

## STARS FROM THE NE

### (Astronomers from North East Scotland)

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Imagine being alive in 100 years' time, looking back on developments in astronomy in the decades around the year 2000. Our great-grandchildren will be doing just this. They will see a time when huge advances were made in our appreciation of the universe, on almost all scales ranging from that of our solar system to the cosmological. Our great-grandchildren will have every cause to say "It must have been great to be alive then". Well, from the past to the future, we can say "It is". If that's so, why am I going to take some of your time speaking about our history? Partly because the rest of this meeting is about the excitement of our times, but mainly because astronomy of all the sciences is not a subject that's a few decades old but a subject of millennia. We're sitting on the shoulders of our ancestors and from time to time it's not a bad thing to look backwards in time to see where we've come from and how we got here.

I'm going to talk about 5 astronomers from NE Scotland, starting with James Gregory and ending with David Gill.

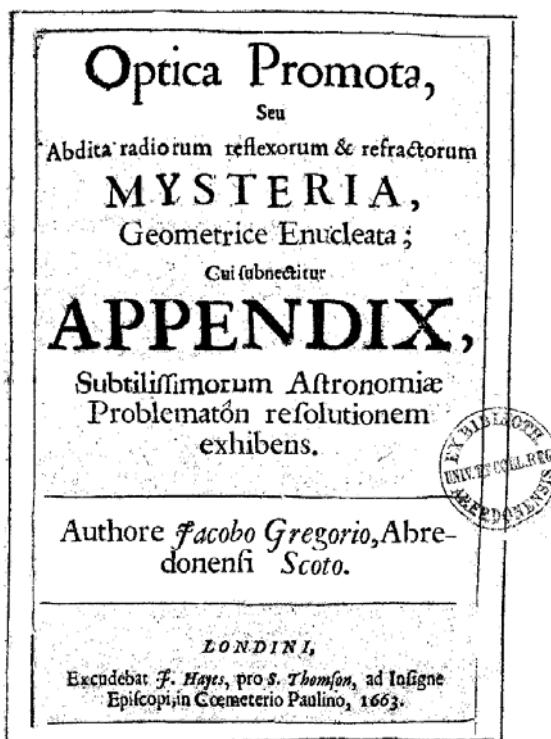
#### *James Gregory (1638 – 1675)*

No student who has come to my Optics lectures will get away without hearing about James Gregory, but I don't really do him the justice he deserves. The Gregory family are one of Scotland's intellectual phenomena. James Gregory, son of the manse, was born at Drumoak, not far from Aberdeen, in 1638. After graduating from Marischal College, one of the two Universities in Aberdeen, he became Professor of Mathematics at St Andrews and then Edinburgh; his son, became a Professor at Aberdeen, his grandson, his great grandson and his great-great grandson were all professors in Scottish Universities or in Oxford, particularly of medicine or mathematics. In all, some 22 related Gregory's were professors over a span of 200 years. Mind you, James' elder brother David, who looked after James' education when their father died, gave the family a good start by having 32 children. He too was a notable mathematician, a specialist in exponential growth perhaps, one of whose sons became Professor at Oxford.

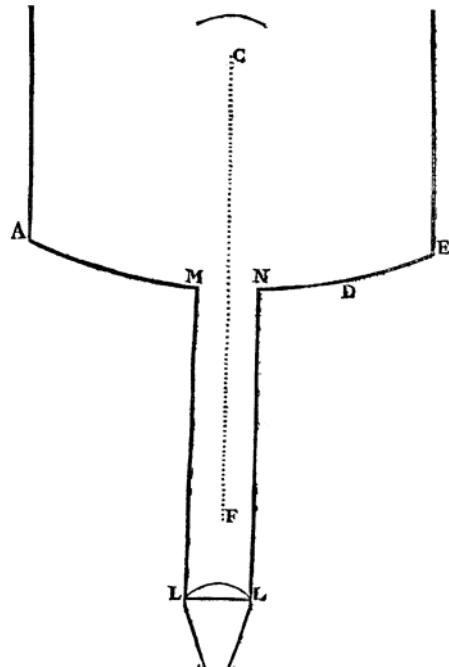


**James Gregory, courtesy  
the University of Aberdeen**

To return to young James. Why should we remember his contributions? I hardly need to say to this audience that it was James Gregory who invented the reflecting telescope, publishing his version some nine years before Isaac Newton published his. Gregory's design appeared



Title page from *Optica Promota*  
in the library of the University  
of Aberdeen



Gregory's diagram of  
the reflecting telescope  
in *Optica Promota*

in his first book, *Optica Promota*, in 1663. By then, aged 24, he had gone to London and attempted to get one of the best optical instrument makers of the day to make the telescope mirrors for him, but the maker failed to figure satisfactory ones. The Gregorian and Newtonian designs differ from each other somewhat as a flute differs from an oboe. Perhaps because of their more obvious method of use, simply looking straight into the end, Gregorian telescopes became the most popular of all in the following century, and very fashionable among the amateur scientists of the aristocracy, of whom there were many.

On one famous occasion, while Professor of Mathematics at St Andrews, James Gregory persuaded the good folk of Aberdeen to hold a church-door collection throughout the town to supply money for astronomical instruments for the observatory at St Andrews. That takes real talent.

Gregory made the first reasonable estimate, to my knowledge, of how far away the stars are. He compared the amount of light coming from the Sun to that from Sirius. Assuming they were both similar bodies, he deduced from the weakness of Sirius's light that it was about 90,000 times further away than the Sun. In fact, the Hipparcos survey parallax measurement shows that Sirius is 6 times farther away than even this but Gregory's answer is a pretty good estimate for an astronomically huge distance, and Gregory didn't know that Sirius was an intrinsically much brighter star than the Sun.

In *Optica Promota* he spelt out how you could find the distance to the Sun itself, by the method of watching and timing the transit of Venus across the disk of the Sun from different latitudes on Earth. These transits only occur in pairs about every 120 years. The last in the 1600s occurred when Gregory was barely one year old. On the next possible occasion, in the

18<sup>th</sup> century, the measurements were made and produced the best answers then available for the astronomical unit. Again in the 19<sup>th</sup> century, the method was re-used effectively to within the intrinsic limit of its accuracy. I'll say more about this later.

Gregory's greatest talent lay in mathematics, and historically minded mathematicians point out that he not only discovered Taylor's fundamental theorem in calculus 40 years before Brook Taylor did, but achieved so much in advancing the techniques of calculus that he deserves to be credited as a co-inventor of calculus, with Newton and Leibnitz. What did St Andrews University make of all this talent on their doorstep? His students learnt facts in mathematics that made some of the teachings of the other masters seem wrong. These masters gave orders to the servants not to help Gregory with his astronomical observations; they '*kept scholars of the most eminent rank from me, contrary to their own and their parent's wills*', as Gregory put it, persuading them that their brains were not able to endure his mathematics; they even withheld his salary. It is often thus that talent isn't appreciated at home. He left to go to Edinburgh University, at twice the salary.

Gregory's girl was Mary Jamieson, daughter of the great Scottish painter George Jameson, the Van Dyke of Scotland, another Aberdonian. He had only one son by her, also called James, before he died a year into his Edinburgh professorship at the tender age of 37, still mathematically active. Charles II thought sufficiently highly of Gregory to award a pension to his widow and family "*in recognition of his services to science and to Scotland*". Tell your friends about James Gregory, the Scottish inventor of the reflecting telescope, measurer of the heavens and co-inventor of basic calculus. Like many other famous astronomers, he has a crater on the Moon named after him.



From the stained glass window  
in the Mitchell Hall, Marischal  
College, Aberdeen

#### *James Ferguson (1710 – 1776)*

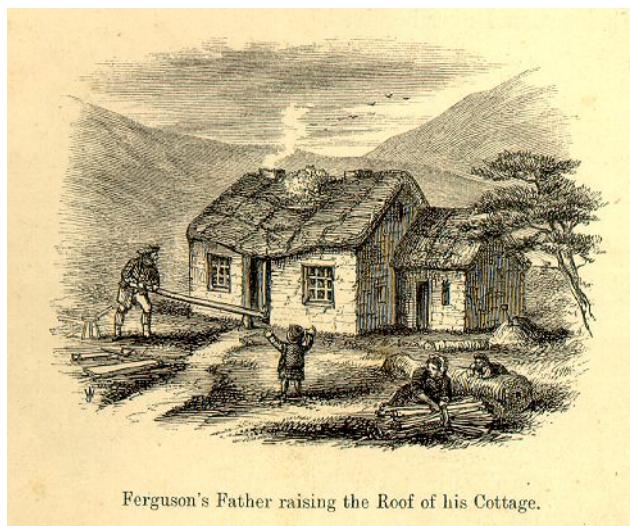
James Ferguson was born in the parish of Rothiemay, in Banffshire, the son of a peasant farmer. It's an interesting comment on the value that we in the NE have placed on education over the centuries that his father living 300 years ago in an isolated country cottage in this part of Scotland could both read and write. James Ferguson was what is known as self-taught or, as he liked to say, 'taught by God'. He had negligible formal schooling but did receive informal instruction from some of the local educated men. Later he had guidance from his own friends, amongst whom was one of the 18<sup>th</sup> century's most able mathematicians, Colin Maclaurin, who had by then moved from Aberdeen to Edinburgh. [The Scottish National Portrait Gallery has a copy of a drawing of Maclaurin made by Ferguson].



James Ferguson. Portrait by  
John Beatson, 1756, courtesy  
University of Aberdeen

Ferguson based himself in London for much of his professional life. He didn't push forward the boundaries of astronomy in the 18<sup>th</sup> century but he did push many people into taking a real interest in astronomy. He was well known to all the practitioners of the time in Britain, FRS, author of astronomical textbooks, designer of astronomical clocks that have never really been surpassed, a public lecturer whose reputation earned him a comfortable living and a pension from the King.

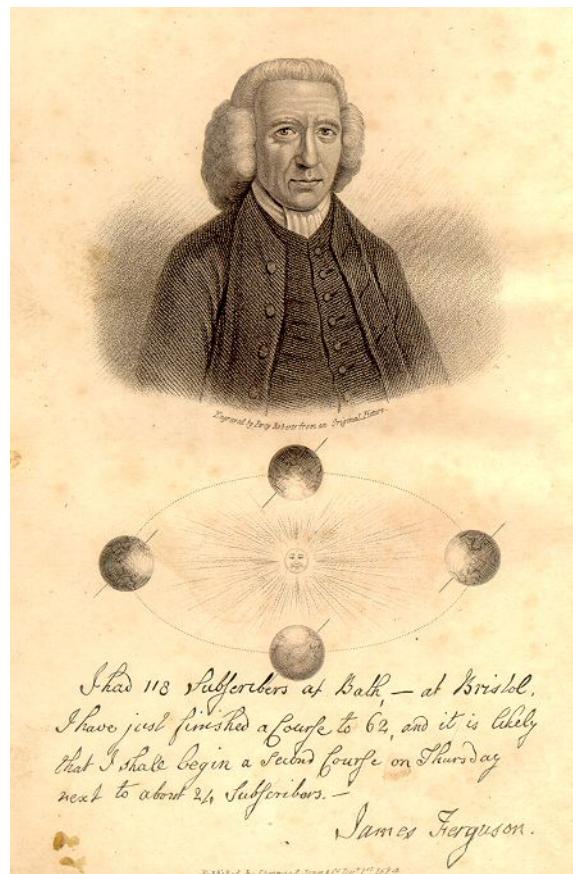
**Ferguson's portrait published in the author's copy of his *Lectures on Select Subjects* [London, 1837]**



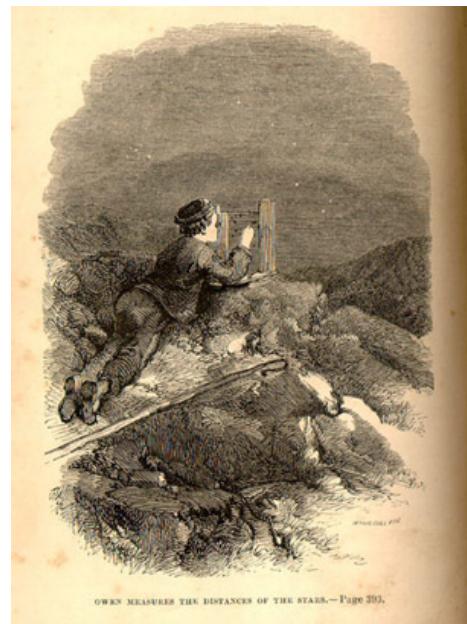
Ferguson's Father raising the Roof of his Cottage.

Ferguson's self-taught origin was an inspiration to others. I have a book on my shelves of 484 pages called *the Story of the Peasant-boy Philosopher* by one Henry Mayhew. It is a piece of fiction written about 150 years ago designed to inspire children to learn for themselves, based, as they say in the TV trailers, "on the true story" of James Ferguson's childhood years. Nowadays astronomers can aspire to a Nobel Prize, and some have achieved this, but how many have inspired an author to write a novel based on their life?

In Ferguson's time, astronomy was mainly about the solar system, about eclipses, about tides and about the Moon's motion. Telescopes hadn't the aperture for deep space work. Indeed it wasn't until comparatively well on in Ferguson's life that the achromatic objective was invented by John Dollond. Even by the end of his life, a 4 inch aperture refractor was pushing the limits of glass technology. Spectroscopy was nowhere to be seen. The 'fixed stars' seemed to carry little information. Nonetheless, astronomy was evolving into a technical



**Ferguson's father's cottage from *Life of James Ferguson F.R.S.* by E. Henderson [Edinburgh, 1867]**

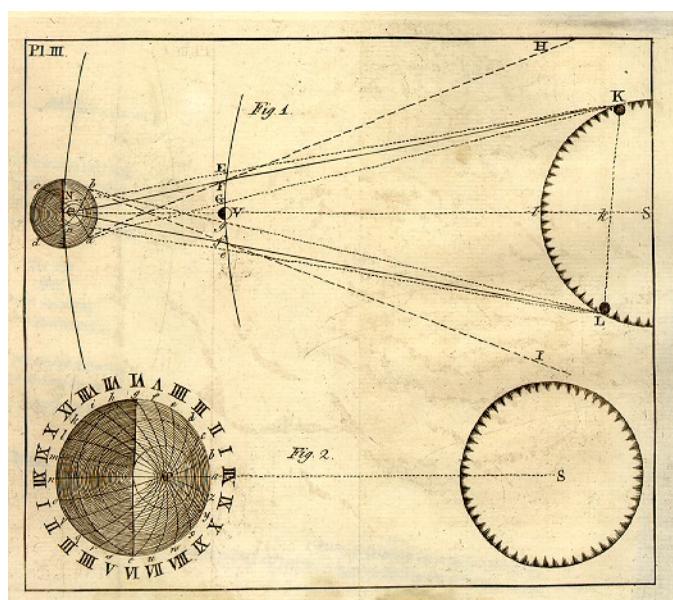
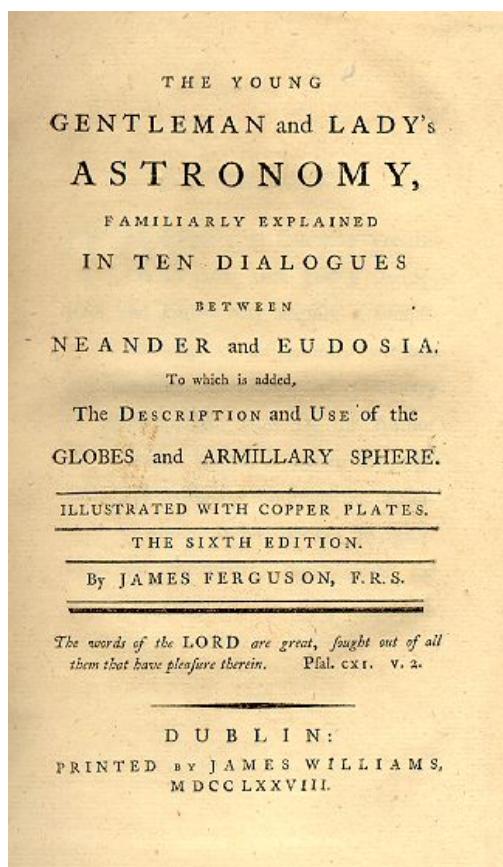
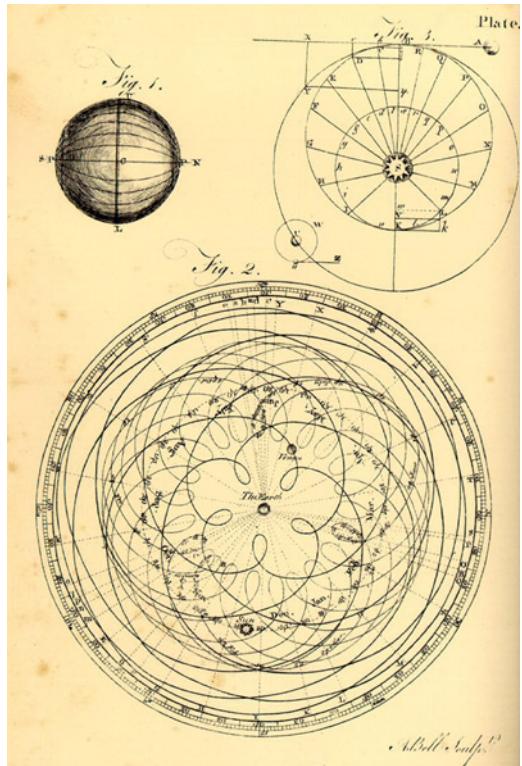


**An event paralleling that in Ferguson's childhood, illustrated in *The Story of the Peasant-Boy Philosopher***

subject, technical enough to need a sympathetic expositor to keep the public informed. The nearest analogy I can make is that James Ferguson was the Patrick Moore of his day.

Ferguson's hot-selling book *Astronomy Explained* was re-printed as the very long article on *Astronomy* in the first edition of the Encyclopaedia Britannica. The diagram alongside shows how retrograde motion occurs naturally if you view the heliocentric orbits of planets geocentrically. He drew it by fitting a pasteboard over the Earth on his mechanical orrery and marking off the directions of Venus and Mercury over a span of several simulated years.

**Example of Ferguson's own  
carefully drawn diagram  
from *Astronomy Explained***



**Title page (left) and transit of Venus illustration (above) from *The Young Gentleman and Lady's Astronomy***

Lecturing almost 150 years before women were accepted into Universities in this country, Ferguson was keen to make his instruction equally accessible to them. Like all his books, *The Young Gentleman and Lady's Astronomy* ran to many editions. It covered topics such as size and motion in the solar system, sidereal time, solar time, mean time and the art of dialling (i.e. making all sorts of sundials), finding latitude and longitude, very topical subjects for the century, the Moon's motion, tides and eclipses and some even more technical matters such as

scaling the solar system from timing the transit of Venus across the face of the Sun. The book was presented as a dialogue between Eudosia and her brother. Whether a real Eudosia in the 18<sup>th</sup> century would have the bottle to strike up a technical conversation on the transit of Venus with a visiting gentleman I'm not sure – I can't recall any author describing the scene in a novel – but Ferguson's heart was in the right place. How many ladies from the social classes will be discussing this topic with visitors next year when the transit happens again for the first time for 121 years?

The 4 m high monument to James Ferguson in the parish of his birth, Rothiemay, seems to be little known outside the locality. It was sculpted by an Aberdeen mason from local granite and erected in 1907. The Rothiemay countryside in the Deveron valley is well worth a visit. Put it on your list of places to go to.



**Ferguson's memorial in Rothiemay**

#### *Andrew Mackay (1760 – 1809)*

Having mentioned briefly in passing the importance of the subject of determining latitude and longitude in the 18<sup>th</sup> century, I must introduce you to Aberdonian Andrew MacKay, *a little, bustling, bandy-legged man with eyes of jet and a countenance of much intelligence and animation*. He became notable in his day as the author of best-selling books on navigation. Most prominent among them was his *The Theory and Practice of Finding the Longitude at Sea or Land*, which was written while he was “Assistant keeper of the Observatory in Aberdeen”. This was the Castlehill observatory, Scotland’s first semi-public observatory equipped with modern instruments, erected in 1781. It was masterminded by Professor Patrick Copland of Marischal College, who funded it by public subscription.



**Andrew Mackay**

It was in keeping with the age that the *usefulness* of all branches of science was being emphasised at the end of the eighteenth century and the beginning of the 19<sup>th</sup> century. The obvious usefulness of Astronomy was at least three-fold – in time keeping, in navigation and in terrestrial mensuration. MacKay and Copland measured the latitude of the observatory accurately to within a few seconds of arc and the longitude by various methods. One such measurement involved meridian transit timing, arranging with Neville Makelyne, the Astronomer Royal at the time, to have a chronometer sent from Greenwich to Aberdeen. A second method involved the simultaneous observation by MacKay and Maskelyne of a solar eclipse in 1788. If this sounds tame in relation to today’s astronomy, remember that this was the time when a major effort was made to determine the exact positions of the observatories of Greenwich and Paris on the globe, or at least exact to within a few seconds of arc. Astronomy and geodesy were intimately linked. We tend to forget these days that everyday concepts like the North Pole and latitude are more astronomical than anything else. MacKay

narrowly missed being given a chair at King's College, Aberdeen and went on to set up his own School of Navigation in the city. He certainly earned a living from the practical application of astronomy.

### *John Ramage (1783 - 1835)*

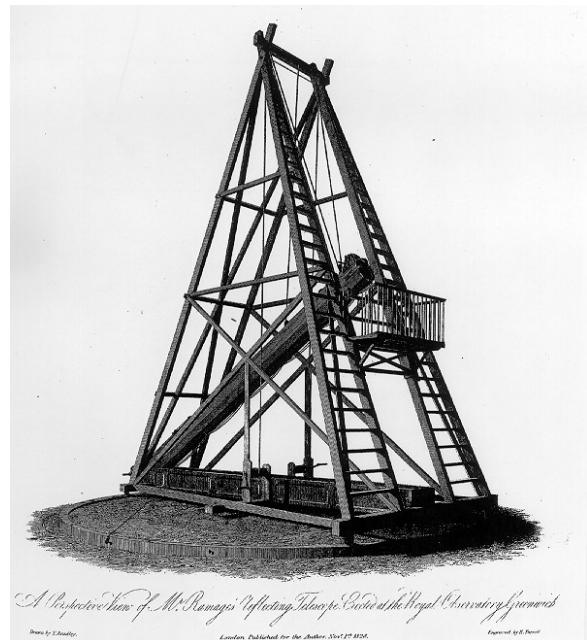
Comparatively early in the 19<sup>th</sup> century, bigger telescopes than the refractors of Dollond and Ramsden that were in the Castlehill observatory began to appear in the city. Although professors in both Universities in the city were interested in astronomy, this new generation of instruments was the product not of academics but of gifted artisans. I'll mention John Ramage as one. His inspiration was clearly William Herschel's great 40 foot focal length, 4 foot diameter, instrument using the front view into a slightly inclined mirror.

#### **Ramage's telescope erected at Greenwich, from Pearson's Astronomy**

Ramage began making large telescopes around 1810 and his attempts were noted across the country. One of Ramage's instruments was offered to King's College but they hadn't the space for it. One with a 15 inch mirror and 25 foot focal length was sent down to Greenwich in 1825, erected there and regarded as something of a wonder because it was designed to be used by a single operator. This was quite a feat in a device almost 10 m high. However, as a historian of astronomy commented later in the century *the perfection of these instruments does not seem to have been commensurate with their magnitude* and they did not make the discoveries they should have done. It must be said that neither did Herschel's great instrument, which even by 1811 was little more than scrap. Ramage's Greenwich instrument eventually ended up at the Glasgow University observatory, as can be seen on a local engraving. An interesting trailer to this story is that mechanics of the great Birr Castle reflector, which certainly did make the discoveries it should have done, was said to be based on Ramage's arrangements.

### *David Gill (1843 – 1914)*

Sir David Gill, KCB, President of the RAS, FRS, the very first Honorary member of the Astronomical and Astrophysical Society of America, showered with international recognition, was an Aberdonian born and bred who would feel totally at home in our audience today. Gill's story is intimately tied up with the establishment and flowering of one of the best observatories in the world at the



*A Perspective View of Mr. Ramage's Reflecting Telescope Erected at the Royal Observatory Greenwich*  
Drawn by E. Dandy  
London, Published for the Author, Nov 1<sup>st</sup> 1826.  
Engraved by H. Fairall



**David Gill, courtesy of the Royal Astronomical Society**

time, at Dunecht (modern spelling) just a few miles west of Aberdeen. Later, his work as Her Majesty's Astronomer at the Cape of Good Hope Observatory for 27 years put science in South Africa on the map and confirmed Gill as one of the foremost astronomical observers and experimentalists of the 19<sup>th</sup> century.

Gill was the astronomer who established the first-class running of the Dun Echt observatory activities. He was the ideal man for the job, with the ideal qualifications. These were not a PhD in astrophysics but the following: he was a keen amateur marksman, a skilled watchmaker, he had a passion for astronomy and had attended James Clerk Maxwell's third year Natural Philosophy course at Marischal College, Aberdeen. He had the eyesight, the mind and hand that got the very best out of equipment, the passion to take himself into the unknown and had been taught physics by a man whose own enthusiasm and competence set standards that would inspire the best of any of us.



**King's College, Aberdeen**



**Marischal College, Aberdeen,  
in the 19<sup>th</sup> Century**

To begin almost at the beginning, following up from Maxwell's lectures, Gill became friendly with Professor David Thomson at King's College, Aberdeen, who gave him an introduction to Piazzi Smyth in Edinburgh, the man who had set up the 'one o'clock gun' service that bought accurate astronomical time to the Edinburgh public. What better combination of interests for the son and heir of one of Aberdeen's premier watch-making businesses? This was in the early 1860s. Gill had come back from a two year 'finishing school' trip, honing his watch-making skills with internships at some of the best London and French watchmakers. Gill & Sons were watchmakers to the Queen, with David now a partner in the business. He and Prof. Thomson set up a time-service for Aberdeen, with an electrically controlled pendulum clock driving slave clocks, first at King's College tower, then taking wires up to Marischal College, a mile away and then, later, to Gill's shop another mile away up Union Street, Aberdeen's main street. The whole enterprise was powered, as it were, by transit telescope observations from the Cromwell Tower



**Twin domes of the Cromwell Tower  
Observatory, King's College, Aberdeen**

observatory at King's College. Accurate time was brought to the citizens of Aberdeen not just at one o'clock in the 1860s but throughout the day.

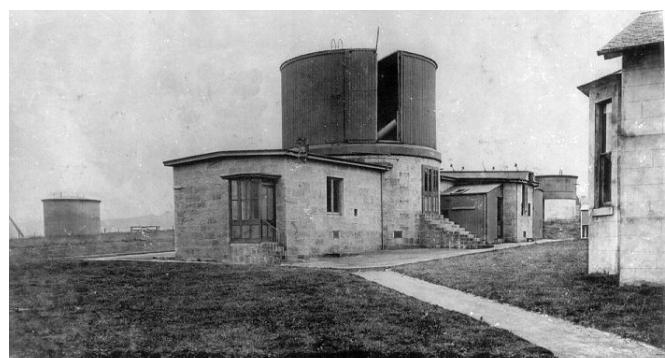
Gill helped Thomson set up an equatorial instrument for the Cromwell Tower Observatory. This was a second-hand, 3.75" diameter, refractor by Ross. However, Gill soon found he personally wanted something bigger in diameter with better tracking control. He bought himself a 12" reflector of 10 feet focal length which he set up in the grounds of his father's house not too far from the centre of town. No need to worry about electric street-lighting then.



**Above:** Lord Lindsay's eclipse expedition in Cadiz, with Gill's 12" telescope, courtesy Royal Observatory Edinburgh Library & Archives

**Left:** Spy magazine's affectionate caricature of Lord Lindsay, from Gill's biography

Meanwhile, almost in a different world, the young James Ludovic Lindsay, son of one of Scotland's premier aristocrats, was honing his interests in astronomy as a student under John Couch Adams at Cambridge. Lindsay was immensely talented. In 1869, at the age of 22, he inherited the title of Lord Lindsay and became immensely rich. In 1870, Lindsay organised a private eclipse expedition to Cadiz to observe the shape and structure of the solar corona and to take spectra of any prominences that could be seen during the eclipse. He borrowed David Gill's 12" telescope. The expedition was entirely successful and the results written up and published,



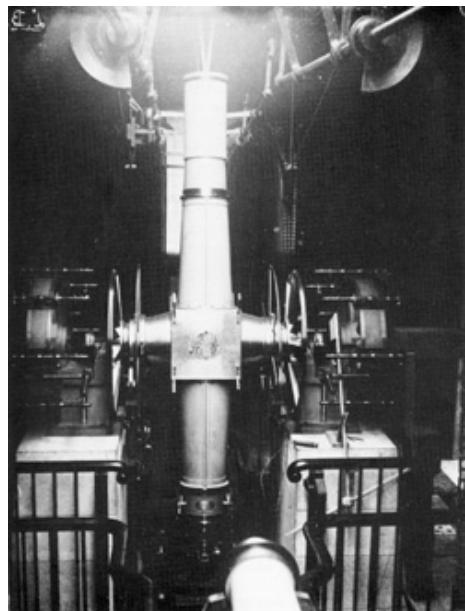
**Dun Echt observatory, courtesy University of Aberdeen**

as was all Lindsay's subsequent astronomical work.

Lindsay was completely bitten by the astronomy bug. In the following year he planned the Dun Echt observatory, to be purpose built on his father's huge Dun Echt estate, which stretches as far as the eye can see over rich Aberdeenshire agricultural land. The observatory was to be equipped with the finest instruments of the day, not for the pleasure of showing his dinner guests the stars after dark but for the purpose of serious astronomy and astrophysics, to be reported alongside the work of the best observatories in the world. David Gill was offered the job of Director of the Dun Echt Observatory. Gill recalled later in life "*I was in business for 8 years, had married, was making £1500 a year, and working at night in my own observatory when Lord Crawford offered me £300 a year...In 24 hours Lord Crawford had his answer – 'yes'. I never regretted that decision*".



**Left: Dun Echt Observatory's 15" equatorial by Grubb erected at the ROE. Courtesy ROE Library & Archives**



**Right: Dun Echt Observatory's 8.5" transit by Troughton & Simms. Courtesy ROE Library & Archives**

What really bought David Gill to the attention of professional astronomers was his handling of Lord Lindsay's transit of Venus expedition in 1874. The Dun Echt Observatory observations would be undertaken in Mauritius, which is some distance away. Lindsay purchased a 398 ton 3-masted schooner for the purpose of taking him and his instruments through the Suez canal to the southern Indian Ocean. They left England in early July but unfavourable weather meant that they didn't arrive until early November, only a month before the event. However, Gill had been sent by more reliable steamer with the crucial micrometric heliometer that was to provide precision spatial measurements, and a collection of no less than 50 precision marine chronometers, set up at Greenwich, that were to provide both crucial timing of the event and determine the longitude of the observing site. Lindsay and Gill were serious about their astronomy. To cut a very interesting story short, the results were among the best obtained by anyone. However, Gill confirmed that there was a serious problem with the method. This problem resulted from the uncertainty in timing the exact moments of visual contact of Venus with the Sun's limb because of the effect of Venus' atmosphere.

The twist in the tail of this story is that Gill had hit upon a better way to scale the solar system through observing an asteroid at its closest approach to Earth both in the evening and in the morning. The rotation of the Earth caused a parallax between the two observing positions and, by application of the relevant geometry, the distance to the asteroid can be computed in terms of the Earth's diameter. Hence the solar system can be scaled relative to this distance

through the use of Kepler's 3<sup>rd</sup> law. During the weeks running up to the transit of Venus, Gill made measurements on the asteroid Juno that, on being worked up confirmed that this method was superior to the transit of Venus.

In 3 or so years at Dun Echt, Gill had grown in stature to become personally friendly with and highly respected by leading astronomers across the world, from Newcomb and others in the States to Struve in Russia. The problem of measuring the astronomical unit accurately was considered so important in astronomy that the transit of Venus measurements and even Gill's Juno measurements could not be considered the end of the story.

Gill left Dun Echt in 1875 under very friendly terms with Lord Lindsay and, sponsored by the RAS and by private subscription, set off with Lord Lindsay's heliometer on his own expedition to Ascension Island. The point of the expedition was to look the other way from the Sun, to look at Mars in opposition, which in 1877 would be closer to the Earth than at any time for over a century.

This year, with the imminent occurrence of Mars coming closer to the Earth than at any time in some 80,000 years, it's appropriate to remember how Gill responded to the earlier opportunity. His intention was to deduce a better value for the AU by measuring the parallax of Mars than had been done by any other method. Gill and his young wife Isobel set up camp for 6 months on Ascension Island. Isobel Gill's account of the expedition was published as a book entitled *6 Months in Ascension*. It is well worth the read. Astronomically, after a problematic start, the expedition was entirely successful and obtained a better value for the AU than came out of all the transit of Venus observations. Gill's final value for the solar parallax from this excursion was 8.783" of arc. I'd challenge any of us to get results from telescopic observations to 0.01" arc, even with today's instruments. This is about the difference between Gill's result and today's value for the ratio of the equatorial radius of the Earth to the AU. Anyone can read suitable micrometers to this accuracy but measuring angles correctly to this precision is another kettle of fish altogether. For comparison, 0.01" arc is the change in meridian altitude of a star when you move your telescope 1 foot (0.3 m) North on the Earth.



MR. AND MRS. GILL IN CAMP AT MARS BAY, ASCENSION, 1877.

### Camp on Ascension Island, from David Gill's biography



**Heliometer used by David Gill, now at the Royal Observatory, Edinburgh. Notice the divided object glass**

Gill was technically unemployed after this trip but it took more than a year to work up the Mars results. I particularly like the story of his first meeting with James Nasmyth at the house of their mutual friend Samuel Smiles at this time. Nasmyth was an Edinburgh man, famous for his invention of the steam hammer. He had built up a huge engineering business in the North of England and, unusually for the times, had retired at the age of 48 to enjoy his fortune and pursue his favourite hobby of astronomy. Gill and Nasmyth had much in common and got on very well. Gill and his wife had taken the same omnibus home as Nasmyth, who got out a few stops before the Gills. When David Gill proffered their fare to the conductor upon alighting, the conductor said "And a penny for the other gentleman, please; he said you would pay his fare". This amused the Gill's. The next day a letter arrived from Nasmyth enclosing a cheque for £1000 to spend on whatever astronomical instrument Gill might think best suited to his work. That's more like £100,000 in today's money. Where are the likes of James Nasmyth now? It so happened that Gill was appointed Her Majesty's Astronomer at the Cape of Good Hope Observatory not long afterwards. This was in February 1879.

The second half of Gill's biography is subtitled *the work of a real astronomer* and it begins here. I shall be quite brief.

Gill pioneered the use of astrophotography. After having produced excellent, comparatively wide angle, photographs using a portrait camera piggy-backed onto his own telescope at the Cape Observatory, in 1886 he suggested that a range of observatories around the world should combine to make a photographic star atlas, the Carte du Ciel as it shortly came to be known. The French name arose because Admiral Mouchez of the Paris Observatory launched it at the astrographic conference in Paris in 1887. The undertaking was the greatest international astronomical research project that had ever been embarked upon until then. Gill acted as project director, as well as contributing some 1500 plates. The sky was to be divided into  $2^\circ$  sectors with stars down to 14<sup>th</sup> magnitude recorded and stars to 11<sup>th</sup> magnitude catalogued. A standard dual telescope was designed for the task, combining astrographic and visual sighting instruments, to be used by all participating observatories. Gill devised an optical reader to speed up taking coordinates from the plates but still teams of human readers were needed. This aspect introduced many women to practical astronomy. The project was a labour of



**Above:** the Cape's Carte du Ciel telescope, from *History of the Cape Observatory*

**Below:** The Carte du Ciel telescope dome, same source



THE ASTRONOMICAL OBSERVATORY.

decades and perceived as that from the outset. This was not the only star catalogue Gill was producing for he also undertook a less ambitious scheme, the CPD – Cape Photographic Durchmusterung - which succeeded in doing for the southern hemisphere what the Bonn catalogue did for the northern hemisphere, namely accurately recording all stars down to magnitude 9.5. There are just over 450,000 stars in the CPD, which covers declinations south of -19°.

Gill's forte was precision measurement. He'd got his teeth into the problem of determining the solar parallax to the highest precision possible. He'd managed to persuade the Admiralty (who funded the Cape observatory) to find £2000 to purchase a 7" objective heliometer for the most accurate fine angular measurements. The device was to be made by the famous instrument making firm of Repsolds in Hamburg, who had made smaller heliometers that a few observatories possessed. I like the story that Professor Kapteyn of Groningen recalled. He and Gill had journeyed to Hamburg to see the heliometer. After a very tedious trip they arrived in the city close to midnight. Repsold himself met them and told them that the finished instrument was ready for inspection in the morning. Gill wouldn't hear of it. "We must see it", he said. And they did. Gill inspected every bit of it before retiring to bed a happy man. Back at the Cape, he used this instrument first for precision parallax measurements on the asteroids Iris, Victoria and Sappho. To analyse the result, you need to take account not only of the Earth's elliptical orbit but of the wobble in the orbit introduced by the Moon. When Gill grouped together sets of observations he found that the wobbles still showed up in the data at the level of fractions of a second of arc but they all disappeared to the level of a few hundredths of a second of arc if he used a different value for the mass of the Moon than the best value to date. For reference, the Rayleigh criterion diffraction limit for a 7" objective in absolutely perfect seeing conditions is about 0.6 seconds of arc. Out of this work came not only the very best value for the distance of the Sun, but the mass of the Moon and its nutation constant, all of which were taken in 1896 as the definitive international values for use in Almanac calculations around the world.

There is a nice story that when Gill was interviewed by a journalist, he compared his accuracy in measuring star positions to measuring a threepenny piece a hundred miles away. The response came back



[To face page 196.  
THE HELIOMETER HOUSE, WITH DR. AUWERS AND  
DR. AND MRS. GILL.

**David Gill, his wife, Isobel, and Prof Auwers in front of the heliometer house; from Gill's biography**



[To face page 202.  
THE STUDY, CAPE OBSERVATORY. MISS AGNES CLERKE WITH DR. AND MRS. GILL.

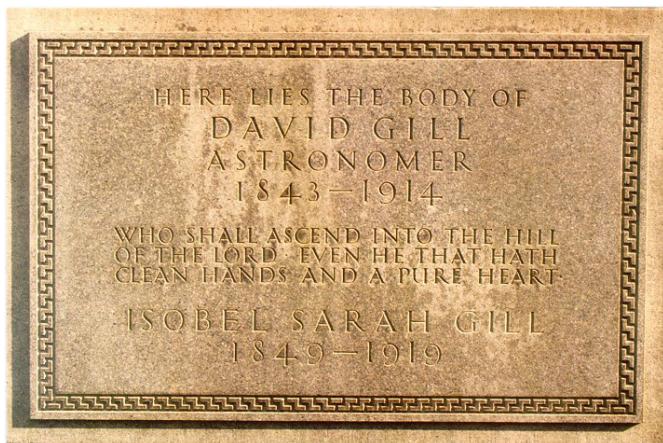
**David Gill in his study with the notable astronomical author Agnes Clerke in the foreground; from Gill's biography**

quickly that only an Aberdonian would be worried about a threepenny piece at that distance.

Precision measurement is exactly what is necessary to determine stellar parallax and Gill made more advances with this than anyone else, by a long way. It's fair to say that his work ushered in the themes of the 20<sup>th</sup> century by pushing forward the use of astrophotography, by highlighting the importance of stellar parallax as the basic method of stellar distance determination and by his spectroscopic work, which I haven't mentioned. For this, thanks to a private donation, he equipped the observatory with a 24" aperture telescope with objective prism, known as the Victoria telescope. On top of this, the Carte du Ciel has proved a tremendous resource for working out the proper motion of stars, for identifying binary stars and longer term variable stars. There's almost certainly still a lot more that could still be got from it today if someone would fund the digitisation of the plates. Gill was no astrophysicist, no Jeans or Eddington, but a person who believed passionately in the value of observational astronomy and the need to get the very best results out of every task he undertook. He was a supreme instrument man and observer.



**St Machar's Cathedral, Aberdeen**



**David & Isobel Gill's grave stone**

My final illustration finishes where Gill's biography ends, in St Machar's churchyard.

I'll end, like a good sermon, with a moral for the day. David Gill FRS, FRSE, PRAS, etc. was a man of tremendous integrity and humanity. He co-operated with astronomers around the world. He didn't have a real University degree to his name. Yes, he had Honorary DScs and LLDs from Oxford, Cambridge, Edinburgh, Aberdeen, etc. but he got where he did by what he did. The quality of his work convinced people, not the letters after his name. This may seem an odd point to make to all in the audience who are working up their PhDs but in many respects today is not really that different from Gill's day. Nowadays the PhD doesn't single you out for a job but simply gets your CV on the pile that's looked at. What really counts is what you've done. Don't be shy in making this as good as you can and in telling people about it.

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