

## David Gill FRS (1843 – 1914): The Making of a Royal Astronomer

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### *Abstract*

David Gill was an outstanding astronomer over several decades at the end of the 19<sup>th</sup> and into the early 20<sup>th</sup> century. He was famous for his observational accuracy, for his painstaking attention to detail and for his hands-on knowledge of the fine points of astronomical instrumentation. Astronomy, though, was a second professional career for David Gill. This account maps out the surprising and unusual path of David Gill's life before he became Her Majesty's Astronomer at the Cape of Good Hope. It covers aspects of his education, his horological career, his employment by Lord Lindsay to oversee the Dunecht observatory, his personal expedition to Ascension Island and his appointment as Her Majesty's Astronomer at the age of 34. The account includes local detail and images not found in the main biography of David Gill. It ends with some detail of Gill's continuing interest in clocks after his appointment.

### *Key words*

David Gill, Aberdeen, Lord Lindsay, Dun Echt, time signals, transit of Venus, solar parallax, Ascension Island, Cape of Good Hope

### *Introduction*

David Gill's contributions to astronomy made him one of the most successful astronomers of his era, a time covering the last quarter of the 19<sup>th</sup> century and into the 20<sup>th</sup> century. This was a time when astrometrics came of age, astrophotography began to transform astronomy, stellar spectroscopy became a technique that all professional observatories needed to embrace and international, multi-observatory projects were shown to be the way forward into the 20<sup>th</sup> century. David Gill played a seminal part in all these developments. His achievements were recognised in his lifetime both in the United Kingdom and abroad<sup>1</sup> but as happens with many who promote an era of change, it has been the achievements of those who succeeded him when the techniques matured who are better remembered.

David Gill was much more than a benefactor of astronomy and Her Majesty's Astronomer at the Cape of Good Hope. One person who began his professional career with David Gill and ended up as Director of the Trigonometrical Survey, Cape Town, looked back on David Gill after an eventful life of his own and was moved to say<sup>2</sup> "*He was quite the most outstanding personality I have known in my life*". Remarkably, David Gill achieved distinction in three different professions, but astronomy was his lifelong passion and the profession in which he made his greatest mark. More than a century after his death, his life deserves to be more widely known, both for its



*Fig. 1 David Gill, a portrait in 1884 by fellow Aberdonian and friend, Sir George Reid, later President of the Royal Scottish Academy; courtesy of the Royal Astronomical Society.*

intrinsic interest and as an example of ‘how things got done’ in his day. There has been one biography<sup>3</sup>, written soon after his death by his friend George Forbes, and several tributes written at a similar time. Since then some personal material has been lost but other material relevant to his life has become accessible, for Gill was a prolific correspondent and his contemporary reputation has helped its preservation. In recent years Paul Haley has explored aspects of this material<sup>4</sup>. The route Gill took to becoming an astronomer of international stature is a particularly interesting part of the story, combining serendipity, enthusiasm and ability. This paper aims to put this now largely unknown story into the public eye, including local contemporary references and previously unpublished photographs.

### *Early life*

David Gill was born at 48 Skene Terrace<sup>5</sup>, Aberdeen (*Fig. 2*) on 12<sup>th</sup> June 1843, the eldest son after two infant deaths for his parents David and Margaret Gill (*Fig. 3*). His father was in his mid-50s when David Gill jnr. was born and had very firm ideas on what young David should do in life. He would be groomed to take over the family business. In fact, the Gills had three more sons and a daughter but it was their eldest, of course, who had to succeed his father. The family business was watch and clock making, wholesale and retail, started by his grandfather in the 18<sup>th</sup> century. It occupied a well-placed shop on Aberdeen’s principal street, not far from the city centre.



*Fig. 2. 48 Skene Terrace, Aberdeen, the house where David Gill was born and grew up. His observatory was across the road in the garden, now a car-park.*

David Gill lived in his parent’s house for most of his life until marriage in 1870. As heir to the business, his schooling was quite substantial for the times. After primary lessons, for at least four years from the age of 9 he attended the nearby Dr Tulloch’s Academy<sup>6</sup>, in Academy Lane, now Academy Street off Crown Street. This school took about 120 boys between 5 and 15 and gave instruction in English, Latin, Arithmetic, French and some Physical Education. The school building still survives, somewhat altered. It is now a dance academy.

After this local education he was sent in 1857 for a year to Dollar Academy, roughly a dozen miles east of Stirling. It was at Dollar that he began to take a serious interest in learning more about science<sup>7</sup> and this interest was reinforced during the two succeeding years he spent as a private student at ‘Marischal College and University’ in Aberdeen. The main classes he attended there were the Natural History class of the very able Professor James Nicol in 1858/59 and the Natural Philosophy class of James Clerk Maxwell in 1859/60. Gill was inspired by Maxwell, met him in later life and said much later, on several occasions, “Maxwell was supreme as an inspiration.”<sup>8</sup>...“His teaching influenced the whole of my future life.”<sup>9</sup> By the time he was a student his enthusiasm had extended to setting up his own laboratory in an attic room in Skene Terrace.



*Fig. 3 David Gill's parents: (left) David Gill Senior 1789 – 1878 (right) Margaret Gill (néé Mitchell) 1809 – 1870. Cartes de viste, courtesy Ian Wallace.*

David Gill junior may have been keen on science but it was ‘business’, though, that earned one a living. In 1860 ‘science’ was not a likely career option. As well as spending time in his father’s shop, young David undertook a two-year apprenticeship in the skills a good watchmaker would need, learning workshop practice and mechanical design knowledge. His biographer George Forbes mentions that he went to Switzerland and the chance survival of a watch shows it was to Le Locle. He also spent time in Besançon in France, in Coventry and in London. He learnt to speak French well, a skill that would help him much later in this astronomical life.



*Fig. 4 Engraving within a watch made by David Gill in Le Locle while on his apprenticeship in 1861/62. Courtesy J. Dillon.*

David Gill was gifted with a sharp eye and steady hand. He honed both these gifts with his favourite past-time of rifle shooting. His biographer records that he was selected as a small-bore, long-range (typically 1000 yards, 910 m) shot for Scotland in 1869 but was unable to attend the event. He had obtained a commission as lieutenant in the first Aberdeenshire Rifle Volunteer Corps. Shooting would remain an interest throughout his life and he extolled his prowess at grouse shooting and deer



stalking in the last year of his life on a return holiday to Scotland. His sharp eye and steady hand would stand him in very good stead in the workshop. He wrote much later when he was in charge of the Cape of Good Hope Observatory<sup>10</sup>

*“I assure you the best part of my astronomical education was the time I spent in a workshop. Here [in South Africa], far away from Grubb, or Cooke, or Troughton & Simms, many a mess I should have been in but for that training and many a change of great practical utility I have made on the instruments here with my own hands.”*

#### *Watchmaker turning astronomer*

On his return from his apprenticeship he was made a partner in the family firm. In 1864<sup>11</sup> they secured a Royal Warrant as ‘David Gill & Son, Watchmakers to the Queen’. There is still a Gill clock at Balmoral Castle (the Scottish home of the Royal Family) and another at the nearby Royal residence of Birkhall<sup>12</sup>. David Gill seemed set to follow successfully in his father’s and grandfather’s footsteps.

All this doesn’t seem like the start in life you might expect for one of Britain’s great astronomers. ‘Time’ would be an interest of Gill throughout his life and ‘time’ introduced him to practical astronomy. At Marischal College, Maxwell had explained how accurate time was determined by the rotation of the Earth; how that rotation was measured using a transit telescope that was fixed to observe stars passing across the meridian plane in the sky. By the time Gill had come back from his watchmaking apprenticeship, Maxwell had left Aberdeen but David Gill the clockmaker became friendly with Professor Thomson at King’s College, Old Aberdeen, in 1863. King’s College was the other university in Aberdeen and Thomson was in charge of the little used College observatory at the top of the Cromwell Tower. At the time it had no telescopes mounted under its twin domes. Thomson gave him an introduction to Professor Piazz Smyth of Edinburgh, then Astronomer Royal for Scotland, who was responsible for installing the Edinburgh time ball (1853) and the one O’clock gun (1861). Gill visited Piazz Smyth and saw at first-hand how his system operated. On his return, he tried to get the Aberdeen Harbour Commissioners to install a time gun<sup>13</sup>. They didn’t oblige.

Thomson responded to the young Gill’s enthusiasm. He mounted a transit telescope by Thomas Jones that had been languishing in a store cupboard. Gill fitted electrical contacts to a master clock he supplied to the observatory<sup>14</sup> (Fig. 5) and at first they took wires across the quadrangle to the College clock that they fitted with a slave Bain’s pendulum. Later they took wires to two modified clocks in New Aberdeen a good



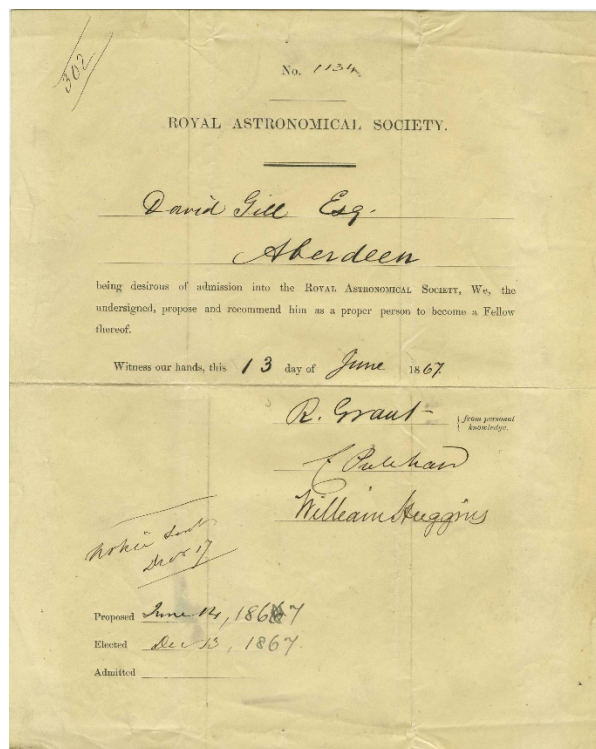
*Fig. 5 David Gill’s clock from the Cromwell Tower Observatory.*

mile away and so brought accurate time to the citizens in Aberdeen any time of the day and night.

David Gill attempted to use his University experience to diversify his clock business. An advert of 1864 announced the shop now stocked air-pumps and they would also obtain for customers Negretti & Zambra's instruments at London costs<sup>15</sup>. In 1865 the firm of Smith and Ramage that had made models for James Clerk Maxwell was dissolved and taken over by 'Anderson & Co.'<sup>16</sup> The advertisement noted that they would continue as before as watch and clockmakers, opticians and nautical instrument manufacturers with 'chronometers rated by transit observations'. Any suspicion that Gill was involved is confirmed by an 1867 announcement that the partnership of David Gill Junior and Anderson was dissolved and that Anderson would continue the business on his own at the same location<sup>17</sup>. Gill's broader interest in science than just watchmaking is also confirmed by his election as a Director of the Aberdeen Mechanics Institute<sup>18</sup> in 1869. By this time, though, his astronomical interests had developed too.

Gill had continued to frequent Thomson's house in Old Aberdeen and they usually made their way some 200 m into King's College to the Cromwell Tower observatory. Thomson, undoubtedly persuaded by Gill, purchased for the other dome an equatorial refractor with 3¼ inch diameter objective and clockwork drive by the late Andrew Ross, advertised in the Monthly Notices<sup>19</sup> of the Royal Astronomical Society (RAS). Over the next two years this telescope drew David Gill more and more into astronomy. He was surely introduced by Thomson to Robert Grant, King's College MA graduate, author of a compendious history of physical astronomy<sup>20</sup>, Regius Professor of Astronomy at the University of Glasgow from 1859 to 1892, who returned to King's College in 1865 to be awarded an Honorary doctorate. In 1867 Grant was one of the sponsors of Gill's application (Fig. 6) for Fellowship of the Royal Astronomical Society. The other sponsor was William Huggins, with whom Gill would become very friendly in future years<sup>21</sup>. The RAS would play a significant rôle in Gill's life. They supported a future expedition, ran the journal he published most in, provided a base for his astronomical work and he would, four decades on, become their President.

By 1867 Gill's interest in astronomy had outgrown that of his professorial mentor. He set up his own observatory in the garden opposite the house in Skene Terrace with a high quality 12 inch (300 mm) reflecting telescope of his own construction. In early 1866<sup>22</sup> he had



*Fig. 6 David Gill's 1867 application for Fellowship of the Royal Astronomical Society, signed by Robert Grant, Charles Pritchard (President) and William Huggins (RAS Papers 61). The RAS would feature prominently in supporting Gill's early work and publishing his results over the next four decades. He would become its President from 1909 to 1911.*

purchased a 12 inch diameter mirror of 10 feet 6 inches focal length (3.2 m) from Henry Cooper Key, one of the pioneers in England of silver on glass reflecting telescope mirrors. Gill designed the mounting himself and had a local shipyard make the casting. He purchased accurate divided scales from Cooke of York and of course made the driving clock himself.

He recalled later in life<sup>23</sup>:

*“I employed the instrument in measuring double stars, examining nebulae, making photographs of the moon, and generally in satisfying my curiosity as to the wonders of the heavens, and I had just begun to plan attempts to determine the parallaxes of some stars with a micrometer by Steinheil of Munich when I received a visit from Lord Lindsay.”*

If any amateur of the time could have measured stellar parallaxes it might just have been David Gill, given a bit more experience<sup>24</sup>. The reference to Lord Lindsay in the quotation introduces the next key development. Gill teamed up with Aberdeen based George Washington Wilson, portrait ‘Photographer to the Queen’ and outstanding landscape photographer, to photograph the Moon. With Wilson’s photographic technique using wet collodion plates and Gill’s sharp imaging telescope with a particularly steady drive they took some excellent plates. His was by no means the first photograph of the Moon<sup>25</sup> but he sent a positive enlargement to William Huggins of the first quarter moon, taken on 18<sup>th</sup> May 1869. While still a student, Gill had attended the 1859 BAAS Meeting in Aberdeen a decade earlier where Warren de la Rue had talked at length on celestial photography, mentioning Huggins’ Moon photographs. Among a display of camera equipment he had shown some of his own Moon pictures<sup>26</sup>, setting an example of what could be done then. Gill’s motivation is speculation but the outcome was that Huggins hung the plate by his living room window where it was admired by Lord Lindsay. This plate would launch Gill’s career as an astronomer. When Huggins died over



*Fig. 7 David Gill’s original photograph of the Moon taken in 1869 that effectively launched his professional astronomical career. The original has acquired a hair-line blemish outside the image of the Moon. Courtesy RAS.*



40 years later his widow returned the plate to Gill who not long before his own death gave it to the RAS. The RAS librarian has rediscovered it (*Fig. 7*).

Lord Lindsay was the son of the 25<sup>th</sup> Earl of Crawford and 8<sup>th</sup> Earl of Balcarres who owned Dunecht House with its surrounding estate of 8855 acres<sup>27</sup> some 13 miles west of Aberdeen. The young Lord (who would inherit the Earldoms in 1880) was a scholar of exceptional talent who, like Gill, had a passion for astronomy. He was four years younger than David Gill but soon introduced himself in 1870. They got on famously well.

In 1870 Lindsay organised a very successful eclipse expedition to Cadiz taking some of the earliest photographs of the solar corona during the December eclipse. Among Lindsay's instruments was<sup>28</sup> "A 6<sup>in</sup> equatorially mounted refractor by Troughton and Simms to which was attached a spectroscope by Browning having 1 prism of 60° with small dispersion was kindly lent me by my friend Mr David Gill of Aberdeen". Gill might have been on this expedition but for the illness of his mother and her death on 18<sup>th</sup> December of that year. It had been his mother who had encouraged him in science while his father saw for him only a career as a prominent watchmaker.

It was also in 1870 that an impediment erected by his father was finally removed. David Gill had met his future wife in 1865 when he was 22 and she was 16 but his father would not sanction their marriage, either then or for 5 years. Isobel Black, 2<sup>nd</sup> daughter of John Black<sup>29</sup>, successful farmer at Linhead, close to the parish church of Foveran<sup>30</sup> north of Aberdeen, would prove to be hugely supportive of David Gill through the remaining 44 years of his life. (*Fig. 8*) She was bright, well organised and very happy to share in all David's adventures. Isobel (Isabella on the marriage certificate) and David married on 7<sup>th</sup> July 1870<sup>31</sup> at Linhead. The young Gills moved to 26 Silver Street<sup>32</sup>. 1870 also proved to be the year his father made his eldest son the sole owner of the business<sup>33</sup> – his father was then 82. Symptomatic of Gill's wider interests than watchmaking, a year later he subscribed as a life member to the British Association for the Advancement of Science, whose annual meeting was held in Edinburgh that year. Many years in the future he would become the chairman of the central organising committee in 1905 and BAAS President in 1907.

### *The Dunecht Observatory*

The narrative returns to Lord Lindsay. He decided to set up his own observatory at his father's Dun Echt estate (nowadays written Dunecht), an observatory whose equipment would rival the best in the world for undertaking serious astronomy. In December 1871 he sent David Gill a letter that would change Gill's life<sup>34</sup>.

*"... I have sometimes thought that you might, in the interests of Science, and from your own love of astronomy, be willing yourself to accept the post of Resident Astronomer*



*Fig. 8 Isabella Black, a carte de visite taken in May 1870 before her wedding in July, courtesy Ian Wallace.*

*were I to offer it to you, with such advantages as the instruments we are now getting together would afford....”*

Gill was to write later<sup>35</sup>:

*“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 to take the directorship of Dun Echt Observatory. ... in 24 hours Lord Crawford had my answer – yes. I never regretted that decision – my life became full of interest, and has so continued ever since.”*

[The official offer had come from Lord Crawford, Lord Lindsay’s father, the owner of Dun Echt estate]. So began Gill’s career as a professional astronomer. The watch and clock business was sold in March 1872<sup>36</sup> and the Gills moved to a house near the estate and then to a house built for them close to the observatory.

Gills first job was to supervise the erection of the observatory and the procurement and setting up of equipment. To facilitate the selection of the very best for the observatory, Gill embarked on a continental tour of major European observatories in 1873. This took him to Hamburg, Copenhagen, Stockholm, the Pulkowa Observatory near St Petersburg; back to Hamburg, and then to Hanover & Paris, meeting many of the world’s active research astronomers at an international meeting<sup>37</sup> on his second visit to Hamburg. He liaised with leading instrument makers in Britain and Europe to acquire the very best instruments. This tour was in some ways the equivalent of his watchmaking apprenticeship but now the focus was on astronomical instruments. The personal contacts he made then would last for the rest of his professional career.

Hermann Brück has described and illustrated the equipment and history of the Dun Echt Observatory<sup>38</sup>. It was Lord Lindsay intention to undertake serious astronomy. The results would be published by the Royal Astronomical Society and in Lindsay’s own specialist publications, the Dun Echt Circulars, brief newsletters of which there would be well over 100, and the book length volumes of the Dun Echt Observatory Publications. One of their initial efforts was *On a new driving clock for equatorials*<sup>39</sup>, under the joint authorship of Lord Lindsay and David Gill describing an improved telescope driving clock fit for use in the new age of stellar spectroscopy and astrophotography. Undoubtedly David Gill was responsible for the details of the new design. The clock was made by T. Cooke & Sons of York for the Dun Echt observatory.

### *1874 Transit of Venus*

Before the observatory could really get into its stride, Lord Lindsay decided that they must participate in one of the astronomical events of the century, observations around the globe of the transit of Venus across the face of the Sun in 1874. The previous transit had been in 1769 and the event had been used as a means of measuring the scale of the solar system. The two transits of Venus in the 18<sup>th</sup> century had shown how observations of this phenomenon could allow the scale to be deduced and hence in particular how far away the Sun was from the Earth. This was considered, and still is, a key piece of astronomical knowledge. The Astronomer Royal, George Airy, had described it as ‘the noblest problem in astronomy’<sup>40</sup>. He was responsible for sending no less than seven official expeditions world-wide to record the details of the transit telescopically, chronologically and photographically<sup>41</sup>.

### *Mauritius expedition*



Lindsay knew that the transit would occur in Dunecht from roughly 2 am to 6.30 am on a December night. He decided that Mauritius in the Indian Ocean would be a promising observational base for the transit of Venus. Indeed, nowhere in Europe would see the full transit. Unfortunately, Mauritius was some 15,000 km away by sea. Gill had to oversee the organisation of Lord Lindsay's transit expedition to Mauritius in the southern Indian Ocean. The expedition would be equipped with top-of-the-range instruments from Dunecht, including a heliometer purchased from A. Repsold & Son of Hamburg<sup>42</sup>, an accurate alt/azimuth telescopic instrument from Troughton & Simms<sup>43</sup>, a 40 foot long solar telescope, precision clocks and photographic equipment<sup>44</sup>.

Lindsay's expedition had multiple scientific aims and Gill's handling of it would be central to the rise of his reputation. Gill left Southampton on June 19<sup>th</sup> on a steamer of the Peninsular and Oriental Steam Navigation Company (P&O) bound for Aden via the relatively newly opened Suez Canal. Then he and the expedition carpenter transferred to another line for the remaining journey of 5000 km to Mauritius, which they reached on August 4<sup>th</sup>. He had with him an astonishing 52 chronometers, all the wooden houses, domes, etc. needed to set up the temporary observatory. Lord Lindsay left on July 9<sup>th</sup> in a 398 ton, 3-masted schooner he had purchased and christened the 'Venus'. He had a crew of 22 and the main astronomical instruments. His journey via the Cape of Good Hope took him until 2<sup>nd</sup> November, much longer than planned, and the crew arrived in poor health.

The transit itself was on 9<sup>th</sup> December but Gill and Lord Lindsay had a second purpose to their expedition. This was to measure accurately the change in position from evening until dawn of the asteroid Juno relative to the background stars. The effect is known as diurnal parallax. Juno is a large asteroid in an elliptical orbit that would bring it nearest the Earth in October of 1874. From the observed change in position, the distance of Juno could be deduced from the observations after some tedious calculations and hence the size of the solar system found by an alternative route. George Biddell Airy had suggested the feasibility of this method but never used it.

Much of the observing for the whole expedition fell on David Gill, partly because of the poor health of Lord Lindsay. A third string to their bow was to determine accurately the longitude of places within reach. This was one reason for the tricky task of carrying a raft of working chronometers, because for the past century they had become the vital tool for longitude determination. Who better than to care for these and use them to their limits than a professional watchmaker! Another reason was to obtain accurate times for the various points of contact during the transit of Venus, for one method of obtaining the desired results used these times. Mary Brück has written an illustrated account of the expedition<sup>45</sup>.

### *Outcome and return*

Gill's return trip also took several months. The chronometers were used to find accurate longitudes for several places in Mauritius, for the island of Reunion, for Victoria, the capital of the Seychelles, Aden, Suez, Alexandria and, indirectly, Malta. At some stations, accurate latitudes were also found from astronomical observation. The Dun Echt Publications vol. III describes all the observations and calculations in a volume of some 520 pages. It was tedious work that to some extent revealed the problems, the care needed and the limitations of the chronometer method. Nowadays, over a century of science later, any device with a GPS receiver will produce even more accurate results in a trice.

The transit of Venus measurements were as good as any of the official expeditions but the difficulty of timing the exact start and finish of the phenomenon proved that this method would not yield a high precision answer for the scale of the solar system<sup>46</sup>. The Mauritius expedition did not of itself produce notable astronomical results but it had two lasting impacts for Gill. First, his handling of the expedition and his subsequent involvement with Airy's official results gave him a presence on the international stage of astronomy<sup>47</sup>. Secondly, the whole purpose of the expedition, namely determining the solar parallax 'got under his skin'. It was an issue that he worked on during his entire astronomical career and indeed into his retirement. Two decades in the future he would have the satisfaction of seeing his own (later) result accepted as the international standard<sup>48</sup>. What must have helped cement this interest was that his pioneering work with Juno at Mauritius produced a result more accurate than any analysis of the transit results and showed that such a method had the potential to yield the best result obtainable from any astronomical technique.

The site of Lindsay's Transit of Venus observatory is now preserved as a site of historic interest in Mauritius<sup>49</sup>.

### *Egyptian Survey work*

When in Egypt on his way back David Gill came into contact with surveyors in Egypt and was invited by the Khedive to Cairo to discuss surveying the whole country. (Egypt was notionally part of the Ottoman empire but there was significant British involvement in its management). He was joined by his wife Isobel, who had been staying in Cannes. Gill set up an accurate baseline near Giza and surveyed the great pyramid but then nationalism reared its head. The British military under General Stone were keen on Gill taking the post of Chief Surveyor in Egypt and Lord Lindsay encouraged him. Release from his Dunecht contract would not be an issue. Unfortunately for this development Gill had to write back in May 1875<sup>50</sup>

*"...It appears however that the present Professor of Astronomy and the present Professor of Geodesy are men with powerful interest here. General Stone's proposals having meantime got abroad, these men began to fear for their places and moved heaven and earth to persuade the Viceroy that the existing maps were for the present good enough, that Egypt should be surveyed by Egyptians not by foreigners &c. &c., and finally upset all General Stone's plans."*

Notwithstanding, he was awarded the Order of the Medjidie from the Khedive<sup>51</sup>. Gill returned to Dunecht having been away a year. Not long after, even Gill's baseline was pointlessly destroyed. Gill almost became then a surveyor of nations and not an astronomer. He didn't know it at the time but in fact he would become both in the coming decades. David Gill, a supreme geodetic survey organiser in the Southern hemisphere, is remembered in some circles who scarcely know of him as watchmaker and astronomer. His achievements in that field is a story not yet fully told.

Gill spent some four months in Egypt on his survey work. About his survey of the great pyramid, the noted Egyptologist Flinders Petrie, who had been involved in the reduction of Gill's measurements, said<sup>52</sup> *"this far surpassed all previous work in its accuracy"*. Gill placed small survey markers on the bedrock by the corners of the great pyramid that he surveyed to an accuracy of 1 mm. These are still in use<sup>53</sup>. He also boldly installed a survey post at the very top of the only surviving 'great wonder' of the ancient world – a memorial to David Gill seen by a great many tourists with sharp eyes.

### *After Dunecht – Ascension Island*

When Gill came back in mid-1875 after a year away he was no longer simply an assistant astronomer helping out Lord Lindsay's hobby. He was in his own right an astronomer of note, personally known to many in the international community. Lord Lindsay's mother was finding this difficult to adjust to. In a letter to Gill written from her London residence in July 1875 about his home on the estate, she commented<sup>54</sup>

*“You have friends coming to you whose carriages and horse you send to our stables and the whole position seems to me now changed from what I originally calculated upon. ...had I known at the beginning that it was the habit to make use of the house in this way I should at the very first have expressed a decided disapproval of it and I cannot see that this is any more inconvenient to you than it would be to any gentleman living in a small country place without stable accommodation when his friends come to see him his horses must be put up at the nearest inn. It is always done elsewhere and I cannot see why it should not be done on this occasion.”*

Lord Lindsay himself noted that Gill's appointment was never intended to be a lifetime job so after some discussion he was released from his contract, with over £1000 compensation.

David Gill decided that he would pursue the idea of finding the distance to the Sun as accurately as possible using Mars, not Venus, with the diurnal parallax method that had been so promising with Juno. The method required measuring the parallax of Mars between observations taken at dusk and dawn. The location of Mars in the sky would be very accurately determined with respect to reference stars using the Dun Echt heliometer. Between dusk and dawn Mars moves in its orbit and so does Earth, so there are basic effects to allow for. In 1877 Mars was going to be at its closest to the Earth for over a century and closeness meant the most accurate value would result from observations. The diurnal parallax angle is bigger near the equator. Ascension Island's location is 7.9° S 14.4° W. If Gill could achieve a diurnal baseline of about 12,000 km, with Mars about 60 million km distant the diurnal parallax would be about 0.69 minutes of arc. [*Addendum: the published article contains an embarrassing factor of 2 error in the baseline*]. To get a value for the distance better than 1 % he needed to measure angles to 0.4 arc seconds or better. Crucial to this effort was the heliometer, an instrument not found in a modern observatory but which Gill truly became the contemporary master<sup>55</sup>. Lord Lindsay freely lent the Dun Echt heliometer to Gill along with other instruments. The Royal Astronomical Society lent a precision transit telescope and the Admiralty a portable wooden hut<sup>56</sup>.

The Royal Astronomical Society contributed half the cost, for which Gill was extremely grateful. In his will decades later he paid them back, though they had not expected that. An application for the other half of the cost was sent to the Royal Society of London who disbursed Government money, but they refused. In a gesture of personal confidence, to enable the expedition to go ahead, Lord Lindsay, Warren De La Rue and William Spottiswoode, notable scientists and FRSs, offered to guarantee from their own pockets the £250 needed if a second application to the Royal Society failed<sup>57</sup>. This converts into about £25,000 in today's buying power. Gill was extremely grateful. The Royal Society, though, did come good upon a second application.

The expedition was to the naval base known as 'tender to H.M.S. Flora', or as the geographers called it, 'Ascension Island', a desolate volcanic outcrop in mid-Atlantic. David and Isobel Gill set off from Dartmouth on the *Balmoral Castle* mail steamship in mid-June



1877. Isobel Gill wrote a personal account this expedition “*Six months in Ascension - an unscientific account of a scientific expedition*”<sup>58</sup>. The Gills camped on sand in a field of lava boulders in a bay christened and still called ‘Mars Bay’ (Fig. 9). There were no facilities but some help was seconded from the local naval crew.

While Schiaparelli peered at close Mars and made drawings of *canali*, Gill employed the heliometer to make precision measurements of its location relative to nearby stars. When he sent a dispatch to the Royal Astronomical Society that he had been successful, there was a standing ovation for Isobel Gill. The Gills spent about half a year on the island but it took David Gill some two years afterwards to process the results. Accurate positions of the reference stars were made for him by the observatories of Greenwich, Oxford, Liverpool, Albany, Cambridge (Mass.), Washington, Cordoba, Konigsberg, Leipzig, Berlin, Pulkowa, Leyden, Paris and Melbourne.

This list alone is a testament to the respect and value given to Gill and his one-man, one-woman expedition. He came up with a single figure that gave the scale of the solar system, accurate to within 0.2% of the modern value<sup>59</sup>, a figure about ten times more accurate than the range of mid-19<sup>th</sup> century determinations<sup>60</sup>. This work would earn him his first Gold Medal from the Royal Astronomical Society.

#### *Gill's Royal Appointment*

There were basically only two ways then into serious astronomy. The first was to be wealthy enough to build and run your own observatory, and probably retire from your job while you were still young enough to see clearly and spend your nights awake. This was a route taken by quite a few in the 19<sup>th</sup> century<sup>61</sup>. It was not open to Gill, for he had insufficient wealth even though he had inherited the 830 acre estate of Blairythan upon the death of his father in April 1878. The second route was to be employed by a patron, which increasingly meant a University, though there were few senior posts. In the United Kingdom and in Ireland, Oxford, Cambridge, Durham, Glasgow and Edinburgh had Professors of Astronomy. The observatories of Dunsink, Armagh and Liverpool had Directors. There were Astronomers Royal in England and Scotland and a Royal Astronomer of Ireland who was also the Andrews Professor of Astronomy at Trinity College, Dublin; the Cape of Good Hope observatory had ‘Her Majesty’s Astronomer’ and there was a ‘Government Astronomer’ post in New South Wales<sup>62</sup>. There were a few Assistant and less senior posts but once appointed, residents tended to stay for life or until ill health forced retirement.

In 1878 the Radcliffe Observer at Oxford University died. David Gill applied for the post with a superlative list of references<sup>63</sup>. He didn’t get it<sup>64</sup>. The post went to Her Majesty’s Astronomer at the Cape of Good Hope, Edward Stone, and that still left a vacancy in the system. David Gill at that time didn’t have a University degree to his name nor had he attended any advanced courses in Astronomy, Mathematics or Physics. He certainly didn’t tick the boxes expected. One of the other applicants did: William Christie, educated at



Fig. 9 Four stamps from Ascension Island showing David and Isobel Gill’s expedition, issued to mark the centenary. David Gill was never the ‘Professor’ mentioned on the stamps.

King's College School, London, a Cambridge wrangler who had followed Stone in his first post as Assistant to the Astronomer Royal at the Greenwich Observatory and wanted to follow him to the Cape. To their credit The Admiralty appointed the sharp-shooting clockmaker in preference to the conventional candidate with his Cambridge degree and Greenwich experience. The man taking responsibility was W. H. Smith, First Lord of the Admiralty, the very same Smith whose family firm ran the eponymous railway news and book stands that had sprung up everywhere. As it would turn out, the appointment was an excellent choice, for Gill would raise the status of the Cape Observatory to the best in the Southern hemisphere with a place among the world's leading observatories.



*Fig. 10 Sailing into a new era, the Taymouth Castle that conveyed David and Isobel Gill to the Cape of Good Hope. Courtesy Glasgow City Museums.*

In early 1879, David Gill had just enough time to make a second European tour, this time for his own benefit. He visited Paris, Leiden, Groningen, Hamburg, Copenhagen, Helsingfors, Pulkowa and Strasbourg. The Gill's left for the Cape on the Royal Mail steamer the *Taymouth Castle*<sup>65</sup> in early May. When they arrived on 26<sup>th</sup> May three weeks later his predecessor was among those who would leave the next day for the return journey. The Royal Observatory is now described as a *cultural treasure* and the oldest continuously occupied scientific building in South Africa<sup>66</sup>. It is the administrative home of the South African Astronomical Observatory (SAAO), located near sea level at 33.93° S, 18.48° E, but no longer an active observatory since the Cape Town lights have encroached and surrounded the complex. Nonetheless it has a distinguished history<sup>67</sup> in which David Gill played a leading part.

*David Gill and 'time' continued*



David Gill now had a Royal Appointment and this part of his story finishes. However, amongst all the astronomy he contributed at the Cape<sup>68</sup>, Gill didn't drop his interest in clocks and it seems appropriate to finish this account with a note of his continuing interest in them, though it seldom features among his later achievements. Accurate time was absolutely essential to his Admiralty work of preparing star catalogues, for the right ascension of stars is measured in time. Steady telescope driving beyond that necessary for visual observation was essential for the astrophotography that Gill became heavily involved with. In addition, David Gill would surely have been pleased that the Royal Observatory at Cape Town was one of the first in the world to have initiated a time ball for mariners<sup>69</sup> and he made quite sure that activity was continued and improved on his watch.

In 1878 he had been appointed to a committee of the British Association for the Advancement of Science 'to consider the question of *Improvement in Astronomical Clocks*'. His fellow members were Professor George Forbes (the same who would be his biographer), the instrument maker Howard Grubb and C. H. Gimmingham, assistant to William Crookes. Gill was re-appointed in 1879 in spite of being at the Cape and their first two reports<sup>70</sup> can be found in the BAAS meeting proceedings of 1880. The clock described by Lord Lindsay and Gill mentioned earlier was specifically aimed at driving regularly a telescope that might be slightly unbalanced by attachments. In the BAAS investigation, the aim was timing accuracy. They presented a design for the nearest they could achieve to a free pendulum, oscillating in vacuum with electrical timing pulses taken out by wire. Gill took one of the prototypes to the Cape for study. He had too much astronomical work to construct the Cape observatory's own astronomical clock. He acquired one by Howard Grubb<sup>71</sup> who had evolved the design of Gill and Lord Lindsay.



Fig. 11 Carte de viste of David Gill, courtesy Ian Wallace.

The noonday time ball was one of the Admiralty's core activities for the observatory. By the time Gill took office at the Cape, the time ball had been moved from the observatory to the docks and the noonday signal communicated there by telegraph. The telegraph signal was also distributed further afield to other time balls and guns. An important practical question that arose for Gill was 'what noon was to be signalled?' Was it local noon, Greenwich noon (the most important for navigators), or noon of civil time? Gill recorded<sup>72</sup> that until 1892



local mean time, aka ‘Observatory Mean Time’, was used and then replaced by GMT. Observatory Mean Time was widely used by the telegraphy system in the province but, unlike the British example, the railways continued to use local time. This led to the bizarre situation of public clocks being fitted with two hands, one for each version of time. Civil time was introduced for the entire province on 8<sup>th</sup> Feb. 1892 based on longitude 22.5° E. This soon spread to other South African colonies and Gill urged that a uniform time based on two hours difference from GMT should be adopted, in accordance with the principle of international time zones that had been promoted at the International Meridian Conference of 1884 but not internationally agreed there. This suggestion was eventually implemented in 1903. Meanwhile, in 1893 Gill was able to achieve what he had done in the 1860s in Aberdeen. A clock in the Harbour Tower of the Cape Town dock was fitted with a seconds’ hand and electrically controlled from the observatory. In 1894 he established a reverse link with a new harbour time ball, the exact time of it starting and finishing its fall being recorded on a chronograph at the observatory. From 1894, hourly signals were sent from the observatory to allow the railway clocks to be synchronised on the hour. The Colony had better access to accurate time than almost anywhere else in the world.

A final confirmation of David Gill’s continuing interest in public time can be found in the House of Commons Select Committee report on the Daylight Savings Bill of 1908<sup>73</sup>. A proposal was afoot to introduce summer time, championed by William Willetts. The main argument before the committee seemed to whether the clocks should be changed or simply that the clocks should be left alone and everyone should agree to open their business an hour earlier in summer. The absurdity of the second suggestion was not what really concerned Gill. He didn’t see any great merit in changing the clocks but the draft bill suggested that the clocks be moved forward an hour in April in four quarter-hour intervals over the month and likewise turned back in September. Gill was possibly the only witness who had been intimately involved in changing public time, once in 1892 and again in 1903. In a rambling interrogation by the committee he argued that if the change was going to be made then it should be an hour all at once and for the summer months only. In the event the Bill was not passed in the Commons and it was not until after Gill’s death that summer time was implemented in Britain 1916. It was introduced with a single change of one hour, as Gill had argued.

### *Conclusion*

Following an introduction to his early years, this account of David Gill has concentrated mainly how his career took him from watchmaker to the post of Her Majesty’s Astronomer at the Cape of Good Hope. David Gill lived a full and varied life but it was time and space that motivated him in almost all his undertakings – not the philosophic aspects of time and space but the practical consequences and uses of measuring time and space. His enthusiasm, confidence and expertise seem to have affected all who came into contact with him. Summing up after his death, John Pattison said in the Journal of the Royal Astronomical Society of Canada<sup>74</sup> “*He was not an astronomer for gain, or even for professional renown, or self-advancement. He was an astronomer because he could not help it. ... In a word he did not live by astronomy but he lived for astronomy.*”

### *Acknowledgements*

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use the illustration of the *Taymouth Castle*. I would also like to thank Paul Haley for sharing some of his thoughts and material on David Gill's correspondence.

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*Notes and references*

<sup>1</sup> He was awarded the Watson medal for astronomy by the US National Academy of Sciences, the Bruce medal of the Astronomical Society of the Pacific for life-time achievement in astronomy and the Gold medal of the Royal Astronomical Society twice. He received the Royal Medal of the Royal Society of London and his portraits in oils hang in the Royal Society of London, the Royal Astronomical Society and the Pulkowa Observatory near St Petersburg. He built up the best observatory in the Southern hemisphere, was famed for his observing skills, was knighted by Queen Victoria in 1900, received the French Commander of the Légion d'Honneur and the Prussian Pour le Mérite amongst other honours.

<sup>2</sup> Whittingdale W. *Monthly Notices of the Astronomical Society of South Africa* 1943: 73-79.

<sup>3</sup> Forbes G. *David Gill; Man and Astronomer* London: John Murray, 1916. George Forbes was a son of Professor J D Forbes of Edinburgh, later St Andrews, who had been James Clerk Maxwell's highly respected mentor. George Forbes started his professional career as an astronomer who secured a professorship in Natural Philosophy at what would become Strathclyde University in Glasgow but he left in 1880 for a career in electrical engineering. He never lost his interest in astronomy nor his contact with David Gill.

<sup>4</sup> Haley PA. *The Antiquarian Astronomer*: 2014, 8, pp 46-65 & 2016,10, pp 13-37.

<sup>5</sup> Skene Terrace is quite close to what would now be considered the centre of Aberdeen. A 'yellow plaque' erected by the Town Council on the house commemorates David Gill.

<sup>6</sup> The enrolment book from 1852 in the University of Aberdeen Library Ms M561 shows David Gill as enrolled from 1852 to 1857, excepting the year 1854-55. See also Mackenzie G. So that's why this is Academy Street, *Leopard Magazine*: Aberdeen, April 1994: 38-39.

<sup>7</sup> His biographer reports that at a prize-giving in Dollar Academy in 1909 David Gill attributed to Dr Lindsay of Dollar his initial interest in science. Forbes G. op. cit. ref. 3, p 8.

<sup>8</sup> Gill D. *History of the Cape Observatory*: HMSO: London, 1913, p xxxi.

<sup>9</sup> Quoted by his biographer Forbes G. op. cit. ref. 3, p 14.

<sup>10</sup> Forbes G. op. cit. ref. 3, p 20.

<sup>11</sup> Aberdeen Journal, advertisement 21<sup>st</sup> Dec. 1864.

<sup>12</sup> The Royal Collection Trust records extant items "RCIN 12791 at Balmoral - A mid Victorian mahogany kitchen clock w moulded case. Moulded surrounds to dial" and "RCIN 110019 at Birkhall - Mahogany longcase clock, glazed arched polished steel & brass dial w roman & arabic numerals, striking movement".

<sup>13</sup> Aberdeen Journal, announcement 3<sup>rd</sup> Feb. 1864.

<sup>14</sup> The master clock, without its electrical connections, still exists in the University of Aberdeen's historical instrument collection.

<sup>15</sup> Aberdeen Journal, announcement 21<sup>st</sup> Dec. 1864 "We have also to call attention to Students and others to our Stock of Air-Pumps, &c., for Microscopic Preparations. Nigretti [sic] & Zambra's Standard, and other instruments and Apparatus, we supply to Order at London prices free of carriage."

<sup>16</sup> Aberdeen Journal, Wednesday, August 2, 1865; Issue 6134.

<sup>17</sup> Aberdeen Journal, Wednesday, March 20, 1867; Issue 6219.

<sup>18</sup> Aberdeen Journal, Wednesday, November 3, 1869; Issue 6356.

<sup>19</sup> Advertisement in *MNRAS* 1865; xxv, Jan 13, p.68. This telescope, without accessories, still exists in the University of Aberdeen historical instrument collection. Its objective has devitrified.

<sup>20</sup> Robert Grant, *History of Physical Astronomy from the earliest ages to the middle of the nineteenth century*. London: Henry G. Bohn, 1852.

<sup>21</sup> William Huggins was the previous generation to David Gill but both men clearly had a high mutual respect for each other's astronomy and corresponded for the next forty years, mainly during Gill's tenure in South Africa. See Becker, Barbara J. *Unravelling Starlight; William and Margaret Huggins and the Rise of the New Astronomy*. Cambridge: CUP 2011.

<sup>22</sup> Gill mentioned that the mirror was purchased from Cooper Key following an advert in 'The Astronomical Register'. An Advert for "Silvered glass speculum 12 in." appeared for the last time in *The Astronomical Register* Feb. 1866; IV, p. 55. No advert for any similar item appeared in the next two years. Gill took his telescope with him to Dun Echt and in *Monthly Notices of the Royal Astronomical Society* v. 33, pp 226 – 7,

Lord Lindsay reporting on the inventory at Dun Echt includes the description *A silver on glass Newtonian reflector of 13 inches aperture (formerly Mr Gill's telescope), equatorially mounted, focal length 10 feet, 6 inches. This instrument also had Cassegrain mirrors, equivalent to a focal length of 40 feet.* Hermann Brück op. cit. ref. 38 says that the 12 inch (Newtonian) telescope illustrated in Lord Lindsay's eclipse expedition was borrowed from David Gill but Lindsay's own records now in the Royal Observatory Edinburgh archives (*Eclipse expeditions to Spain' 1870-1878* 30.194) record it was Lindsay's own telescope made by Browning, modified for photography.

<sup>23</sup> Gill D. *History of the Cape Observatory* London: HMSO; xxxii, 1913. Double stars were still thought to be comparative rarities and no amateur had measured stellar parallaxes at that time.

<sup>24</sup> Paraphrase of a comment by Jacobus Kapteyn quoted by George Forbes op. cit. ref. 3, p 39.

<sup>25</sup> Warren de la Rue, Report on the present state of Celestial Photography in England, in *Report of the 29<sup>th</sup> meeting of the British Association for the Advancement of Science*. London: John Murray, 1860, pp 130 – 153 gave an extensive account of celestial photography at the 1859 Aberdeen Meeting of the BAAS in which he mentioned several English photographers' Moon photographs taken over the previous 6 years.

<sup>26</sup> The display of the Warren de la Rue's Moon pictures is not mentioned in the extensive report of the meeting, op. cit. ref. 25, nor in the catalogue of the photographic display at the meeting but is recorded by a reporter for *The Photographic Journal*, Vol 6, Oct. 1<sup>st</sup> 1859, p 244.

<sup>27</sup> *Scotland. Owners of lands and heritages 17 & 18 Vict., cap. 91. 1872-73. Return I. The name and address of every owner of one acre and upwards in extent.* Edinburgh; HMSO, 1874, p. 2.

<sup>28</sup> Royal Observatory, Edinburgh archives 30.194 Lord Lindsay's notes on '*eclipse expeditions to Spain' 1870-1878.*

<sup>29</sup> Birth/Baptismal records on [Scotlandspeople.gov.uk](http://Scotlandspeople.gov.uk) show John Black's daughters' names as Ann (06 October 1837); Isabella Sarah (26 Dec 1848) and Elizabeth Margaret (9 November 1851). The third daughter was known as Bessie.

<sup>30</sup> David Gill's mother, née Margaret Mitchell, was also a farmer's daughter from Foveran parish.

<sup>31</sup> The marriage was announced in the *Aberdeen Journal*, Wednesday, July 13, 1870; Issue 6392. The marriage certificate on [Scotlandspeople.gov.uk](http://Scotlandspeople.gov.uk) describes David Gill as 'wholesale watchmaker and landed proprietor'.

<sup>32</sup> The Gill's married address was in a part of town that encompasses *Golden Square* and *Diamond Street*, established earlier in the 19<sup>th</sup> century by the Hammermen trade that included watchmakers. It was only just over 100 m from the Skene Terrace home where Gill had lived for most of his life and set up his telescope. 26 *Silver Street* was described by Isobel Gill as a comfortable but '*ugly little house*'. In the late 1890s it and neighbouring properties were demolished to make way for a hall that later became Aberdeen's first cinema.

<sup>33</sup> *Aberdeen Journal*, Wednesday, January 4, 1871; Issue 6417 announced that David Gill senior had retired from the business on 31<sup>st</sup> July 1870 leaving David Gill Junior in sole charge.

<sup>34</sup> Dated Dec 3 1871, letter from Lord Lindsay at Echt to David Gill, in The Gill Collection, Royal Geographical Society with The Institute of British Geographers, DOG/50.

<sup>35</sup> Forbes G. op. cit. ref. 3, p 233.

<sup>36</sup> See copy letters in the Royal Observatory archives of David Gill to Lord Lindsay dated 28<sup>th</sup> Jan. 1872, 25<sup>th</sup> March 1872.

<sup>37</sup> Fifth general meeting of the Astronomische Gesellschaft in August 20-22, 1873.

<sup>38</sup> Brück HA. Lord Crawford's Observatory at Dun Echt 1872 – 1892. *Vistas in Astronomy* 1992; 35, pp 81 – 138.

<sup>39</sup> Lord Lindsay and Gill D. Jun. On a new driving clock for equatorials. *MNRAS* 1873; 34: 35 – 38.

<sup>40</sup> Quoted by Clerke A. in *A Popular History of Astronomy in the 19<sup>th</sup> Century*. 3<sup>rd</sup> ed. London: Adam & Charles Black, 1893, chpt 6, p 280. <https://archive.org/details/popularhistoryof00clerrick>.

<sup>41</sup> Airy W. (ed.) *Autobiography of Sir George Biddell Airy*. Cambridge University Press, 1896, 286-7, 295, 304-5.

<sup>42</sup> This heliometer is now in the Collection of Aberdeen City Museums and Galleries.

<sup>43</sup> The Troughton & Simms instrument is now in the collection of the Royal Museum of Scotland.

<sup>44</sup> Details of the elaborate preparation for the expedition can be found in Lindsay, L & Gill D. On Lord Lindsay's Preparations for Observations of the Transit of Venus in 1874. *MNRAS* 1872; 33, p. 34. Doi: [10.1093/mnras/33.1.34](https://doi.org/10.1093/mnras/33.1.34).

<sup>45</sup> Brück MT. Lord Lindsay's expedition to Mauritius in 1874. *Proceedings IAU Colloquium No. 196*; 2004. doi:10.1017/S174392130500133X.

<sup>46</sup> G. B. Airy, the Astronomer Royal, wrote an extensive report of 532 pages on the results from the official UK expeditions. Airy, Sir George Biddell. *Account of Observations of the Transit of Venus, 1874, December 8, made under the authority of the British Government: and of the reduction of the observations.* London: HMSO, 1881.



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<https://archive.org/details/accountofobserva00airyrich>. He was well aware of the issue of selecting well-defined events in the transit sequence and had constructed a model of the transit's changing appearance on which his official observers were trained. Gill, too, saw this model before he left, as mentioned by Ratcliff, op. cit. 47. Nonetheless, this aspect of the measurements created a substantial uncertainty in the aggregated results.

<sup>47</sup> Ratcliff, Jessica. *The Transit of Venus Enterprise in Victorian Britain*. London: Pickering & Chatto, 2008 gives a very good impression of the enormous effort stretching over more than a decade and a half that went into just the British effort to find the solar parallax from the 1874 transit and its sequel in 1882.

<sup>48</sup> *Conférence Internationale des Etoiles Fondamentales de 1896* in *Annales du Bureau des Longitudes*, Paris: Gauthier-Villars, vol. 5, pp. D1-D90.

<sup>49</sup> An amateur astronomy group returned to Mauritius 130 years after David Gill and Lord Lindsay to observe the transit of Venus in 2004. Their blog includes excellent pictures of the transit, giving some idea of the phenomenon that Lindsay's expedition observed and echoing Gill and Lindsay's opinion on how hospitable the Mauritians are. <http://eclipssetours.com/2010-2002-trips/2004-transit-of-venus-in-mauritius/>.

<sup>50</sup> Letter from David Gill to Lord Lindsay, Cairo 14<sup>th</sup> May 1875, quoted in Forbes G. op. cit. ref. 3, p 79.

<sup>51</sup> The medal is now in the Special Collections Department, National Library of South Africa: Cape Town campus, along with other medals awarded to David Gill.

<sup>52</sup> Petrie WMF. *The Pyramids and Temples of Gizeh*. Cambridge: CUP, 2003, p 2.

<sup>53</sup> Web page <http://glendash.com/blog/2013/12/22/the-man-who-put-the-mast-atop-the-great-pyramid/> visited 10.01.2014.

<sup>54</sup> Margaret Crawford, 8-page letter of 6<sup>th</sup> July 1875 to Mr Gill in The Gill Collection, Royal Geographical Society with The Institute of British Geographers, DOG/50. Gill's response to this and other concerns raised by Lady Crawford was to suggest taking the train from Aberdeen to London and ask for a personal interview to clear the air.

<sup>55</sup> The heliometer would be a mainstay of David Gill's precision work in South Africa. He described this telescope in detail in the article heliometer in *Encyclopaedia Britannica*. 11<sup>th</sup> ed. New York, 1910; 13, pp 224 – 230.

<sup>56</sup> The instruments taken by David Gill are fully described in a manuscript account in the RAS archives, RAS MSS Gill 4.

<sup>57</sup> RAS Papers 61.

<sup>58</sup> Gill Mrs. *Six months in Ascension - an unscientific account of a scientific expedition*. London: John Murray, 1878. <https://archive.org/details/sixmonthsinasce00gillgoog>.

<sup>59</sup> Gill did later work at the Cape observatory with a larger heliometer determining the distances of 3 asteroids and settled on a value for the solar parallax of 8.80 arc seconds. This value was accepted internationally for the preparation of almanacs until 1968 when it was replaced by 8.794 arc second.

<sup>60</sup> Clerke A. in *A Popular History of Astronomy during the Nineteenth Century*. London: Adam & Charles Black, 1903, p237 pinpointed one reason why diurnal parallax was a promising method "A single mind, looking through the same pair of eyes, reinforced with the same optical appliances, is employed throughout, and the errors inseparable from the combination of data collected under different conditions are avoided."

<sup>61</sup> In the UK one thinks of retired engineers such as the Scottish engineer Robert Newall whose refracting telescope was the largest in the world for several years, the Welsh mechanical engineer Isaac Roberts, pioneer of astrophotography of deep sky objects in the last quarter of the 19<sup>th</sup> century, the drainage engineer Frank McLean, a spectroscopist who comes into Gill's story later, another Scottish mechanical engineer James Nasmyth who contributed the 'Nasmyth view' telescope design, the sanitary engineer Andrew A Common known for his planetary work and photography. There were non-engineers like the stationer Warren de la Rue, solar astronomer and pioneer of astrophotography in the 1860s and William Huggins, pioneer stellar spectroscopist who sold the family drapery business to become an astronomer but later accepted the patronage of the Royal Society. All these except Newall were awarded the Gold Medal of the RAS for their astronomical work.

<sup>62</sup> For further detail see Bryn Jones *Some historical astronomical posts in Britain and Ireland*, [http://www.jonesbryn.plus.com/histastron/posts\\_gbi/posts\\_gbi.html](http://www.jonesbryn.plus.com/histastron/posts_gbi/posts_gbi.html). The University posts are discussed at length in Hutchins op. cit. ref. 64.

<sup>63</sup> Gill's supporters included James Clerk Maxwell from Cambridge, Professors Robert Grant and Sir William Thomson from Glasgow, Dr William Huggins from the RAS, Dr Thomas Romney Robinson from the Armagh Observatory and Robert Stawell Ball, Royal Astronomer of Ireland and Professor at Dublin, Wilhelm Döllén and

Otto Wilhelm von Struve from St Petersburg, Dr Arthur Auwers from Berlin, Dr Hermann Carl Vogel from Potsdam, Professor Winnecke of Strasbourg, Professors Hendricus Bakhuyzen from Leiden and Jean Oudemans at the Utrecht Observatory, Professor Edward Pickering from Harvard and others comparably well known.

<sup>64</sup> The Radcliffe observatory and observer at Oxford is discussed at some length in Roger Hutchins *British University Observatories 1772 – 1939*. Aldershot: Ashgate, 2008. Hutchins attributes the result to the influence of G B Airy who favoured Gill for the South African posting.

<sup>65</sup> Glasgow City Museums possess a colour lithograph of the Taymouth Castle and a trials notebook of 1877.

<sup>66</sup> For a brief description of the Observatory now, see IAU *Portal to the Heritage of Astronomy*.

<http://www2.astronomicalheritage.net/index.php/show-entity?identity=35&idsubentity=1>.

<sup>67</sup> Warner B. *Astronomers at the Royal Observatory Cape of Good Hope*. Cape Town: A. A. Balkema, 1979.

<sup>68</sup> The author presented a summary of Gill's achievement at the Cape Observatory to mark the centenary of his death. See <https://arxiv.org/ftp/arxiv/papers/1601/1601.02519.pdf>.

<sup>69</sup> Bartky IR and Dick SJ. The first time balls. *JHA* 1981: xii, 155 – 164.

<sup>70</sup> *Report of the Fiftieth Meeting of the British Association for the Advancement of Science; held at Swansea in August and September 1880*, pp 56 – 61.

<sup>71</sup> Grubb H. New arrangement of electrical control for driving clocks of equatorials. *MNRAS* 1888; 48, 352 – 356. DOI:[10.1093/mnras/48.8.352](https://doi.org/10.1093/mnras/48.8.352).

<sup>72</sup> Gill D. op. cit. ref. 8, pp cxliii – cxliv.

<sup>73</sup> *Report, and Special Report, from the Select Committee on the Daylight Savings Bill, together with the Proceedings of the Committee, Minutes of Evidence, and Appendix.*, HMSO (London, 1908).

<sup>74</sup> Paterson JA. Sir David Gill, K.C.B – The growth, the work and the charm of a real astronomer. *Journal of the Royal Astronomical Society of Canada* 1919: XIII October, No. 8, pp 343 – 359.