admission’, which records more than 200 instruments and pieces of apparatus held at that date; and also the catalogue of apparatus provided by William Swan, Professor of Natural Philosophy from 1859 to 1880, on his retirement.\textsuperscript{89} Today, the Collection of Historic Scientific Instruments of the University of St Andrews contains more than 1000 instruments obtained for teaching and research purposes from the seventeenth to the twentieth centuries; collecting is ongoing; and the importance of the Collection is acknowledged through its status as a ‘Recognised Collection of National Significance’, the Scottish equivalent of the ‘Designation’ scheme in England’s museums. Broad information on the Collection is available online via the university’s website and Culture Grid; individual catalogue records for objects are due to appear on both sites during 2015.\textsuperscript{90} It is in the instruments thought to have been acquired by Gregory that the foundations of the collection lie, just as the shift in mathematical teaching in St Andrews from medieval precepts to modern scientific thought lay with Gregory.

\textbf{APPENDIX. INVENTORIES OF SCIENTIFIC INSTRUMENTS HELD IN THE UNIVERSITY LIBRARY, ST ANDREWS CA. 1699–1718}

\textit{St Andrews University Library (SAUL), UYUY459 Box A/6}

\textbf{‘A note of things wanting in of Instruments as received by Mr Henry’, ca. 1699}

The Images of ye Magick Lanthorn altogether wanting
Of the two Celestial & two terrestrial globs there is only ye remains of one terrestrial, & a broke Meridian of another
The gilded \textsuperscript{[past]}board telescop wants all ye glasses save ye eye glass and a plain glass put in for ye object glass; and ye case of ye eye glass broke off from ye frame
The kane telescope is intirely broke
The frame for mounting the telescope is broken
Of the Iron chain for measuring ground there are but thirty links
Only one glass recipient intire; and two broke
Of four lead weight one is awanting
The glass tubs are all broke
Of the four pairs of \textsuperscript{[indecipherable]} compasses there are two wanting & one broke.
All the capillary tubs broke
All the glasses in the little wooden box are awanting but three, & these are broken.
The broken Prism awanting
The frame of ye dipping needle is as formerly, but ye needle is awanting
The gilded case of one of ye Sectors is awanting
The little Microscope broken
One brass planetsphere awanting
[In another hand]
The celestial globe wanting

[On the opposite (left) page to this inventory is written in another hand]:

‘The Instruments that are wanting or broke in Mr Crie's time’, ca. 1702–1718
The gilded pastboard telescope [rendered] useless and spoilt
The case of the hazle cane telescope broke
The object glass of the cane telescope lost
Only Thirty links of the surveying chain remaining
Three recipients either broke or lost
Two pair of small compasses lost and one pair broke
The needle of the dipping needle lost
A gilded case of one of the sectors lost
The small microscope broke

SAUL, UYUY459 Box A/6

‘The Instruments that are wanting or broke in Mr Henrys time’, ca. 1699–1702
The hazle cane telescope lost all its glasses
One of the handles of the semisextant broke
The staves of the surveying chain lost
The bottle for the Artificial Rainbow broke
The Multiplying glass lost
The Large Astrolabe broke
The whole prism crackt
The brass syringe broke
The glasses of the dipping needle broke
A Brass Square wanting
The Micrometer broken
The Compass of the plain table lost

SAUL, UYLY105/3

Catalogue of the University Library, St Andrews, ca. 1714–16
[The first part of the catalogue appears largely to be an amended copy of UYLY105/2, the University Library catalogue produced ca. 1687–95. Books acquired 1703–14 are then listed, followed immediately by a list of objects in the library, p. 33]:

The Sceleton with an Inscription relating to it
The Globs, Celestial & Terrestrial, with the two boxes to keep them in, with their appartenances, viz. The Circule Horari [ ]xis Nautica, Semicircular positionis & Quadrant altitudinus
Note: The Library Keeper is not to allow ye use of ye Globs & pertments to any Person without the outer gate of ye Parl. Hall [Parliament Hall, earlier known as ‘the public school’, directly below the Library]
A Copperplate of ye wonderful preservation & deliverance of David Bruce & six other young Lads with him &c Given to the Library by Robert Bruce Goldsmith in Edin
[Then follows a list of books added up to May 1716. Pasted in near the end of the volume, p. 41, is the following catalogue, torn down the left side with some loss of text.]

‘[ ] Catalogue of ye Clocks, mathematical instruments & others in ye publick Library’
[Pe]ndulum Clocks whereof two have long & the third a short pendulum
[Di:o]ptick Lanthorne with the Glasses that goe into it whereof three are wanting
[Ce]lestial and Two Terrestrial Globes
[ ] Boyliana
[ ] large Quadrant and another loss
[ ] Sphere
[Te]lescope of 24 foot with its case
[ ] other Telescopes where of one is of kane, ye other of hazel, & ye third of parchment of a considerable length
[ ] frames for Telescopes
[ ] [B]aroscope
[ ] broken Thermometer
[ ] Staves and a chain of Iron with two pieces of Iron for measuring the ground
[ ] five Iron nails and other little pieces of Iron belonging to the larger Instruments
Two brass segments of Circles
The Condensatory pump with the shuttle iron wanting one of it’s Glasses
Five Recipients whereof one is broken
Four lead weights
[ ] Bottle for Artificial Rainbow
A Barometer with a broad and lead for an Index
A Case for a Barometer
Twenty eight Glass Tubes
A Multiplying Glass
A Sphere of the planets
A Hemisphere for Measuring of Angles
[ ] made with a covering of Glass in a brass Case
A large Astrolabe
A microscope wanting the objective Glass with the frame of it
One pair of large Compasses
[ ] pair of lesser ones
[ ] capillary Tubes inclos’d within a larger Tube
[ ] Instrument folding several ways
[ ] small Glass Tubes whereof the greatest part are broken and inclos’d in a little wooden box
A broken prisme and a whole one
A brass Syringe
A round brass needle inclos’d in a rod leather case
A brass dyal
A brass Square
Eight ocular Glasses lying out of the Instruments
A brass Ring-dyal
A brass Square
pieces of [long blank space] wood
[little] Tubs with 3 needles in them all in a little wooden box
[Se]cticar with a gilded case and one without a case
Instrument for dividing an Inch in many pieces
piece of an unpolished Loadstone
Fifteen screw nails and six pieces of brass with a large screw nail
A brass circle with an Index for measuring angles of Altitude
An unpolished Loadstone
A plain Table with it’s Fulcrum and sights
[ ] Protractor
A little Microscope
Another brass planets-sphere
A polished loadstone

NOTES

1 P. Hume Brown (ed.), Tours In Scotland 1677 & 1681 by Thomas Kirk and Ralph Thoresby (D. Douglas, Edinburgh, 1892), p. 18. The Professor of Mathematics at this date was James Gregory’s successor, William Saunders (1674–88).

2 The commission is published as ‘Commission, University of St Andrews to Mr James Gregory, Professor of Mathematics, 10th June 1673. From the Original’ in Archaeologia Scotica, vol. 3, pp. 285–286 (1831) and in Herbert Westen Turnbull (ed.), James Gregory tercentenary memorial volume (G. Bell & Sons Ltd, London, 1939), pp. 273–274.

3 Kirk recorded ‘we went to New College, or Mary’s College . . . . In this College is a public room for university exercise; in a room here are kept some mathematical instruments . . . .’ The university building consisted of the University Library on the upper floor, where Gregory is known to have been based for at least part of his time in St Andrews, and the ‘public school’, which was occasionally used as an exercise room for the students, on the lower floor. Although it belonged to the university as a whole, it was commonly misassociated with St Mary’s College in the accounts of visitors, as a result of its proximity to the college grounds.

4 John Slezer, Theatrum Scotiæ (London, 1718), p. 18. The same reference appears in the 1693 edition, the text for which is thought to have been produced for Slezer by Robert Sibbald (information on, and the text of, the 1693 edition is from the National Library of Scotland: http://www.nls.uk/slezer/index.html).


7 Macky, op. cit. (note 6), p. 89.

8 Published in Reverend James Grierson, Delineations of St Andrews, 2nd edn (Cupar, 1823).

9 Translated from the Latin in William Knight (ed.), Andreapolis: being writings in praise of St Andrews (D. Douglas, Edinburgh, 1903), pp. 7–8. Jaspar Laet de Borchoelen was the author of De Eclipsi Solis Anni MCCCCXCI currentis Pronosticum (1491).


13 The extracts of records of the 1574, 1579 and 1588 Visitations are contained in Evidence, Oral & Documentary, Taken and Received By the Commissioners Appointed by His
Majesty George IV, July 1826 and reappointed by His Majesty William IV, October 12th 1830 For Visiting the Universities of Scotland, vol. 3 (St Andrews) (London, 1837): citations from pp. 188 and 194.

14 Edinburgh, Advocates Library, ms29.27, Balcarres Papers, VIII, 150r. I am indebted to Steven Reid for providing this reference.
15 Cant, op. cit. (note 11), pp. 44–45.
17 Vera circuli et hyperbolae quadratura (Padua, 1667), in which Gregory developed algebraic sequences for determining the area of central conics by convergent series, and Geometriae pars universalis (Padua, 1668), which is concerned with problems of geometrical transformation.
19 JGTMV, p. 9 and Cant, op. cit. (note 11), p. 45.
20 JGTMV, p. 9.
21 SAUL, ms31009.
22 JGTMV, p. 13.
23 Gregory to Frazer, Edinburgh, 13 July 1675: JGTMV, pp. 311–312.
24 SAUL, UYLY105/2, p. 34. Antoni Malet, op. cit. (note 18), p. 84, provides the analysis of the types of book.
25 Gregory to Collins, St Andrews, 15 February 1669, and Collins to Gregory, London, 15 March 1668/9: JGTMV, pp. 69–71. In manuscript, Collins’ reply actually bears the date 1668/9: in Scotland, as Collins was clearly aware, the New Year began on 1 January from 1600, but in England the change was not made until 1752.
26 SAUL, UUY459 Box A/6, ‘A note of things wanting in of Instruments as received by Mr Henry’.
27 Collins to Gregory, 23 September 1672: JGTMV, p. 244.
28 Collins to Gregory, 26 December 1672: JGTMV, p. 248.
31 Gregory to Collins, St Andrews, 13 May 1673: JGTMV, p. 268.
32 ‘Commission’, op. cit. (note 2).
33 As cited in Malet, op. cit. (note 18), p. 80.
34 ‘Commission’, op. cit. (note 2).
35 ‘Commission’, op. cit. (note 2).
36 Flamsteed to Collins, Derby, 12 July 1673. Published in The correspondence of John Flamsteed, the first Astronomer Royal (ed. Eric G. Forbes, Lesley Murdin and Frances Willmoth), vol. 1 (1666–1682), pp. 221–223 (Bristol, 1995).
38 Hume Brown, op. cit. (note 1), p. 18; Macky, op. cit. (note 6), p. 89; Kemp, op. cit. (note 6), p. 271; Grierson, op. cit. (note 8).
Slezer, op. cit. (note 4), 1693 edition, plate 13, ‘The Prospect of the Town of St. Andrews’. I am indebted to Eric Priest, Emeritus Professor of Mathematics, University of St Andrews, for pointing out the observatory on Slezer’s engraving.

Ronald Cant, historian of the University of St Andrews, suggested (op. cit. (note 11), p. 45, and p. 60 n. 18) that Gregory’s description of the observatory at this date ‘could only be satisfied by a location on the west building of St Leonard’s College’, and this location for the observatory is given in various sources, although Cant recognized that the observatory was ultimately erected ‘at the foot of West Burn Lane’, in other words at the end of the St Mary’s College grounds (Cant, op. cit. (note 12), p. 82). However, Cant’s footnote (n. 18) makes clear that he based this assessment on extracts from Gregory’s letter to Flamsteed published in a source that, I discovered, did not give Gregory’s description of the observatory in full, namely H. W. Turnbull and G. H. Bushnell (eds), University of St Andrews James Gregory tercentenary: record of the celebrations held in the University Library, July 5th MCMXXXVIII, pp. 15–16 (St Andrews, 1939). St Leonard’s can be discounted as the planned site of the observatory.

41 JGTMV, p. 514.
43 Collins to Gregory, Westminster, 16 July 1672; Gregory to Collins, Aberdeen, 6 August 1672; Gregory to Collins, St Andrews, 23 September 1672; Collins to Gregory, 23 September 1672; Collins to Gregory, London, 8 November 1672; Gregory to Collins, St Andrews, 7 March 1673; Gregory to Collins, 13 May 1673: JGTMV, pp. 239–241, 245, 247, 260 and 270.
44 Gregory to Campbell, St Andrews, 30 April 1674: JGTMV, p. 280.
45 Collins to Gregory, 12 January 1673/74 and 5 March 1673/4: JGTMV, pp. 276–277.
46 Flamsteed to Collins, Derby, 20 August 1673, October or November 1673 and 27 December 1673: Forbes et al., op. cit. (note 36), pp. 242 and 260.
49 In the spring of 1674 Gregory himself recorded the latitude of St Andrews as 56° 22′, after making observations of a lunar eclipse. Gregory to Campbell, St Andrews, 30 April 1674: JGTMV, pp. 11, 276 and 281.
51 Ibid., p. 36.


56 ‘Archebaldi Areskine’ cannot be confidently identified. Robert Smart (retired Keeper of Muniments of the University of St Andrews) informed me that he can trace only one student of that name in the period 1589–1747. This individual was born in ca. 1598, the son of Sir James Erskine of Tullibody, matriculated at St Leonard’s College in 1611/12 and paid for the BA and MA in 1615. He may then have accompanied his father south to attend the royal court but ended up in Ireland, serving as Rector of Tullycorbet, Devenish, Inishmacsaint and Errigal Keerogue. He is not known to have maintained any connection with his old college, so, given the tenuousness of the London connection, is perhaps an unlikely candidate for the donation of the dip circle. Another Archibald Erskine is the 7th Earl of Kellie (b. 1736), who held estates near St Andrews; however, Smart feels that an association with the instrument is unlikely, because the spelling ‘Areskine’ ceased to be used much after the early years of the eighteenth century. So far, then, the donor’s identity and the date of the presentation remain unresolved.

57 See John Anderson (ed.), *The Muses Welcome to the Most High and Mightie Prince James* (Edinburgh, 1618).

58 Collins to Gregory, 23 November 1674 and 31 December 1674: *JGTMV*, pp. 290 and 294.

59 Anon., *An Historic Exhibition* (exhibition catalogue) Parliament Hall (University of St Andrews, 1962), p. 11, refers to ‘a catalogue of the clocks, mathematical instruments and others in the public library. 1703’. However, the university’s archivists have been unable to locate this, and it is unclear whether it is to be identified with one of the inventories discussed here.

60 These three inventories are all catalogued as SAUL, UYUY459 Box A/6.

61 Gregory to Campbell, St Andrews, 30 April 1674: *JGTMV*, p. 281.

62 What level of damage to this astrolabe should be inferred is unclear. By the time that the ‘Great Astrolabe’ was examined by Gunther, the central pin or axis was missing, as were two of the original plates. Gunther, ‘The Great Astrolabe’, *op. cit.* (note 48), p. 277.

63 SAUL, ULYL105/3, p. 41; SAUL, UUY452, Minutes of the *Senatus Academicus*, University of St Andrews (hereafter SM), 18 February 1715.

64 SM 25 January 1710, 15 February 1712 and 25 February 1714.

65 Malet, *op. cit.* (note 18), p. 84.

66 Gregory to Collins, St Andrews, 20 April 1670: *JGTMV*, pp. 89–90.


68 Gregory to Campbell, St Andrews, 30 April 1674: *JGTMV*, p. 281.


70 Gregory to Collins, St Andrews, 2 July 1672: *JGTMV*, p. 238.


72 SM 2 June 1705, 2 June 1713, 10 June 1729, 7 September 1736, 22 November 1736, 20 February 1751, 26 April 1751 and 17 October 1761.

73 *JGTMV*, pp. 13 and 515.

74 Cant, *op. cit.* (note 12), p. 86, n. 2; Malet, *op. cit.* (note 18), p. 64.

75 *Evidence, op. cit.* (note 13), p. 199.

76 SM 11 September 1710.

77 SM 23 February 1714.

78 Cant, *op. cit.* (note 11), pp. 56–57.

79 SAUL, UYSS800/4. The document is undated.

80 SAUL, UYSL110 S12.
SM 22 November 1736, 13 December 1736, 3 June 1737, 6 December 1738, 13 April 1741, 28 September 1750 and 17 December 1750.

SM 14 September 1748.

Grierson, *op. cit.* (note 8), recorded the Gregory connection (pp. 191–192). Authorities including Turnbull repeated the error, for example *JGTMV*, p. 11: ‘The boards have perished upon which Gregory marked the line, but the position has been preserved; and so also has been the iron bracket, affixed to the wall beside the tall window, upon which he mounted his quadrant or telescope.’ (The reference is to the removal of the original line and its replacement by a strip of wood during Library renovations in the 1920s.) However, Cant notes that it was Short who laid down the meridian line (Cant, *op. cit.* (note 12), p. 89, n. 2).


SM 28 September 1750. Probably this reference relates to the extant bracket: the reference to the ‘north Window’ may be an error, or the bracket may have been moved to the south window after the north windows were blocked up during renovations that took place in *ca.* 1765 (see SM 9 January 1765). Grierson, *op. cit.* (note 8), records that the meridian line was marked to the north of the library by ‘a small iron cross, to be seen on the west end of the house at present possessed by the principal of the United College’ (71 South Street, owned by James Playfair), although the proximity of buildings on South Street would surely have interfered with observations. The bracket now in the south window once held an adjustable slide, but this was dislodged and lost in the bomb blast of 1940.

SM 14 December 1730, 13 March 1733, 29 November 1734, 7 September 1736 and 31 October 1737.


Duncan Liddell, who left money in his will to found and endow the Chair of Mathematics at Marischal College, Aberdeen, in 1613, also bequeathed his books and instruments to the college. These were augmented by other mathematical instruments listed as being in Marischal’s library by 1670, probably purchased by the first Professor of Mathematics, William Johnstone. None of these are known to have survived. Sir Robert Sibbald (1641–1722), co-founder of the Royal College of Physicians in Edinburgh, bequeathed a collection of scientific instruments to Edinburgh University, which seem to have been lost within 50 years. Apparatus from the late seventeenth century does survive at the University of Glasgow, although instruments first seem to have been acquired there in 1658. See A. D. Morrison-Low, ‘“Feasting my eyes with the view of fine instruments”: scientific instruments in Enlightenment Scotland, 1680–1820’, in *Science and medicine in the Scottish Enlightenment* (ed. C. W. J. Withers and P. Wood), pp. 17–53 (Tuckwell Press, East Linton, 2002), at pp. 21–22; A. D. Morrison-Low, ‘Natural philosophy collections of the Scottish universities’, paper given at XII Scientific Instrument Conference, National Museums of Scotland, Edinburgh, September 1992, pp. 1–2; Cant, *op. cit.* (note 11), p. 56.

Inventory inserted into United College Minutes, 4 March 1797; ‘Catalogue of the Apparatus in the Museum of the Natural Philosophy Class in the United Colleges of St Salvator and St Leonard’, May 1880, published as E. M. Wray (ed.), *Swan’s Catalogue* (St Andrews, 1884).