



# Interpreting James Gregory: Mathematician and Astronomer



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## Idea:

James Gregory (1638 – 1675, pictured on the right), was the first Regius Professor of Mathematics at the University of St Andrews, being credited as one of the co-founders of calculus along with Newton and Leibniz. In the late 17<sup>th</sup> century, the University of St Andrews commissioned an astronomical observatory, years before the famous Greenwich Observatory was constructed, and for Gregory to be the main figure behind its planning. St Andrews was not an obvious place to build such an observatory, and a multitude of theories on the reasoning behind the commissioning, the decisions on what instruments were purchased for it, and its eventual fall into a state of disrepair. In the collections that the university museum has, three main instruments presumably purchased by Gregory for the observatory stand out, whether it be for their technological innovation, ornate design, or both. The instruments being analysed and interpreted are:

- The Great Astrolabe - (Humphrey Cole, crafted 1575)
- The Universal Instrument - (Humphrey Cole, crafted 1582)
- The Knibb Split-seconds Clock - (Joseph Knibb, crafted 1673)

Scougal, John, James Gregory (1638 – 1675), MA, FRS, National Trust for Scotland, Fyvie Castle

## Gregory and the Observatory:

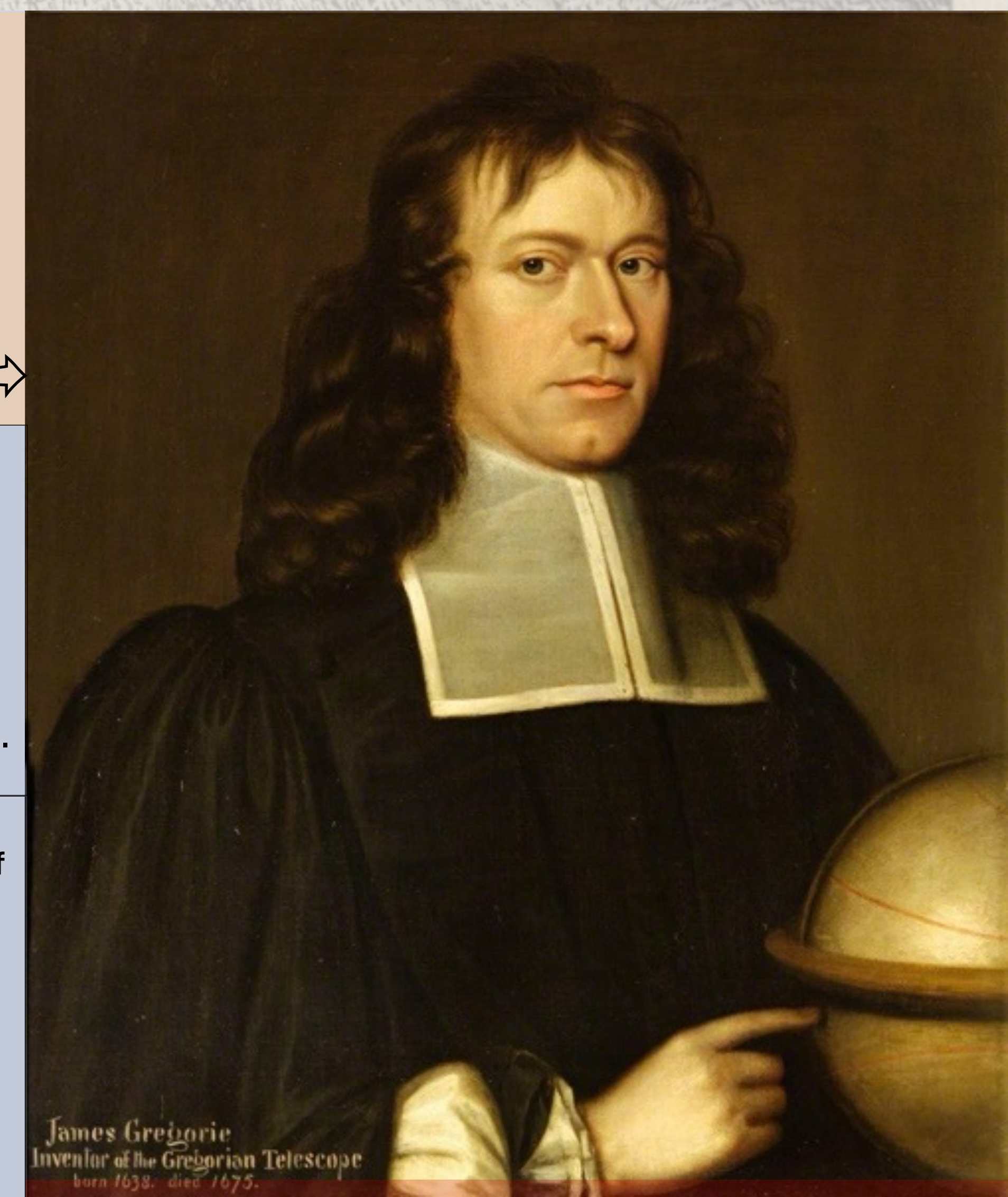
James Gregory was born the son of a university-education episcopalian minister, and a mathematically literate woman from a family with a strong flare for Mathematics. Gregory's academic interests were nurtured from a young age, with his mother teaching him geometry when he was a child. He was always a somewhat of a high achiever, attending Aberdeen Grammar School, then graduating alma mater Marischal College in 1657. Gregory then travelled to London in 1663, where he met the mathematician John Collins, a man who corresponded with many of the key men throughout the Scientific Revolution. Gregory then travelled Europe, working with the Italian mathematician Angeli.

The hopes for the Observatory, the first of its kind in Great Britain, were dashed as reality met these hopes. Gregory, after feeling underappreciated by both students and staff at the University of St Andrews, left to take up a position at the University of Edinburgh in 1674. From Gregory's letter to Frazer, describing a university where scholars 'did mock at their masters, and deride some of them publicly,' it is clear that Gregory's flare Mathematics in the era of the scientific revolution was not warmly welcomed. Gregory died in 1675 in Edinburgh, and without him, the observatory was shelved and never reached its potential.

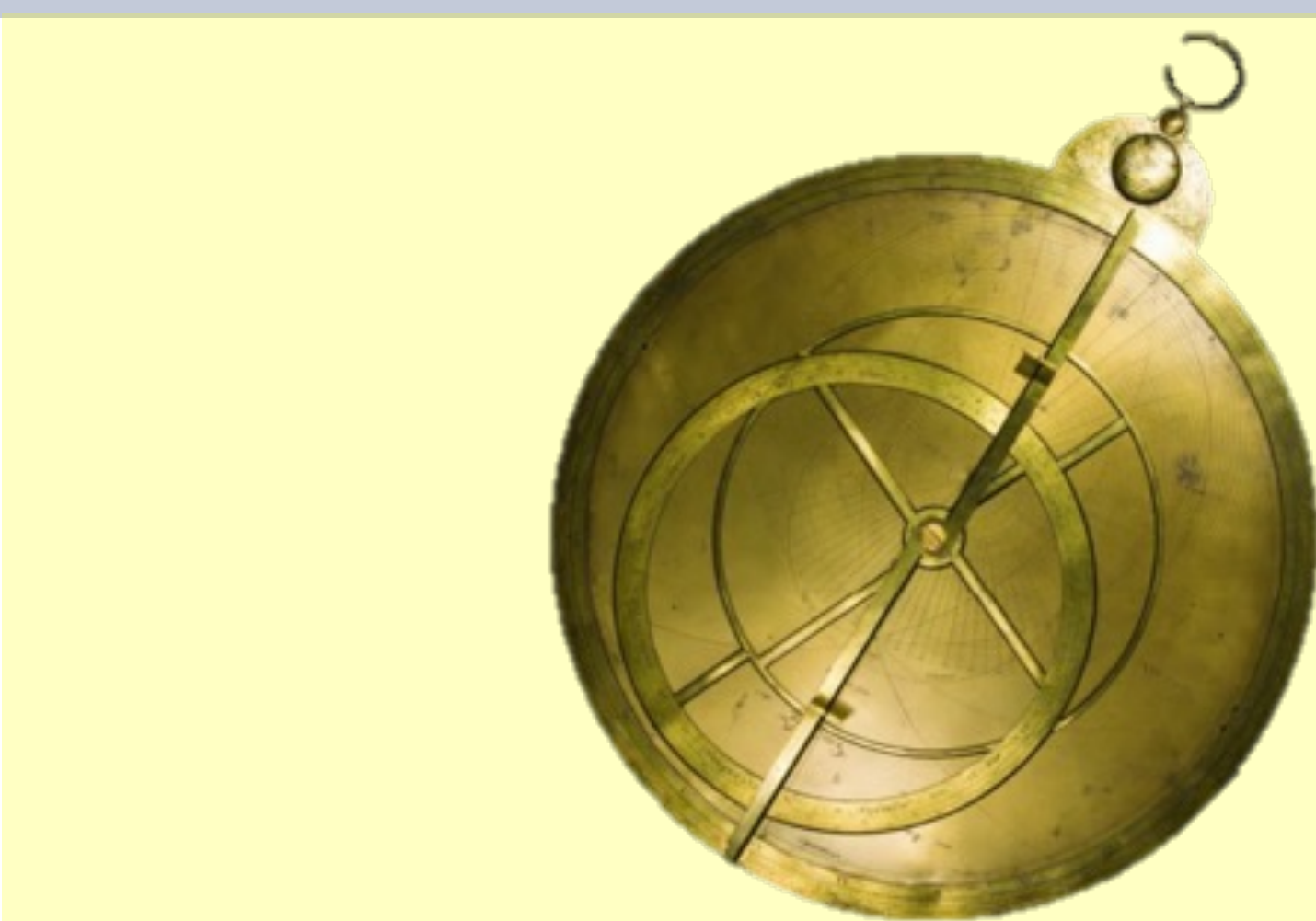
In 1668, Gregory travelled back to Scotland to take up the position of Regius Professor of Mathematics at the University of St Andrews, beginning the formal teaching of mathematics at the university. The university commissioned for the construction of an observatory on the 10<sup>th</sup> June 1673, citing reasons such as 'the honour of the kingdom' and 'improving of natural philosophy and Mathematicall sciences'.

The definite reasons may never be fully known, but from the devastation of the English civil war, to the loss of autonomy due to the union of the crowns, Scots may have felt that project such as this would reignite a new sense of Scottish pride.

Unlike the observatories in Greenwich and Paris, which were funded by their respective royal families, the St Andrews Observatory was funded via private donors and benefactors. Such donors include John Steuart of Grandtully and the Duke of Lauderdale. In 1673, Gregory was urged by the university to travel to London, the epicentre of instrument making at the time, and purchase the required instruments for the observatory.



James Gregorie  
Inventor of the Gregorian Telescope  
born 1638, died 1675



## The Great Astrolabe (Humphrey Cole, 1575)

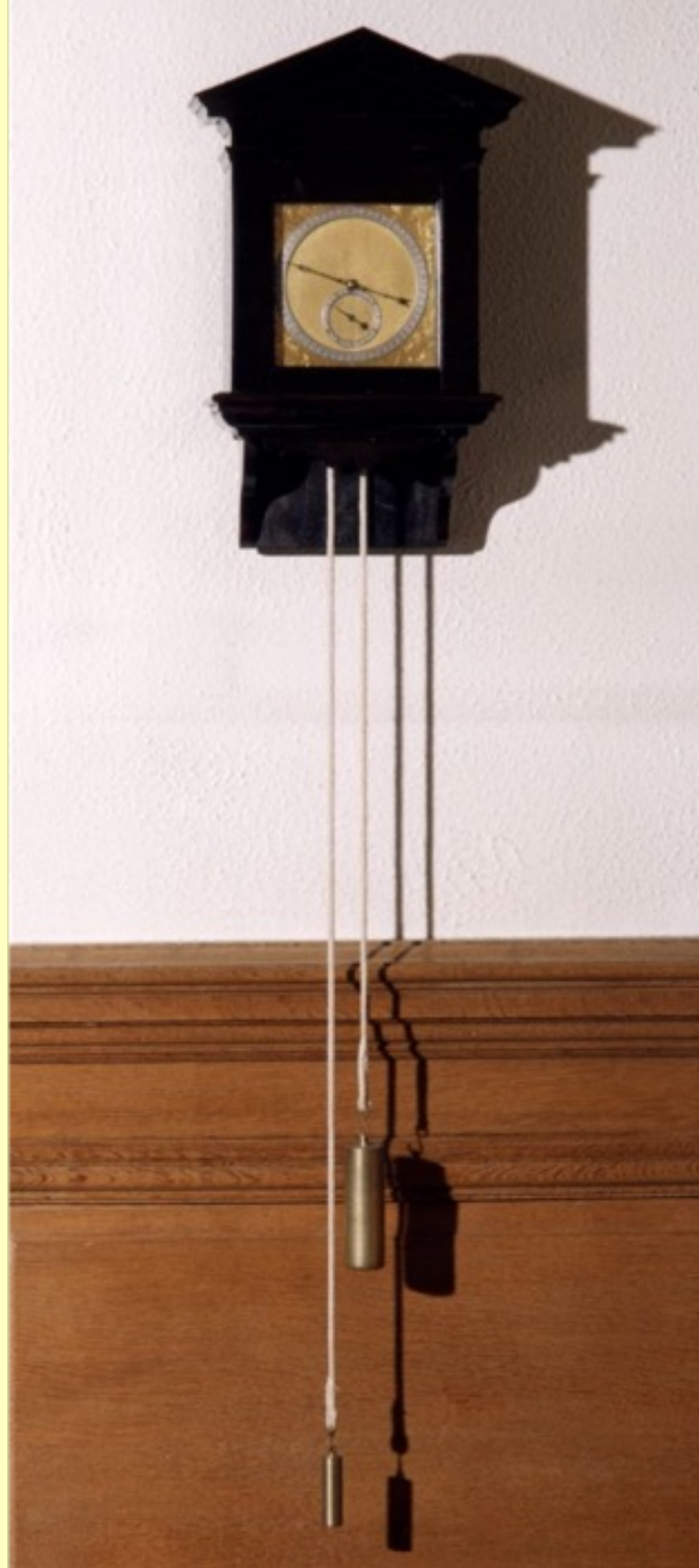
This instrument is one of the key instruments thought to have been bought by Gregory that we still have access to in the University Museums Collection. The manufacturer, Humphrey Cole (1530? – 1591), was the most well-known instrument maker in Britain during the late 16<sup>th</sup> century. Despite the instrument being crafted long before Gregory's birth, it was still used to carry out astronomical observations in Gregory's time.

An astrolabe's main use was to chart the stars that would be visible on a defined date, time, and latitude. By adjusting the outer ring until it lines up with the desired date, the rotating the rule and rete, we can get a representation of the constellations that would be visible. A drawback is that specific plates designed for a required latitude are required, and an astrolabe could only be used at the latitude the plate was designed for.

This quirk of an astrolabe plate only being used at a specific latitude has been key in deducing the intended user of the Great Astrolabe. If one were to look closely at the plate, one would see the maker's inscription, that of John Marke, as well as the latitude of 52°25', the approximate latitude of St Andrews at the time.

As well as a main plate, the Great Astrolabe also contains a *Quadratum Nauticum* (see right) on the back, which a navigator could use to ascertain by how much latitude and longitude had increased or decreased after sailing on a definite course.

The *Quadratum Nauticum* engraved on the back of the Great Astrolabe<sup>1</sup>



## Split-seconds Clock (Joseph Knibb, 1673)

The split-seconds clock is one of the most fascinating instruments acquired by Gregory, both its physical capabilities and the story behind its commissioning being much more than meets the eye. The clock was crafted by Joseph Knibb (1640 – 1711), belonging to the Knibb family of clockmakers, first established in Oxford by Joseph in 1662.

The key feature of the clock is that it is able to measure time to a degree of less than a second, and is considered to be the first clock to have the ability to do so. It could measure time to an accuracy of two thirds of a second, where the large hand measured this and the small hand measured hours. Gregory commissioned this clock as accurate timekeeping was required for Gregory's astronomical observations, especially the Longitude Problem, where very accurate clocks were needed to calculate longitude.

There is a large discrepancy in Gregory's description of the clock, as he described the clock in a letter to Flamsteed as 'vibrating 4 times a second...', compared to the observed striking every 2/3 of a second. This discrepancy would have been obvious to Gregory, suggesting that he was boasting of the clock's technical prowess before even having it in his possession.

The downgrade in accuracy from what Gregory initially requested was not trivial, and John Ceres Amson commented that this downgrade 'added one more nail to the coffin of his earlier Observatory dreams'.<sup>2</sup>

## What is Next?

After carrying out this research, my plan is to hold a variety of educational workshops with the Wardlaw Museum, targeted at younger children aged 5-12 and their families, concerning the use of such instruments, and explore both heliocentric and geocentric models. Through armillary spheres representing both models, and some open-source software, the plan will be to ignite curiosity about astronomy in those participating. Another plan will be to host a walking tour of St Andrews aimed at tourists, with a focus on the scientific legacy of the town, showing them the key sites associated with Gregory and his contemporaries at the university. Through use of social media platforms, I hope to engage with the public, encouraging those of all ages to attend one of the events, and ignite a spark in the curiosity of the people attending. There is much about Gregory and his observatory that is still unknown, only speculation, and I plan to use these educational mediums to explore further theories about him and his motivations.



## Universal Instrument (Humphrey Cole, 1582)

The Universal Instrument, or Armillary Sphere, is the second of the instruments manufactured by Humphrey Cole thought to have been purchased by Gregory on his trip to London in 1673. An armillary sphere was an instrument used for both demonstrations and observations, with smaller spheres being mostly demonstrations of celestial bodies, and larger ones being used for real observations.

The Universal Instrument is a unique variant of an armillary sphere, with an alidade, which is a pointer used for determining directions and angles in astronomy, that could be rotated on a circular disc. This allowed the user to measure altitudes when in a vertical position, and azimuths, which is the arc length from true north, in a horizontal position.

From the rotating alidade and the compass located on the bottom of the instrument, one can deduce that this instrument was not merely used for demonstration, but for astronomical measurement.

The unique feature of the instrument, the rotating alidade, however, is not novel. This particular feature is described by Cortes [(1510 – 1583)] in his *Breve compendio de la Sphera y de la arte de Navegar*, published in 1545.

Whilst the exact use Gregory would have had planned for the instrument is unknown, it is likely that he would have used this for charting the heavenly bodies

## Acknowledgements and References:

I would firstly like to thank Lord Laidlaw and the Laidlaw Foundation for providing the opportunity to pursue my interests, carry out the research project, and put it into action, as well as Klara Chura from Tufts University with whom I corresponded with throughout the research.

<sup>1</sup> Guther, R. T. "The Great Astrolabe and Other Scientific Instruments of Humphrey Cole." *Archaeologia; or Miscellaneous Tracts Relating to Antiquity*, vol. 26, 1926, pp. 273–317.

<sup>2</sup> Amson, John Ceres. *THE WORLD'S FIRST-SECOND CLOCK, 1673*. University of St Andrews, 14 Oct. 2014.

Gregory's letters to Flamsteed and the original commission for the observatory - Turnbull, Herbert Westren. *James Gregory: Tercentenary Memorial Volume*. Royal Society of Edinburgh, 1938.

Photo of Universal Instrument - The Universal Instrument (Humphrey Cole, 1582), held in St Andrews Museums collection, ID – PH203. <https://collections.st-andrews.ac.uk/item/universal-instrument/1000990>

Photo of Split-Seconds Clock - The Knibb split seconds clock (Joseph Knibb, 1673), held in St Andrews Museums collection, ID – PH208. <https://collections.st-andrews.ac.uk/item/knibb-split-seconds-clock/1001103>

Photo of Great Astrolabe - The Great Astrolabe (Humphrey Cole, 1575), held in St Andrews Museums collection, ID – PH201. <https://collections.st-andrews.ac.uk/item/great-astrolabe/1000988>

Sketch of St Andrews - St Andrews From South East (John Oliphant, 1767) Courtesy of the University of St Andrews Libraries and Museums, ID: OLI-4. <https://collections.st-andrews.ac.uk/item/st-andrews-from-south-east/93069> The University of St Andrews is a charity registered in Scotland, No: SC013528