The Revd William Ludlam (1716–1788) and the Cockfield Tower Observatory

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The life of an eighteenth century astronomer, mathematician and rector, and the surviving evidence of his unique observatory in the tower of a Suffolk church, are described.

Inspiration

The village of Cockfield is situated some six miles south of the West Suffolk town of Bury St Edmunds, and in 1968 the author and his parents moved here from RAF Marham in Norfolk. Apart from my weekday telescopic observations from Chelmsford (1992–2002) virtually all my observing has been done from Cockfield (IAU Observatory 480). This was casual stargazing as a schoolboy/undergraduate from 1968 to 1980, but serious astrophotography or imaging from 1980 to the present day. In my first and only year at the Cockfield village school (1968/1969) I was taken on a short school trip to the very top of the church tower, where I was tantalisingly told, in a teacher's throwaway remark, that a famous rector had once modified the church structure to enable viewing of the night sky with his telescope. As an eleven-year-old amateur astronomer, possessing Patrick Moore's *Observer's Book of Astronomy*, and about to apply for BAA membership, I was fascinated by this casual remark about another Cockfield astronomer's observatory within walking distance of my parents' home. However, for no apparent reason, it has taken me some 36 years to try to find out exactly who the rector was.

As a non-historian, the resumption of my interest in the Cockfield rector largely came about from a successful partnership in 2003–2004 with Ken Goward of the Society for the History of Astronomy, during which we researched the history of the nearby Bury St Edmunds Athenaeum Observatory.[1] A meeting between Ken, myself, and Allan Chapman at Oxford University on 2004 August 11 inspired me further, but there was another factor too. In 2004 I heard that a long term resident of Cockfield had privately published a book on the history of the village. I purchased the book and inside, I found the first evidence of the astronomer–rector's identity and period in office.[2] He was named William Ludlam (a name that seemed vaguely familiar) and had been the rector at Cockfield between 1767 and 1788. As a Cockfield astronomer myself I felt it was my duty to investigate my 18th century predecessor's activities. It was time for serious research to begin.

Figure 1. St Peter's Church, Cockfield, viewed from the south.

The Cockfield–Cambridge link

Going back to the Middle Ages, early church authority stated that any person who built a church on his own lands held the 'right of Advowson', which meant that he had the right to present to his Bishop a suitable person to administer the church. If suitable, the Bishop 'instituted' the man presented. In the village of Cockfield,[3] the de Cockfield family successfully presented William Colum in 1190 and after that date, various Abbots appointed the Cockfield church administrator until the Dissolution of the Monasteries in 1539. In that year the advowson of St Peter's Church at Cockfield (Figure 1) was bought by the Spring family of Lavenham. By 1567 they had appointed Richard Longworth, Master of St John's College, Cambridge, to the post, although he did not actually reside in Cockfield, which lies some 30 miles east of Cambridge. This link with St John's would continue. Almost 130 years later, Sir William Spring sold the St Peter's advowson itself to St John's College and so, inevitably, various Cambridge scholars became rectors of Cockfield. In 1767, William Ludlam was appointed as Rector, succeeding Henry Wrigley who had been appointed in 1743.

Ludlam's income (described as a gift from St John's) would be £300 per annum.[4] His predecessor at Cockfield, the Revd Wrigley, had been a fellow and principal tutor of St John's. To the non-historian a link between leading Cambridge University scholars and an insignificant village in West Suffolk might seem odd. However, although dwarfed by the nearby churches at Lavenham and Long Melford, Cockfield is one of the biggest (and most prestigious) Suffolk village churches, and from the late 15th century, Cockfield was at the heart of industrial East Anglia, midway between the two great merchant towns of Bury St Edmunds and Sudbury and very close to the equally important towns of Lavenham and Long Melford. A prestigious church deserved a prestigious rector, hence Ludlam's appointment.

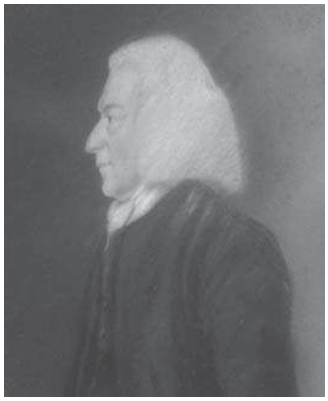


Figure 2. A pastel drawing of William Ludlam in 1785, by Lewis Vaslet. Provided by Veronika Vernier, with kind permission of the Provost and Fellows of The Queen's College, Oxford.

Astronomy in the mid-1700s

A brief resumé of the state of astronomy in the mid-eighteenth century may help to set the scene. Prior to 1781 and Herschel's discovery of Uranus, there were only six known planets in the solar system, and there would be no known asteroids until the first day of the next century, when Ceres was discovered by Piazzi. The first predicted perihelion passage of comet Halley would occur in 1759 (although Halley himself died in 1742, aged 85) and comet Lexell would make a very close flyby of the Earth on 1770 July 1. Probably the most spectacular comet of the mid-eighteenth century was de Chéseaux and Klinkenberg's comet of 1744. Featuring multiple tails and peaking at an estimated magnitude –7 in the spring of 1744, it was truly a Great Comet. Towards the end of the century, Charles Messier became the world's first prolific comet discoverer, bagging a dozen or so finds between 1760 and 1798. As far as equipment was concerned, if you were rich or clever enough to acquire one, a reflector with an aperture of four inches (100mm) and a metal or glass mirror was a highly prized instrument, though greatly inferior to a modern amateur telescope. A telescope easily capable of revealing Jupiter's belts and Saturn's Cassini Division would be considered excellent in the early 1700s.

Typically, focal lengths were quoted to describe instruments (e.g. a 'six foot' telescope) and Gregorians and Cassegrains were available as well as Newtonians. Quite often the magnification (often greatly exaggerated) was the most emphasised feature. James Short of Edinburgh raised the optical standard when he started selling high quality reflecting telescopes in 1740. Concerning refractors, Newton's generalisation that refraction is *always* accompanied by dispersion hindered that instrument's development in the early 1700s: his reflector, of course, had no chromatic aberration. However, Chester Moor Hall's experiments with crown and flint glass from 1729 onwards paved the way for the achromatic refractor, and the financial significance was not lost on the Dollonds; they were busy making such instruments from the 1750s. Even so, in that era glassmakers were highly skilled if they could manufacture quality glass discs as large as 100mm in diameter. Apart from telescopes, there was much written about the use of the astronomical quadrant (an instrument similar to the modern nautical sextant) and the Cockfield rector was involved in the use and appraisal of various such instruments, including John Hadley's variant, often called the octant.

For a comprehensive account of the instruments of this period and the use of the quadrant and transit instruments I would recommend two excellent books, *The History of the Telescope*, by Henry King[5] and *Dividing the Circle* by Allan Chapman.[6] In addition to the quadrant, the transit telescope was a prestigious piece of kit. Having a telescope mounted exactly north–south such that stars precisely on ('transiting') the meridian could be observed and timed, was highly important. As described in *Dividing the Circle*, the transit telescope only became possible because of the technical advances of the seventeenth century. Before such a telescope could be used for astronomical measurement it was necessary to have a reliable regulator clock, something that was impossible before the invention of the pendulum and anchor escapements in 1658 and *c.*1670 respectively.[7]

Outside of astronomy, the mid 1700s world was of course vastly different to that of 2006. The crime of Witchcraft had only been abolished in 1736 and highwayman Dick Turpin went to the gallows in 1739. The Scots were crushed at the battle of Culloden in 1746 and King George III succeeded King George II in 1760. Travelling across the country was limited by the speed of a horse, as James Watt would not invent the steam engine until 1775 and, even then, the first train service was fifty years in the future. For a rector based at Cockfield, nipping over on a horse to an observatory at Cambridge if skies cleared was not really a realistic option.

The early Ludlam years

William Ludlam (Figure 2) was born in 1716 in Leicester. He was the son of Richard Ludlam and became a student at St John's College from 1734. By 1738 he had acquired a BA, and matriculated four years later. In 1744, the year of the aforementioned multi-tailed comet, William was made a fellow of the College and, five years later, he achieved his BD (Bachelor of Divinity).[8] He held the post of Sadlerian Lecturer from 1746–1769 and was one of the most learned mathematicians of his era. On achieving his BD, Ludlam secured the ecclesiastical post of rector of Norton-by-Galby[9] (now Kings Norton), a small Leicestershire parish near to his birthplace. The fact that he was

rarely there seemed to matter little, as long as a curate was available to deputise.

Ludlam's knowledge of mathematics was matched by his understanding of astronomical and chronological instruments. He seems to have known many of the top telescope, instrument and quadrant makers of the day, including John Bird and Jeremiah Sisson. To quote from *Dividing the Circle:*[10]

'*William Ludlam knew both Bird and Sisson, and their names appear in his account books, along with those of some 17 other craftsmen from whom Ludlam bought instruments and tools. Though Ludlam's notebooks say very little about the connections existing between craftsmen, they say a great deal about what they stocked and what they charged. In a letter of 1747, recorded by Ludlam, Bird mentions that it 'is usual to charge 5s per day for a good workman', although John Hacking, Ludlam's jobbing artisan, was regularly docketed at 2s 6d per day*.'

St John's College Observatory

After 14 years as Sadlerian Lecturer at St John's, Ludlam was a candidate for the prestigious Lucasian chair in 1760 (held by Newton only fiftynine years earlier, and, currently, by Stephen Hawking), but he was defeated by Edward Waring, the senior St John's Wrangler in 1757. In 1765 an Observatory was built over the west gateway of the Second Court at St Johns (the 'Shrewsbury Tower'), paid for by Richard Dunthorne, the butler and astronomical observer at Pembroke College. Dunthorne planned and funded the building of the observatory, even donating the instruments himself. He carried out observations of the sunrise/early morning transit of Venus in 1761 and sunset transit in 1769, and prepared new lunar tables.[11] Ludlam was full of praise for Dunthorne, stating:[12]

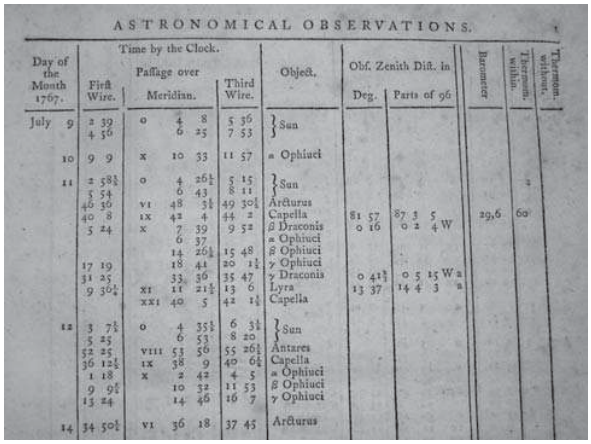
'Without the benefit of an Academical education he arrived at such a perfection in many branches of learning, and particularly in Astronomy, as would do honour to the proudest Professor in any University: and yet notwithstanding this supreme skill in a science so difficult and so important, humanity and modesty, the most engaging diffidence of himself and readiness to advance others are parts of his character not only more excellent and amiable but more peculiar and distinguishing.'

Dunthorne was succeeded as Director of the Observatory on 1766 November 3 by Sir Isaac Pennington MD, but he was swiftly replaced by the much more energetic Ludlam, who published his astronomical observations made there, with a transit telescope and quadrant, in 1767–'68,[12] just as he was starting his period as Cockfield rector. Ludlam's enthusiastic reign as St John's Observatory Director (the precise end date of which does not seem to be recorded) appears only to have been matched some three years after his death in 1788 when, from 1791 to 1838, Thomas Catton observed there with equal energy. Ludlam's final year as a St John's lecturer and Fellow was 1769.

As we have seen, this was an era when astronomical quadrants were being replaced in the observatory by transit telescopes, due to the increased precision of observatory clocks. The quadrant and its variants were typically used to measure angles at sea to precisely determine a ship's position. This was, of course, right in the era of the attempt to construct an accurate marine chronometer, another fundamental stepping stone in that direction. The famous chronometer inventor, John Harrison, lived at Summit House, Red Lion Square, at the corner of Dane St, Cambridge (now an office block) from 1752 until his death there from Blue Plague.[13] It was here, on 1765 August 14–19, that a committee, including John Bird, Neville Maskelyne, Ludlam himself, John Michell, and the clockmakers Thomas Mudge and Larcum Kendal (formerly apprentice to Jefferys), were shown the detailed construction of chronometer H4, leading to Harrison's receiving half of the Longitude Prize. Ludlam's place on the Board of Longitude is testimony to his standing in the late 18th century.

Astronomical quadrants were often used by land-based astronomers to measure the angle between the Moon and the Sun and stars and Ludlam was an authority on the design, construction and use of them. Indeed, one could write a book solely on Ludlam's appraisal of quadrants over the years. However, once reliable regulator clocks became more widespread in observatories, everything became centred on timing objects transiting the meridian using transit telescopes. Typical transit telescopes of this era had a straight or tapering tube (often thickest in the middle) connected to a tapered two-part axis (also thickest in the middle). The refractor itself might have a focal length of 80 or 100 centimetres with an objective lens often only three or four centimetres in aperture. Typically, a magnification of ×20 or ×30 might be used for transit timings on the crosswires.

It is instructive here to study the actual observations (Figure 3) made by Ludlam from St John's College using the transit telescope mounted on top of the Shrewsbury Tower. Fortunately, the observations have survived, in a fascinating book kept in the Institute of Astronomy library at Cambridge, which this author has studied in detail. The observations made in 1767 and 1768 are meticulously recorded. Specifically, from 1767 July 9 to 1768 August 5, Ludlam recorded an impressive 1450 transit measurements from St John's.[14] If we take a calendar year, from 1767 July 9 to 1768 July 9,



ASTRONOMICAL OBSERVATIONS.

Day of the Month 1767.	Time by the Clock. Passage over Meridian. First Wire.		Third Wire.	Object.	Obs. Zenith Dist. in Deg.	Parts of 96	Barometer	Thermom. without.	Thermom. within.
July 9	2 39	0 4 8	5 36	} Sun					
	4 50	6 25	7 53	}					
10	9 9	x 10 53	11 57	α Ophiuci					
11	2 58½	0 4 26½	5 15	} Sun					
	5 54	6 43	8 11	}					
	46 56	VI 48 3½	49 30½	Arcturus					
	40 8	IX 42 4	44 2	Capella	81 57	87 3 5	29,6	60	
	5 24	x 7 39	9 52	β Draconis	0 16	0 2 4 W			
		6 37		α Ophiuci					
		14 26½	15 48	β Ophiuci					
	17 19	18 41	20 1½	γ Ophiuci					
	31 25	33 36	35 47	γ Draconis	0 41½	0 5 15 W a			
	9 30½	XI 11 21½	13 6	Lyra	13 37	14 4 3 a			
		XXI 40 5	42 1½	Capella					
12	3 7½	0 4 35½	6 3½	} Sun					
	5 25	6 53	8 20	}					
	52 25	VIII 53 56	55 26½	Antares					
	36 12½	IX 38 9	40 6½	Capella					
	1 18	x 2 42	4 5	α Ophiuci					
	9 9½	10 32	11 53	β Ophiuci					
	13 24	14 46	16 7	γ Ophiuci					
14	34 50½	VI 36 18	37 45	Arcturus					

Figure 3. The first page of transit timings from Ludlam's observing log at St John's College Observatory in 1767.

Ludlam observed on a remarkable 240 different days and made 1300 transit timings in that year (an average of 5.4 timings per day). Some of the timings were of the Sun transiting the meridian; however, most were transits of stars, made at night. It would appear that Ludlam enjoyed a huge percentage of clear nights. In addition to the transit timings he also used the College's '18 inch' Hadley quadrant (by Bird) to regularly measure the Moon's angular distance from the Sun and stars over the same period. Timings were made using a grid-iron pendulum clock by Shelton, regularly adjusted by Ludlam. (As this paper's proofs were being checked, Ken Goward e-mailed the author to say that the same St John's clock used by Ludlam has survived and is now stored at the National Maritime Museum, Greenwich).

When William Ludlam became rector of Cockfield in 1767 he would have realised that having a transit telescope atop a 23-metre high church tower, with convenient north and south facing walls, would be an excellent solution to enable him to continue his prolific transit timing work. Observing the northern part of the sky, as low down as possible, was critical when initially aligning such an instrument. Again, as described in Chapman's *Dividing the Circle*,[15] once it was possible to observe a circumpolar star with a transit telescope, one could fix a meridian by simply observing the star's 'upper' (southern) and 'lower' (northern) culminations. If the star took longer to pass through, say, the western arc of its journey around the pole, it indicated that the axis was set too far to the east, and vice versa. Its angular quantity could be determined arithmetically, a correction applied, and the observation repeated. When the star took exactly 11 hours 58'2", or half the sidereal day, to pass through both eastern and western arcs, the instrument was considered to be true to the meridian and valuable transit timings could then be made.

The Shrewsbury Tower observatory remained in use well after Ludlam's era, until 1859, when the still surviving University Observatory off Madingley Road was opened.

Ludlam as Cockfield rector

Fortunately for this author, Frank Fuller, a Cockfield rector from the 1960s, carried out research on Ludlam's local activities in the late 1760s and 1770s. Fuller's notes were recently discovered and brought to my attention by the current rector, Simon Hill, who was aware of my interest in the Cambridge academic. Fuller seems to have had access to many of his numerous predecessors' records at Cockfield, and one can only assume that some of this information was retained in the Rectory itself or in village records that Fuller located. According to Fuller's opening paragraph on Ludlam's period at Cockfield, he first notes that Ludlam was commissioned, in 1767, *to buy two globes, at a price not exceeding 10 guineas* for St John's College Observatory. This was the same year that Ludlam became rector at Cockfield and, as we have seen, he was still the Observatory Director at Cambridge. Indeed, Ludlam was also the rector of Norton-by-Galby in 1767 and retained both church posts until his death. Surprising though this may seem, it was not uncommon in the 1700s. It provided him with two incomes and each parish with a prestigious incumbent.

Figure 4. The south face of the church tower. On the left side, just to the left and below the gargoyle-faced gutter pipe, light and dark flint infills can be seen. These are the remnants of Ludlam's southern observatory aperture.

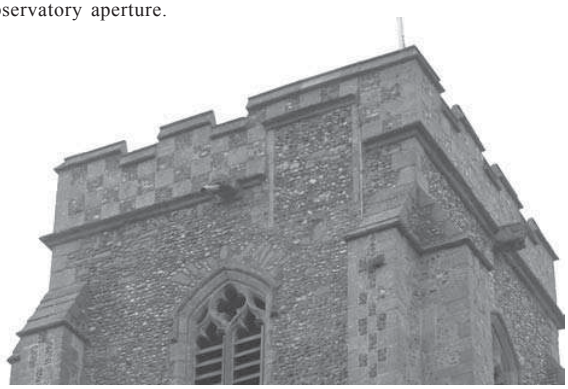


Figure 5. The north face of the tower. On the right hand side the huge door-sized flint infill is clearly visible. This marks the site of Ludlam's northern observatory aperture.

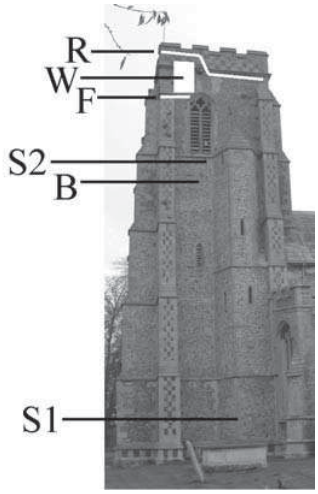


Figure 6. The relative positions of Ludlam's observatory and other features within the Cockfield church tower as viewed from the south. **S1** = Spiral staircase bottom; **B** = Belfry; **S2** = Spiral staircase top; **F** = Floor of Ludlam's observatory; **W** = South facing window/aperture in Ludlam's time; **R** = Roof level (white line) as modified by Ludlam to enable the western end to fold back to access the zenith.

According to Fuller's handwritten notes, upon moving to Cockfield, Ludlam wasted no time in modifying the top of the 23-metre high church tower for the purposes of astronomy (Figures 4, 5 and 6). To make possible the use of a *substantial transit instrument* Ludlam raised the internal roof (inside the tower) at the western end, making it high at the western side with a gutter in the middle of the roof. He then cut rectangular openings in the north and south walls, under the high parts of his new roof, so that the transit instrument had a relatively uninterrupted view of the meridian, i.e. through

the door-sized gaps cut in the north and south flint walls and through the new folding roof overhead. The windows cut by Ludlam's workmen in the stone walls of St Peter's Church would have been approximately two metres high by one and a half metres wide. The surviving visual evidence suggests that the northern window was significantly taller, presumably to access those crucial circumpolar alignment stars above and below the pole. The folding-back roof on the western side would have been roughly seven metres long if it folded along its whole length, allowing unrestricted access to the zenith regions.

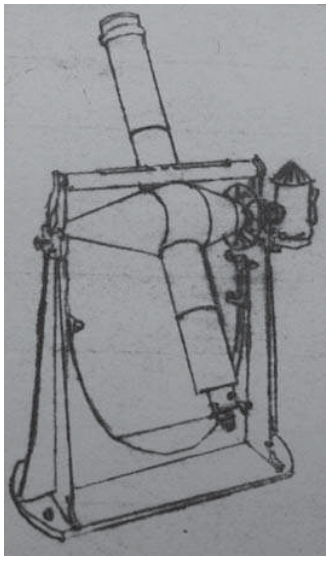


Figure 7A. This sketch accompanies the Revd Frank Fuller's notes regarding Ludlam and his observatory. It is simply labelled 'Transit Instrument'.

The transit telescopes at Cambridge and Cockfield

Crucially, there is a sketch labelled 'Transit Instrument' attached to Fuller's handwritten notes about Ludlam (Figure 7A). It may well have been pencil-traced from another diagram, but the details of that original diagram are not recorded. Could it have been that Fuller, at some point, had Ludlam's own observatory construction notes? If so, they do not seem to have survived in the remains of Fuller's substantial folder, kept by the current rector.

So does any part of Ludlam's Cockfield telescope survive today? Might it have been the same transit instrument used at St John's College Cambridge, or a copy of that instrument, and did either instrument survive? The remaining instruments from St John's College Observatory were placed in the custody of the Whipple Museum in Cambridge from 1951, some 92 years after the Observatory itself closed. The current museum database only attributes two surviving pieces of wood directly to Ludlam. They are catalogued as being lamp supports or supports for a transit instrument. The supports came to the museum from the observatory along with the observatory's transit instrument made by J. Sisson and dated 1763. A counterpoise on the main wooden support is clearly labelled '1767', the first year of Ludlam's recorded St John's observations and the year he became Cockfield rector. [There were in fact two instrument makers called J. Sissons, namely Jonathan (1690–1760) and his son Jeremiah (1720–1783).]

There is much valuable information on the historical astronomical equipment of Cambridge and St John's in a book by

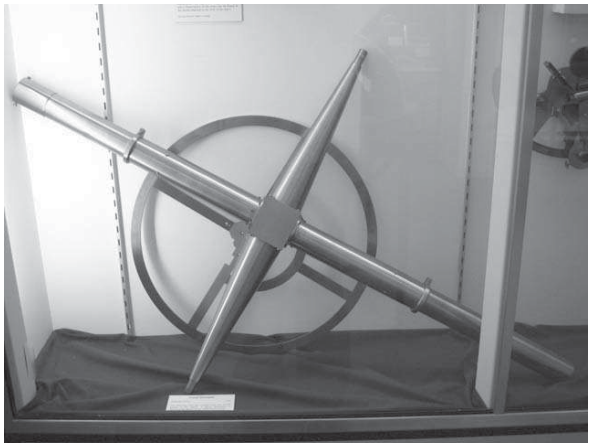


Figure 7B. The St John's Observatory transit telescope in its case at the Whipple Museum, Cambridge. *Courtesy of the Whipple Museum/Dept. of History & Philosophy of Science, Cambridge University. Photo supplied by Lisa Newble.*

R. T. Gunther, kept at St John's College library.[16] This explains that as late as 1761, the only transit telescope at Cambridge appears to have been a 3-foot long instrument, fixed by a Dr Mason in his own room at Trinity College. Its magnification was about 18 times. Mason apparently used it for deducing the time on the occasion of the Transit of Venus on 1761 June 6. Gunther also mentions that the transit of Venus of that year was observed from the leads of St John's College tower with a James Short reflector of '9.6 inches' focal length, and with a Dollond refractor with a compound OG of '66 2/3 inches' focal length and a single eyeglass of 'one inch' focal length. Of the two observers recorded at that location, Gunther presumes that one must have been the Revd William Ludlam and the second was almost certainly Richard Dunthorne.

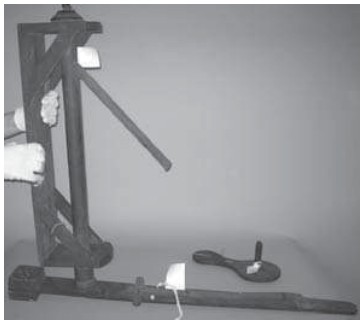


Figure 7C. Part of the mounting and lamp supports of the St John's Observatory transit telescope. This is associated with William Ludlam at the Whipple Museum, Cambridge. *Courtesy of the Whipple Museum/Dept. of History & Philosophy of Science, Cambridge University. Photo supplied by Lisa Newble.*

After researching this subject it is apparent that the St John's transit instrument by Sissons, described by Gunther, is the same instrument that is still stored in the Whipple Museum today (Figures 7B & 7C). It has an objective aperture of 1 3/8 inches (35mm), a focal length of 3 feet 5 inches (1041mm), a magnification of ×28 and possesses an entire 18 inch (457mm) graduated circle. When mounted on the Shrewsbury Tower, the south meridian marker for the transit telescope was a mullion on the tracery of the battlements of King's College, and the north meridian marks were two dots on the wall of a house in Bridge Street!

The Cockfield sketch labelled 'Transit Instrument', made by the Revd Fuller, shows a similar sort of instrument to the components now surviving in the Whipple Museum. Was

this a sketch of the Cockfield instrument from Ludlam's notes? Was it the same instrument that is now stored in two sections in the museum? Or did Ludlam and his artisans build his own Cockfield instrument, as he was certainly capable of doing? Indeed, he describes how to make a transit instrument's tube and mounting out of tin in the aforementioned St John's 1767/1768 observing notebook. That specific instrument was delivered to a Mr Nairne at the Royal Exchange, and the observing notebook records that the idea of using tin was suggested by none other than Nevile Maskelyne (1732–1811).

The precise identity of the Cockfield telescope is a missing piece of the jigsaw. However, if it was not the relocated St John's instrument, it would certainly have been very similar to it. Even after studying the Revd Fuller's notes and the St John's observing records, and after contacting numerous authorities in Cambridge and Cockfield, the precise identity of the Cockfield tower instrument is still not known. All one can say is that either Ludlam relocated the St John's College instrument he used so often (improbable), or he had a very similar one made. The latter seems far more likely, simply because Gunther states the following, from College manuscript notes made in August 1769 by Isaac Pennington: *The center wire of the transit was left nearly bisecting the mullion [of King's College Chapel]*. Gunther goes on to say that: *displacements were noted in 1774 and 1785 which amounted to the diameter of the wire west of the true position. This instrument remained in continual use for at least 20 years from the foundation of the observatory*.

The Cockfield tower today

A careful examination of the St Peter's Church tower at Cockfield, made by the author in 2004, shows that on the north face of the tower, six metres above the belfry, Ludlam had a huge door-sized slot cut into the stonework, thus providing a large aperture through which he could point his instrument towards the circumpolar stars, essential for aligning the transit telescope. The surviving evidence also confirms that another slot (with a smaller dark infill in 2004) was cut in the south face at the same height. Today there is a wooden roof at the top of the tower, but it is said that Ludlam substantially altered this to allow access to the sky, by folding the raised roof section's panels at the top of the tower back during observing. The author examined the inside of the church tower (Figure 8) on 2004 November 1, by kind permission of the current rector, the Revd Simon Hill (Figure 9). A long ladder leading from the belfry to the north side of the tower now leans against that large flint infill on the north-facing wall. Today, a small trapdoor still allows access to the wooden roof of the tower, but there is evidence of the repairs carried out immediately post-Ludlam to correct his observatory modifications. In particular a large wooden beam marked 1815, spotted by the author's father, exists at the very top of the north-facing tower wall. This beam would have been installed during the term of the subsequent St John's academic and rector, George Belgrave, who was resident at Cockfield from 1788–1831. The current roof is probably at the same height as it was before Ludlam raised its western end to accommodate the transit instrument.

Figure 8. Inside the church tower. The author's father (on the ladder) examines the area of the northern wall flint infill. To his left is the site where Ludlam's observatory and telescope would have been situated.

Figure 9. The current Cockfield rector, the Revd Simon Hill, standing near the top of the potentially ankle-twisting spiral staircase (position S2 in Figure 6) near the entrance to the old observatory site above the belfry.

Wooden beams across the tower width, crucially on the western side where the transit instrument was sited, some one and a half metres below the existing roof, may once have marked the floor space of Ludlam's observatory, above the belfry. But there is much evidence of restoration to this part of the tower in more recent times and deducing exactly what Ludlam built is virtually impossible without referring to Fuller's notes. Certainly, experts on Suffolk churches (e.g. Mortlock[17]) are in no doubt that the strange flint infills at the top of the Cockfield church tower are unique, and directly attributable to Ludlam and the post-Ludlam repair work.

Although I am speculating here, it is tempting to think that Ludlam's own transit telescope when mounted in the Cockfield church tower might have had a view through the tower slots and over the surrounding landscape something like that shown in Figure 10. This is an earlier, restored, Jonathon Sisson instrument, marked 1739 and now at Bologna. The instrument was refurbished in 1979 and the telescope is 85cms in length. It obviously differs in appearance from the instrument sketched by the Revd Fuller, but the body is almost identical to the one stored in the Whipple Museum at Cambridge. This may have been the sort of view Ludlam had from his church tower at Cockfield.

Getting from the ground floor of the church to the tower top is quite a business, involving an extremely steep,

tightly twisting spiral staircase with no hand rail, which takes one to either just below or, if one continues, just above the belfry. This must be a potentially ankle twisting (or neck-breaking) experience in the dark. Finally a precarious walkway, over the top of the bells themselves, takes the potential observer to the base of the five-metre ladder which leads to the northwest part of the current tower roof, and past the site where Ludlam's observatory would have been. The floor of Ludlam's observatory would probably have only been about three metres above the top of the bells!

More insights from the Revd Fuller

Also revealed in Frank Fuller's notes was the fact that, after his first six years as Cockfield rector, i.e. 1767–1773, Ludlam moved to live permanently with his brother at Leicester until 1782. He could then resume his duties as rector at Norton-by-Galby, whilst neglecting his Cockfield duties. From 1782 to 1784 he was apparently back at Cockfield, but then returned to his brother's address in 1784 until his death in 1788. During his short and long absences a William Courteen was Cockfield curate from 1771–1780, and a John Smyth signs the register as curate from 1783 to 1788.

Of possible significance here is that in a handwritten 1787 book in the Institute of Astronomy library at Cambridge,[18] Ludlam describes how he acquired an 18-inch quadrant, made by John Bird, in 1771: a quadrant that he remarks had scarcely left his side in the 16 years between 1771 and 1787, and one which would have closely resembled the 18-inch quadrant he used at St John's. It seems, to this author, more than coincidence that the first time a Cockfield curate started deputising for Ludlam at the Church, he should acquire his own personal quadrant. Maybe he expected to be spending a lot more time with his brother at Leicester, away from access to a transit telescope? This is, of course, merely speculation on my part. (Interestingly, there is a pencilled remark in Ludlam's manuscript, by none other than James Challis, dated 1845, in which he states that he has just dispatched the same quadrant, some 58 years later, by coach, to Oxford).

Regarding Ludlam's Leicestershire parish, as we have seen, the 1760s are remembered by astronomers for the two transits of Venus, in 1761 (June 6) and 1769 (June 3). Parts of both were visible from the UK, although in 1769, only ingress, at sunset, was possible from here. Ludlam observed that tricky 1769 transit from his Leicestershire parish and wrote up the experience,[19] along with details of the expedition by James Cook and his stop off at Tahiti (during part of Cook's world voyage of 1769/1770).

Although deducing the precise construction of Ludlam's churchtop observatory from the current appearance of the tower is difficult, extra information from Frank Fuller's notes on his predecessor casts some light on precisely what happened to the church tower after Ludlam's time as rector, with

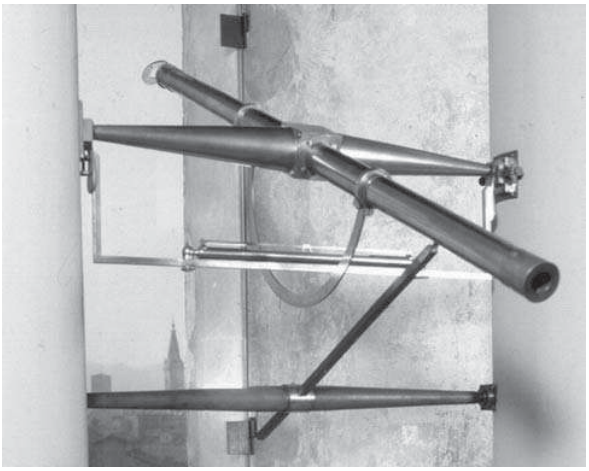


Figure 10. Transit telescope by Jonathan Sisson, dated 1739, remounted at Bologna University in 1979. The construction is a mixture of brass and wood and the telescope is 85cm long. The view from the Cockfield tower observatory may well have looked similar to this in Ludlam's day, i.e. a transit telescope high up, surrounded by stone walls and looking through a vertical slit. *Image by kind permission of Fabrizio Bonoli, Museo della Specola, Alma Mater Studiorum, Università di Bologna.*

the final repair work apparently being carried out as late as 1906. To quote from Fuller's notes:

At some time, presumably when Ludlam [finally] left Cockfield, the openings (in the north and south faces) were filled in again but recesses were left on the outside. When the tower restoration was carried out in 1906 these recesses were filled with flint, as they now are, and the raised portion of the tower roof was restored to its original shape. It is worth noticing the buttresses which come down the eastern side of the tower inside the nave. In the long winter of 1774–75 [Ludlam's] tower was almost destroyed by a violent storm. On the 2nd of August 1775 when the repairs were nearly completed the tower was apparently struck by lightning, set on fire, and, again, much damaged.

Another hitherto unknown piece of information is revealed further down in Frank Fuller's notes. After Ludlam finally moved from St John's to Cockfield he married, whilst in his fifties. Fuller records the following information about Ludlam's marriage:

Having rigidly adhered to his college habits for some years after he had quitted the walls of St John's, he at length, abruptly formed the determination of marrying a wife, and speedily gave effect to it. What could scarcely have been anticipated, considering the period and former usages of his life, he was much blessed and prospered in this connection. The lady whom he married had proved herself a most useful and affectionate helpmate to him, sharing all his little troubles and tenderly relieving all his complaints, making all his bed in his sickness, and kindly exercising herself by much forbearance, self-denial and labour.

Fuller also notes that his Cockfield predecessor was renowned as a clock mender of some skill, and there were 'many clocks still in existence which were either made or improved by him'. This is hardly surprising bearing in mind his knowledge of observatory clocks and of the Harrison chronometer.

An authority on the quadrant and theology

In the same year as Ludlam was appointed rector, John Bird, an expert on dividing quadrant scales, published a description of his quadrant dividing techniques as a condition of the Board of Longitude's reward for his services to precision mechanics. Ludlam, a member of the Board, was appointed to adjudicate the value of Bird's method. According to Allan Chapman, the two papers, by Bird and Ludlam, comprise the first systematic treatise on graduation ever written.[20,21] A year earlier, Jeremiah Sisson's knowledge of George Graham's quadrant dividing methods was conveyed to Ludlam in a letter from Jeremiah's son. This information was used by Ludlam in his own appraisal of Bird's work.

As an example of the plethora of letters and articles regarding telescopes, instruments, and even church organs and church bells published by Ludlam, I will quote the following letter. In a short article dated 1771 August 7 in the *Gentleman's Magazine*,[22] the Revd Ludlam, still based at Cockfield, voices considerable criticism of an American gentleman called Mr Ewing who, it would appear, published an article in the *American Transactions* at Philadelphia that same year. Ludlam's article was about Ewing's claimed improvements to the quadrant, and he does not hold back in flying the British flag! Ludlam's article was entitled: *Remarks on Mr Ewing's account of his improvements 'in the construction of Godfrey's (commonly called Hadley's) Quadrant.'* Ludlam claimed that Ewing's alleged improvements to the quadrant would not improve matters at all. In addition, Ludlam has a lot to say about the origin of the instrument, described by Ewing as 'Godfrey's Quadrant'. To quote from Ludlam's article:

Mr Ewing, speaking of this instrument says 'that it was first invented and constructed by M. Godfrey of Philadelphia.' – Private intelligence is always of doubtful authority.' Ludlam goes on to say that any claimants to be the inventor are: *not worth naming after Newton, who first thought of any instrument of this kind; and after Hadley, who, in 1731, invented perfected and published the instrument now in constant use. This instrument ever since, has very generally and very justly, borne Hadley's name and it is a ridiculous vanity to call it now by that of another.*

In the final years of his life, while at Leicester, Ludlam produced an epic theological work,[23] epic even by todays standards: a book in which he appears to have been trying to summarise the correct way that every man or woman should live their life according to God's will and for maximum spiritual satisfaction. The author has perused a copy of this massive and fragile tome in the Bury St Edmunds Public Records Office, but soon tired of it as it contains little of any astronomical value. However, Ludlam did not neglect his astronomical interests towards the end of his life, and his meticulous comments on the use of the astronomical quadrant were still being published after his death in Leicester in 1788. Ludlam was buried in the church at his Leicestershire parish.

Final remarks

When my parents moved to the village of Cockfield in 1968, there were still the remnants of a railway embankment (post-Beeching) a few hundred metres from our house. It was possible to follow the railway track, first along the embankment, then into a cutting as it passed very close to the church, a kilometre to our southeast. In the intervening 37 years the landscape has returned to its pre-railway state, as it was in Ludlam's time; the railway came to Cockfield in 1870 and was there for some 90 years. The embankment has now been ploughed level (and the rails removed). Because of this, Dutch Elm disease and modern farming methods, in the last year (as I researched this very subject) it has for the first time become possible to see the north and west faces of Ludlam's tower from my own observatory and bedroom window. This is purely a coincidence of course, but it seems fitting that having just researched the life of my Cockfield astronomer predecessor, who lived here 200 years before me, our two observatory sites can now view each other for the first time, albeit through a few intervening tree branches.

My folder on Ludlam is still open and fresh evidence on the construction and removal of his Cockfield church tower observatory and transit telescope would be very welcome.

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References

1 Mobberley M. & Goward K., *J. Brit. Astron. Assoc.,* **115**(5), 251 (2005)
2 Lloyd V., *A Village Pedigree, Cockfield in Suffolk*, Vera Lloyd, 2004, p.75
3 *ibid.,* p.100
4 Handwritten notes by the late Revd Frank Fuller, presented to the author by the current rector, Simon Hill, in 2005.
5 King H., *The History of the Telescope*, Dover Publications, 2003
6 Chapman A., *Dividing the Circle*, John Wiley & Sons, 1995
7 *ibid.,* p.83
8 British Society for the History of Mathematics; Web pages at http://www.dcs.warwick.ac.uk/bshm/zingaz/C.html