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Seeing Stars in the City – A History of Early Astronomy in Sydney

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Abstract: Mankind has always been fascinated by the apparent movement of the objects in the sky. Initially the stars and planets had a spiritual significance, but later their value as markers of time and aids to navigation came to be recognised. The invention of the telescope four centuries ago enabled people to expand their understanding of these celestial phenomena. Astronomy was the doyen of the sciences by the end of the 18th century, the so-called Age of Reason, when Australia was first settled by Europeans. Thus it is not surprising that it was practised in the new colony from the earliest days. This paper traces an almost unbroken line of notable astronomers in Sydney until the early 20th century.

Keywords: Astronomy, history, meteorology, observatory, Royal Society, Sydney, telescope.

When Galileo Galilei turned his telescope towards the sky in Florence four hundred years ago, and wrote about 'The Starry Messenger', he launched an intellectual revolution that we celebrated in 2009 as the International Year of Astronomy.[1] That occasion makes it an appropriate time to reflect on the achievements of some notable astronomers who continued in the same tradition while working in Sydney during the period before Federation.

Let us begin with a little story:

'*Beyond the horizon, where no one has ever been, there is a beautiful land with grassy valleys and tree-covered hills. The inhabitants of that land are Moons – big, shining globular Moons. They have no arms or legs, but they can move quickly across the grass by rolling over and over. It is a pleasant life in that green, watered land, but sometimes the Moons grow restless, and when night comes they have the urge to explore farther afield and stroll across the sky.*

Only one Moon goes on such a journey at a time. It is a pity that they do not go in company, but they do not know that outside the valley there lives a giant. He catches the wandering Moon, and with his flint knife he cuts a slice from it each night, until after many nights there is nothing left but a number of shining slivers. The giant cuts them up very finely and throws them all over the sky.

They are timid little creatures, these cut-up Moons which have become Stars. During the day, when a Sun goes striding across the sky, they hide. Who knows but that, if they showed themselves then, another giant Sun might not creep out and catch them unawares.'

Adapted from Reed 1993

This is one of the many legends and fables recounted by Aboriginal Australians to explain the existence of the sun, moon and stars. Although the stories vary from locality to locality, indigenous people generally believe that every aspect of the world we know today was created by spirits who once lived in the sky. This spirit dreaming is repeated in the dreamings of the people who now inhabit the earth (Bursill 2007).

Unfortunately most of the stories told by the Eora people who were the original inhabitants of the Sydney region were lost before anthropologists became active in the mid-nineteenth century (Turbet 2001). Nevertheless, the story demonstrates the truism that since earliest times humans have been fascinated by the sky, particularly the night sky, and the apparent movement of the objects which they can see.

The settlers who arrived in 1788 were not simply disinterested observers like Cook and Banks who sailed past in 1770; Val Attenbrow from the Australian Museum has pointed out that 'The colonists impacted on the local way of life from the moment they began clearing the land.' (Attenbrow 2002). Although there are colourful accounts of the life and customs of the local Aborigines written by officers of the First Fleet, we cannot assume that these

[1] Sidereus Nuncius was published in 1610. In 1616 the Catholic Church told Galileo to stop advocating heliocentrism, and banned an earlier book by Copernicus on a similar theme.

reports provide an accurate description of pre-1788 conditions, which may already have been coloured by the new circumstances as well as the authors' own pre-conceptions. Furthermore, the local population of the Sydney region (no more than 3,000 on the best estimate) was devastated by a virulent epidemic the following year, possibly smallpox, leaving few older people with a sound knowledge of their own traditions.

Serious research into local customs began during the nineteenth century, particularly amongst groups that had not had significant contact with Europeans. W.E. Stanbridge studied the original inhabitants of the Victorian mallee around 1857, and noted that the appearance of the major star clusters above the horizon were associated with seasonal events – in effect, a primitive calendar (Stanbridge 1857).

Several anthropologists reported that the brightest stars and constellations, such as the Milky Way and the Southern Cross were given a meaning, although this differed between regions. Writing in the Royal Society of New South Wales *Journal & Proceedings* in 1881, Rev. Peter MacPherson noted similarities between Greek and Aboriginal mythology, for instance in associating the Pleiades with a group of young maidens (MacPherson 1881). Still later, some rock carvings at Manly were interpreted as indicating that the Eora people had some concept of the relative motion of the Earth to the Sun, and that they understood that the Earth revolved. If this was the case, these were concepts that Copernicus (1473–1543), Kepler (1571–1630), Galileo (1564–1642) and Newton (1643–1727) had difficulty in convincing the 'civilised' Old World four centuries ago, at a time when other creation myths prevailed (Ramsay 1932).

Scientific values of rational enquiry became more widely accepted in the eighteenth century, during the period called the Enlightenment or the Age of Reason. At this time France and Britain were the international superpowers, engaged in a rivalry for scientific and territorial discovery. Much of the Pacific Ocean was uncharted, yet a problem faced by all navigators when so distant from their homelands was the difficulty of accurately determining their position. Provided that the skies were reasonably clear, it was relatively easy to fix latitude (North-South) by measuring the angle between the sun and the horizon. Longitude (East-West position) was a more difficult proposition for a ship at sea. The only way of measuring a vessel's speed was to cast a knotted rope overboard and count the number of knots that passed through the bosun's hands in a fixed period, usually determined by an hour-glass. That calculation did not take account of tides or currents, so provided only a rough estimate of distance travelled. Clocks of that era were driven by a pendulum mechanism that could not cope with the motion of a sailing ship and so could not measure elapsed time. Astronomical observations were not very helpful in the southern hemisphere because there were no accurate tables of star positions. It is no wonder that many East Indiamen on their way to Java accidentally bumped into New Holland because the Captain miscalculated his position.

So acute was the problem that a Board of Longitude was established in England in 1714, offering a prize of up to £20,000 to the person who devised an accurate and reliable means of finding longitude at sea. After much experimentation, that honour finally went to John Harrison who developed chronometers that were not affected by motion, and could maintain accurate time for an extended period. Knowing that in one hour, the sun's apparent position has altered by 15 degrees of longitude, it was possible to calculate the distance from a fixed reference point – the Greenwich meridian became the benchmark. Nevertheless, Harrison had great difficulty in collecting the prize, and in fact he never received the full sum promised (Wikipedia 2010)[2].

In 1768 the Royal Society in London petitioned King George III to mount an expedition to observe the Transit of Venus the following year, a phenomenon that would be seen at its best in the South Seas. Lieutenant James Cook was selected by the Admiralty to command HM Bark *Endeavour* while Charles Green, a former assistant to the Astronomer Royal, Rev. Dr

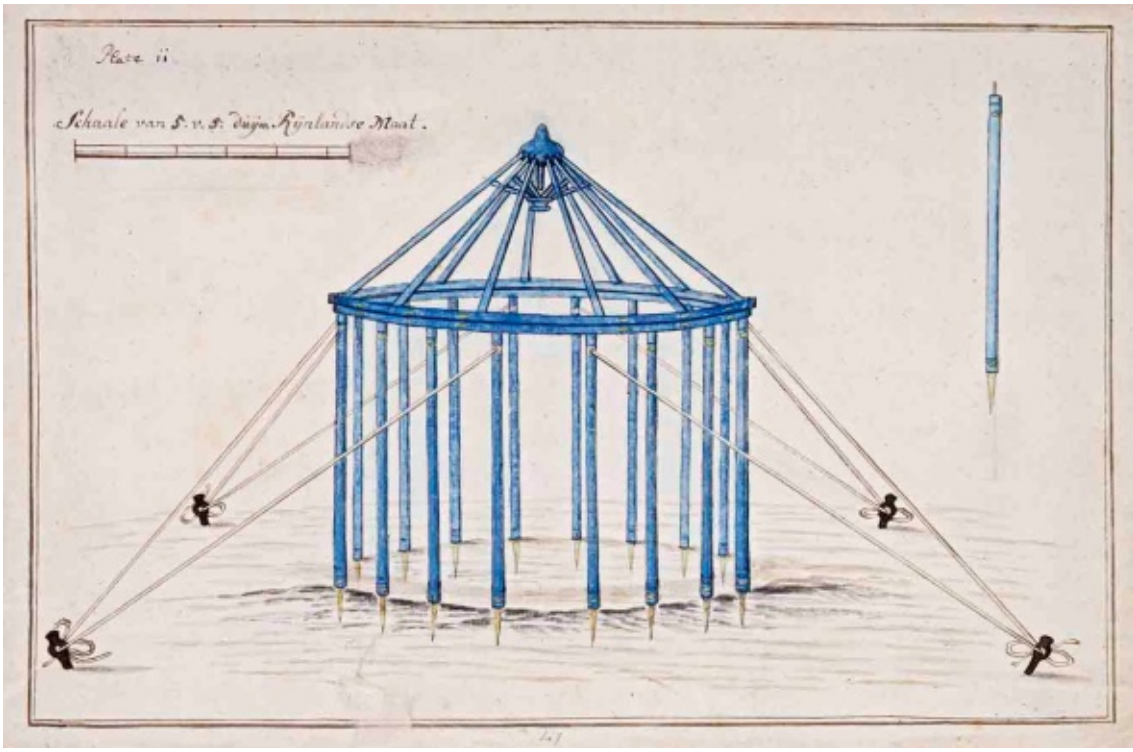
[2] Also see National Maritime Museum website, `http://www.nmm.ac.uk`

Nevil Maskelyne, was appointed by the Royal Society as principal observer. Wealthy young botanist Joseph Banks paid for himself and a retinue of other scientists to secure a place on the voyage.

The Transit of Venus is that rare phenomenon when the planet Venus passes between the Sun and Earth, and therefore appears as a black spot moving across the Sun. It occurs in an unusual pattern; in a pair about eight years apart, and then not again for over a century. The last transit visible from Sydney was in June 2004, the next will be on 6 June 2012, at 8.30 am; thereafter the next will not be until 2117. The significance of the event for astronomers was that if carried out at a number of widely separated locations (77 in this case) it provided a means of calculating the distance between the Earth and the Sun. That distance is now known as the Astronomical Unit – approximately 150 million km. From this information it was hoped that astronomers could deduce the size of the whole solar system (Lomb 2004).

James Cook's skill as a navigator and seaman was displayed when the party arrived at Tahiti several months before the predicted Transit of Venus. This allowed plenty of time to establish a semi-permanent settlement that became known as Fort Venus, with proper facilities for astronomer Charles Green to set up his instruments for observing the Transit.

The observations were reasonably successful, although there was some discrepancy in the times noted by the several observers, which affected the accuracy of the calculations. Taking advantage of the location, Green continued making astronomical observations for another two months. Some of Cook's notes on his own observations are held at Mitchell Library in Sydney. Although Charles Green died on the voyage home, full reports of Green's and Cook's observations were published by the Royal Society in London, the sponsors of the expedition.



Observatory tent as used by Cook's party at Fort Venus, Tahiti. A similar tent was used by the La Pérouse expedition in Botany Bay. The wooden framework was covered with canvas, leaving an aperture for the telescope. (Alexander Turnbull Library, Wellington, New Zealand, B-091-008)

While Charles Green was observing various celestial bodies, the 26 years-old Joseph Banks used his time at Tahiti to gather botanical specimens, and to make ethnological studies of other bodies, remarking on the 'infinite smoothness' of the women's skin, and commenting that 'these people are free from all smells of mortality and surely . . . it must be preferred to the odoriferous perfume of toes and armpits so frequent in Europe.' (Engledow 2008). Because there was no need for their nautical skills on shore, most of Cook's crew devoted their time to similar pursuits by giving a different interpretation to the 'transit of Venus'.

After completing the observations in Tahiti, Cook set off on the secret part of his mission – to discover if a great south land existed to balance the northern hemisphere land masses, as many geographers inferred. The British government hoped that this was correct, imagining untold wealth like the Spanish had discovered in the Americas. Cook soon concluded there was no *Terra Australia Incognita*, but as part of his voyage of global circumnavigation he charted the entire coast of New Zealand, and then the eastern coast of New Holland, for which he claimed possession by the British Crown as New South Wales. We know from Cook's journal that Charles Green began taking celestial measurements on 30$^{\text{th}}$ April 1770, the day after they arrived in Botany Bay. Thus Green became the first professional astronomer to practice on Australian territory.

After returning to England, Joseph Banks went on to become President of the Royal Society, the dominant figure in English science, serving in that office for an unequalled 42 years until his death in 1820. When asked to suggest a site for the transportation of England's surplus criminals, Banks proposed Botany Bay, where he had collected many new species of plant and animals years earlier. That advice was followed and as we know, the First Fleet arrived there at the beginning of 1788.

However, after spending just a week in Botany Bay, Captain Arthur Phillip decided to take his eleven ships to the more congenial environment of Sydney Cove. By remarkable coincidence, the French Comte Jean-François de Galaup La Pérouse sailed into Botany Bay as Phillip was leaving, and set up an encampment on the northern shore, at a location now known as Frenchman's Beach. Following bad experiences at other places he had visited in the Pacific, La Pérouse built a solid palisade around the camp site to protect men and materials from pilfering or attack – rather similar to Fort Venus erected by Cook on Tahiti 19 years earlier.

Amongst the French party was Joseph Lepaute Dagelet (1751–1788), a capable astronomer, who immediately set up a tent to house his instruments and form an improvised observatory. Aged 37 when he arrived in Botany Bay, Dagelet was the youngest Associate Member of the French Academy of Sciences. At first reluctant to join the expedition, it was only following entreaties from the Minister that he agreed to take part. A sensitive soul, he did not enjoy the rough company of sailors, who he wrote to a friend 'sing, swear, smoke, drink and speak of girls all in the same half an hour', although he got on well with La Pérouse. Officers of both the French and English navies visited each other from their respective camps in Sydney Cove and Botany Bay, although Arthur Phillip and La Pérouse never met personally (Barko 2007). The French Revolution began with the fall of the Bastille the following year.

While Dagelet was setting up his observatory at Frenchman's Beach, about 15 kilometres to the north Second Lieutenant William Dawes (1762–1836) of the British Marines was unpacking the telescopes and astronomical instruments supplied by the Board of Longitude in order to observe the expected appearance of a comet later that year (it did not appear). He named his chosen site Point Maskelyne, after his mentor and patron Dr Maskelyne, the Astronomer Royal. This is the location which we now know as Dawes Point. We have some idea of what his observatory looked like from a written description and a sketch he made in a letter home; a convincing re-creation of this building was built in the now-defunct Old Sydney Town theme park near Gosford.

A week after their arrival, Dawes accompanied Lieutenant Philip Gidley King on a visit to the French fleet. The two astronomers met and

exchanged information about their work. Later, Dagelet wanted to visit Dawes by trekking overland, but La Pérouse would not permit this because of unknown dangers. However, one of the French officers did visit Dawes at his observatory site, and reported back to Dagelet, who wrote a long letter to his English counterpart which is now in the Mitchell Library.

Dagelet and La Pérouse never returned to France because their expedition was wrecked in the Solomon Islands and their fate is unknown. Underwater archaeological exploration at the site has yielded a number of scientific instruments of the period, probably including those used by Dagelet. All the records of his observations sank with the ships, with the exception of that letter to William Dawes written on 3 March 1788 in which he gives the geographical co-ordinates of the Botany Bay observatory and some other technical advice to his less-experienced British counterpart.

William Dawes used this information when he established accurate geographical co-ordinates for Sydney, but he also had other responsibilities in the new colony, which needed his training as an engineer and surveyor to lay out streets and fortifications. He hoped to remain in NSW if a suitable position could be found for him, but after a couple of clashes with Governor Phillip, he was obliged to return to England with the marine contingent in 1791, taking his borrowed instruments with him. With no other trained astronomer in the colony, and no instruments, the wooden observatory building soon fell into disrepair (Mander-Jones 1966). Dawes has been treated kindly by historians and novelists because of his apparent benevolence towards the Aborigines[3] but recent research has painted an entirely different picture of the man in his subsequent career as governor of Sierra Leone, where he allegedly engaged in slave-trading amongst other crimes (Pybus 2009).

Towards the end of Lachlan Macquarie's term as Governor in 1821, a small group of educated men in the colony formed the Philosophical Society of Australasia, which became the forerunner of the present Royal Society of New South Wales as well as the indirect antecedent of many other Australian scientific organisations and learned societies. While the early years had been devoted to eking out a tenuous subsistence in a strange environment, by this time increased prosperity gave a little scope for more leisurely pursuits. Nevertheless, Charles Darwin remarked somewhat tartly when he visited Sydney in 1836 that the main topic of conversation was sheep and wool. Darwin was not an astronomer, but HMS *Beagle* did carry 22 chronometers to verify their accuracy over a long period under arduous conditions. Although the Board of Longitude had been disbanded in 1828, there were still some lingering doubts about the reliability of the new technology.

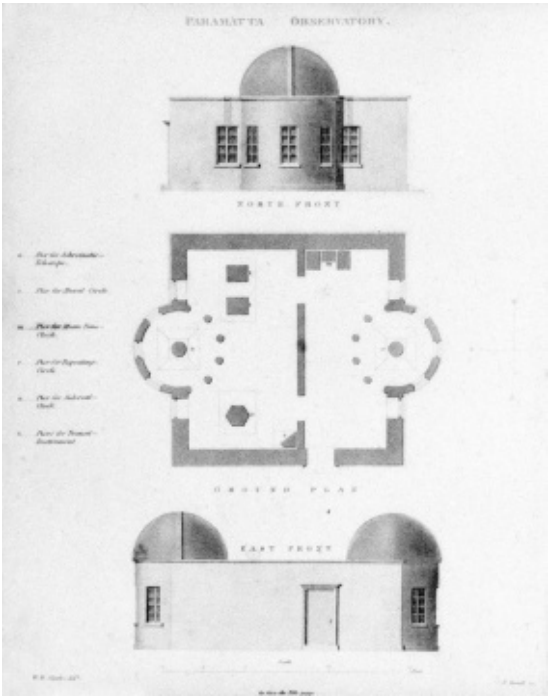
At the end of 1821 a new Governor, Major-General Sir Thomas Brisbane (1773–1860) arrived in the colony together with his family, a retinue of servants, a personal physician, a French chef, and two scientists. Because the Macquaries were still living in the original Government House in Bridge Street, Sir Thomas and his entourage settled into the other (and larger) official residence at Parramatta. Lady Brisbane was sickly, and both she and her husband preferred the climate and unpolluted atmosphere of Parramatta, so the Governor remained there throughout his tenure, only visiting the city establishment one day a week to transact his official responsibilities. This caused considerable resentment amongst the senior administrative, legal and military officers who had to travel to Parramatta to transact their business.

Like Macquarie, Brisbane was a military man and a Scotsman. Living on half-pay since the defeat of Napoleon and only recently married, he sought the appointment to New South Wales in order to maintain his lifestyle (Liston 1996). He had been elected a Fellow of the Royal Society in London because of his interest in astronomy, and he was excited by the possibility of exploring the skies of the southern hemisphere. He brought with him

[3] See for instance G. Karskens, The Colony, 2009; I. Clendinnen, Dancing With Strangers, 2005; T. Flannery, The Birth of Sydney, 1999, and for a novel based on Dawes, see Kate Grenville, The Lieutenant, 2008.

the latest instruments and two astronomical assistants, Carl Rümker and James Dunlop. Under the Governor's supervision an elaborate observatory building was erected in the grounds of Government House at his own expense, and a rigorous program of celestial observations commenced. During the daytime, Brisbane occupied himself with that favourite pastime of the landed gentry to which he belonged – hunting – leading to the accusation that he spent his nights looking at stars and his days chasing parrots (Liston 1985).

During 2009 the Parramatta Park Trust has been conducting an archaeological dig at the site of Brisbane's observatory, and has unearthed some new evidence that still awaits interpretation.



Plans for Sir Thomas Brisbane's observatory at Government House, Parramatta. Governor Brisbane, a notable astronomer, was President of the Philosophical Society of Australasia 1821–2. He later became President of the Royal Society of Edinburgh. Only a few remnants of the Parramatta observatory that he built now exist. (Mitchell Library, State Library of NSW, GPO1-23235)

After four years in Sydney, Sir Thomas Brisbane was recalled to Britain and returned to his estates in Scotland, where he built an observatory to continue his astronomical observations. As a result of this work he was elected President of the Royal Society of Edinburgh, with numerous publications to his credit.

Christian Carl Ludwig Rümker (1788–1862) was born and educated in Germany, but at the age of 21 went to England and served a period in the Royal Navy, where he became interested in astronomy before returning to Hamburg as a teacher of navigation. Governor Brisbane paid him a salary of £200 a year to become his private astronomer. Soon after the Parramatta observatory opened it came to international attention when the trio of astronomers observed the return of Encke's comet, which became only the second comet to have its return successfully predicted in advance, the first being Halley's Comet (Pickett & Lomb 2000, p. 25).

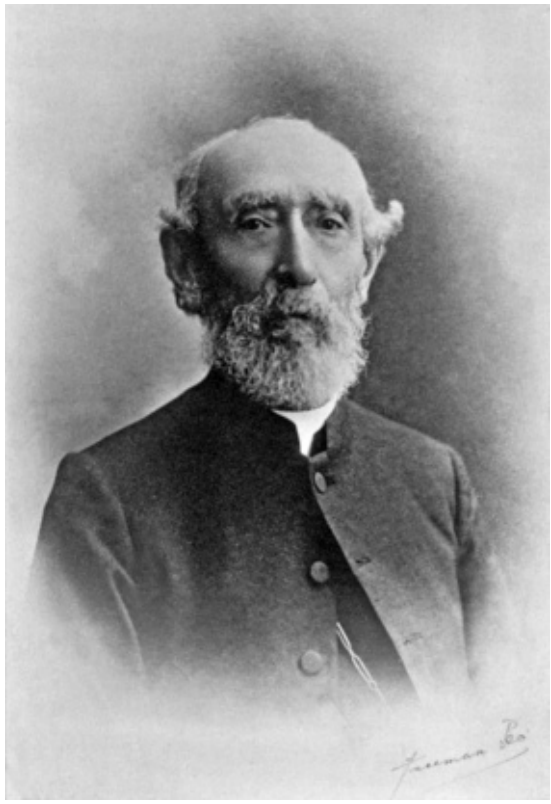
The grateful governor granted Rümker 1,000 acres of land at Picton as a reward. Twelve months later he deserted his job at the observatory and moved to his new rural property. Brisbane was furious, and tried to revoke the land grant. Relations between the two men collapsed (Bergman 1960).

After Brisbane returned to England, the government acquired his observatory. Rümker then resumed astronomical work at Parramatta in May 1826, and discovered another comet. The new governor, Ralph Darling appointed him to the position of Government Astronomer, the first person to hold this title. However, when he went to London in 1829 to purchase new instruments, Sir Thomas Brisbane used his influence to have Rümker dismissed from government service. For many years afterwards Brisbane and Rümker maintained a vitriolic correspondence. Rümker returned again to his native Hamburg and became director of the observatory there, while continuing to work on his Australian star catalogue. He received many international awards for his achievements, but is little recognised in this country (Bergman 1967).

James Dunlop (1793–1848) was born in Scotland of humble parents. With little formal education he showed great aptitude for mechanical craftsmanship, making his first telescope at the age of 17. Sir Thomas Brisbane selected him as one of his two astronomical assistants because of his facility with instruments, whereas Rümker was primarily a mathematician. Dunlop made about 40,000 observations at Parramatta in the four years after Rümker left suddenly, although the quality is rather poor because of inaccurate instruments. In 1831, James Dunlop was appointed superintendent of the observatory. After 1837, however, his activity declined, perhaps due to poor health. Much of his work in this period was never published, and he resigned in 1847, dying the following year (Wood 2009).

In contrast to the volatile Carl Rümker, James Dunlop had an outgoing, friendly personality, with a wide range of interests outside astronomy. Dunlop Memorial Park at Kincumber, near Gosford, where he lived commemorates his work. A memorial tablet in the local Church of England describes him as 'Astronomer Royal at the Observatory Parramatta', which overstates the position he held as superintendent. Although both Rümker and Dunlop (and Brisbane) were awarded the Gold Medal of the Royal Astronomical Society in London, Dunlop was never accepted into the educated ranks of class-conscious Sydney and was not invited to join the Philosophical Society.

Rev. William Scott (1825–1917) became the first director of Sydney Observatory, although his biographer incorrectly called him the first Government Astronomer. While a mathematics lecturer at Cambridge University, he was selected by then Astronomer Royal, Professor George Airy, for the position in Sydney. He arrived in 1856 – the year that the colony achieved responsible self-government, and the year after the railway to Parramatta opened – and was able to help with planning the observatory building which opened in 1858. However, when he returned to Sydney from travels around the colony to set up meteorological stations, he found that the central tower had been built taller than he expected, in order that the time ball could be clearly visible to ships in all parts of the harbour. This meant that the critical eastern horizon could no longer be seen from the telescope dome. That decision revealed the government's true priorities; to provide accurate timekeeping for navigation. The northern dome with unimpeded view was only built after Scott's departure. Initially he had to work with the old instruments from Parramatta, although he persuaded the government to order a large telescope from Germany. He was criticised in the press when amateur astronomer John Tebbutt at Windsor discovered a new comet before Scott observed it, but after all that was not his mandate. Somewhat discouraged, William Scott resigned in 1862 to return to his earlier vocation of teaching (Doyle 2008).



Rev. William Scott, Government Astronomer and first Director of the Sydney Observatory, 1856–1862. He helped with planning the new building, but his scientific work was hampered because initially he had to use the outdated instruments from Governor Brisbane's observatory at Parramatta. (Mitchell Library, State Library of NSW, GPO1-13544)

George Robarts Smalley (1822–1870) succeeded Scott. The son of a Church of England clergyman, he became an astronomical assistant at the Royal Observatory in Cape Town after completing his degree at Cambridge. Later he became a mathematics professor, before the Astronomer Royal recommended him for appointment as the government astronomer in Sydney. His interests were in meteorology and trigonometric surveying rather than celestial astronomy, and these coincided with the government's pragmatic instincts. He organised automatic recording of harbour tides at Fort Denison, and expanded the network of volunteer weather observers throughout the colony[4](Wood 1976).

George Smalley was unusual for a mid-nineteenth century scholar in wishing to see a greater female involvement in the sciences, albeit expressed with a paternalistic Victorian overtone: '*a knowledge of science in ladies is not inconsistent with their natural refinement, or incompatible with their usefulness in domestic and social life*' (Smalley 1868).

Sadly, Smalley died suddenly two years after this address to the Royal Society of NSW in 1868, so was unable to put his ideas into effect. It was to be another seventy years before women were allowed to join the Royal Society.

Sydney Observatory in 1874. Opened in 1858, the building and its surrounds look almost identical today, although it is now an adjunct of the Powerhouse Museum. The tower housing the time-ball obscured astronomical observations from the adjacent dome. (Mitchell Library, State Library of NSW, a089304)

[4] H.C. Russell later pointed out that the tide readings were inaccurate, because they were measured with a hempen rope whose length varied with atmospheric conditions.

Henry Chamberlain Russell (1836–1907) has been called one of the most eminent men of Australian science in the nineteenth century. Born at Maitland, after graduating from Sydney University he joined the staff of the Observatory as a 'computer', and became the first Australian-born Government Astronomer when George Smalley died in 1870, holding the position for the next thirty-four years. During this time he discovered 500 new double stars, and published over 130 papers. For the 1874 Transit of Venus, he set up temporary observatories in several locations in NSW in order to minimise the possibility of clouds obscuring the event, which he described as 'very remarkable and beautiful'.

Henry Chamberlain Russell, NSW Government Astronomer 1870–1907. He was a skilled photographer and inventor. Four times President of the Royal Society of New South Wales. The first graduate of University of Sydney to be elected a Fellow of the Royal Society, London. (Mitchell Library, State Library of NSW, SPF/P1/Russell)

In addition to pure astronomy, Russell was keenly interested in photography and meteorology, inventing new recording instruments and re-establishing the weather stations discontinued by his predecessor, so that he could issue a daily weather map to the newspapers. By 1898, he had 1600 observers throughout the colony of New South Wales sending data by telegraph. He was the first graduate of the University of Sydney to be elected as a Fellow of the Royal Society of London, and he was president of the Royal Society of NSW four times. He later became Vice-Chancellor of the University.

Henry Russell believed that the scientist must be 'patient in investigation, accurate in measurement, cautious in accepting results.' A vigorous, uncompromising man, he made his share of enemies. In 1877 there was an assassination attempt when a bomb was delivered to him at the Observatory; two of his staff were charged, but acquitted because the evidence was circumstantial. Then in 1889 he was physically attacked by one of his workmen (Walsh 1976). He retired in 1905, dying in 1907 while still living at the Observatory.

Henry Alfred Lenehan (1843–1908) had a variety of jobs before being appointed as assistant to H.C. Russell in 1870, cataloguing accurate star positions for the next 37 years. Lenehan was appointed Government Astronomer in 1907, and made a number of significant changes in the work of the Sydney Observatory. He began taking measurements of the force of gravity, and used the branch observatory at Red Hill near Pennant Hills to investigate magnetic fields. This was no longer possible in the city because of interference caused by the electric trams. Like his predecessors and most of his successors, Lenehan was an active member of the Royal Society of New South Wales (Wood 1986).

When Henry Lenehan died, there was a hiatus of four years before William Ernest Cooke (1863–1947) was appointed Government Astronomer in 1912, holding this position jointly with that of Professor of Astronomy at the University of Sydney. Observations continued under his leadership, but in 1926 he took early retirement when the Government decided

to curtail the activities of the Observatory (Hutchison 1981).

While Lenehan was working as astronomical assistant to Henry Russell, Henry Ambrose Hunt (1866–1946) became the meteorological assistant at Sydney Observatory in 1890, responsible for preparing the daily weather map, and working with Russell investigating the movement of anti-cyclones. After Federation, he went to Melbourne in 1906 as head of the new Commonwealth Meteorological Bureau (Walsh 1983).

Then, as now, some people were sceptical about the validity of weather forecasting. Pietro Baracchi, the government astronomer in Victoria in the 1890s, remarked that what he termed 'popular meteorology' was 'of little practical value except as an amusement, and of doubtful credit to science.' (Perdix 1979). To him it was on a plane with astrological horoscopes.

William Shakespeare was making an identical point around the same time Galileo was making his observations: '*Why didst thou promise such a beauteous day, And make me travel forth without my cloak, To let base clouds o'ertake me in my way ...*' (Shakespeare[5]) Shakespeare may have been speaking metaphorically, but the point is still valid.

Professional scientists were rare in the nineteenth-century, therefore it is not surprising to find that serious astronomical investigations were being made by men who were not paid Colonial officials. One of the most significant of all Australian astronomers was John Tebbutt (1834–1916) at Windsor, whose observatory still exists. Tebbutt was offered the position of Government Astronomer when William Scott resigned, but he didn't relish the 'blighting influence' of the civil service and preferred to maintain his independence as a researcher. Educated locally – he never left Australia – his family were relatively prosperous farmers. He had bought his first instrument, a marine sextant, at the age of nine, and continued to acquire mechanical and optical objects throughout his life.

Tebbutt built an international reputation for his accurate observations of comets and minor planets, and his publications were in much demand. He was regarded as Australia's leading astronomer in the late nineteenth century (Orchiston 1989). Tebbutt discovered the great comet of 1861, which is one of the finest comets on record, and discovered another major comet in 1881. He observed the return of Encke's comet on seven occasions (Wood 1976).

Closer to the city there is the observatory in the grounds of St. Ignatius' College, Riverview. This began in 1908 under the direction of Father Edward Francis Pigot (1858–1929). Born in Ireland, he initially studied medicine and set up practice as a doctor in Dublin. In 1885 he enrolled for the priesthood with the Jesuit order, first coming to Riverview in 1889. For the next 15 years he travelled extensively, including a period working at the famous observatory in Shanghai, before returning to Sydney in 1907. He immediately set about planning an observatory of international standard at the College. This included facilities for official daily meteorological observations, a function which continues today. Pigot was particularly interested in movements of the earth's crust, and established a fully-equipped seismological station. The only other equivalent station in the southern hemisphere was operated by the Swedish Academy of Sciences at Samoa, despite the fact that the south-west Pacific region is an area prone to earthquakes. Later he began studying variable stars and solar radiation, which he believed could be used in long-range weather forecasting.

Amongst his many other attributes, Father Pigot was an accomplished pianist, whose playing was once commended by Franz Liszt. As the distinguished geologist Sir Edgeworth David remarked, 'Surely there never was any scientific man so well-beloved as he (Drake 1988).

Some men who are remembered today for other achievements also made notable contributions to astronomical science, a discipline in which they were more than mere hobbyists.

[5] Shakespeare, W. Sonnet 34.

Admiral Phillip Parker King (1791–1856) was born on Norfolk Island, the son of the third Governor of NSW, Phillip Gidley King, who had been the companion of William Dawes when they visited the La Pérouse expedition in Botany Bay. Phillip Parker King was a notable hydrographer as well as a keen astronomer, who built a private observatory on his property at Dunheved. King was influential in persuading the government to establish an observatory in Sydney, and he ensured that the instruments from Brisbane's Parramatta observatory remained in the colony as a nucleus for the new institution (Pickett & Lomb 2000, p. 22).

Phillip Parker King (1793–1856), foundation member of the Philosophical Society of Australasia, hydrographer, pastoralist and amateur astronomer. He was influential in having Sydney Observatory built. King was the son of the third Governor of NSW, and became the first Australian-born Admiral in the Royal Navy. (Mitchell Library, State Library of NSW, GPO1-17497)

Conrad Martens (1801–1878) is known primarily as one of the most distinguished early colonial artists. He was part of the research complement of HMS Beagle, during which he formed a lasting friendship with Charles Darwin. Martens left the expedition in Valparaiso, and made his own way to Sydney where he remained for the rest of his life (Dundas 1967). When he became a neighbour of Rev. W.B. Clarke, rector of St. Thomas's church in North Sydney, his latent interest in astronomy was fostered. Clarke has been called the 'father of Australian geology', but his interests extended to all the natural sciences, and he was a leading figure in the Royal Society of New South Wales. Conrad Martens acquired an astronomical telescope from London so that he and Clarke could observe the solar eclipse of 1856. His observational records demonstrate that this interest was a serious occupation (Ellis 1994). He, too, was an elected member of the Royal Society.

Philip Adams (1828–1901) became Surveyor-General, as well as a successful wine-grower. He was responsible for the dome on the top of the Lands Department building in Bridge Street that was originally designed for astronomical observations by budding surveyors. Adams' reputation as an astronomer was confirmed by his selection as one of the official observers of the transit of Venus in 1874 at Woodford, and in 1882 at Lord Howe Island (McIntyre 1969).

Another member of the surveying staff, Joseph Brooks (1847–1918), carried out most of the original trigonometrical survey of NSW, working from a baseline at Lake George that had been started by Smalley (Nangle 1930). In order to ensure that titles to land ownership were accurately defined, it was essential that the location and length of this baseline were known precisely; this was achieved through astronomical observations. After his retirement Brooks furthered his lifelong interest in astronomy, taking part in a number of expeditions to observe total solar eclipses in the South Pacific region.

Lawrence Hargrave (1850–1915) is remembered as one of the pioneers of aviation. His experiments with box kites at Stanwell Park proved that heavier-than-air flight is feasible for humans. Hargrave made many experimental engines to power his kites, but could not develop a design that provided the required combination of power and light weight. Hargrave published his theoretical work on aerofoil wing design in the *Journal and Proceedings of the Royal Society of New South Wales*. He refused to patent any of his inventions, believing that

scientific knowledge should be for the benefit of all humankind. After receiving a comfortable inheritance, Lawrence Hargrave was able to pursue his scientific interests in many directions at once. Astronomy was one of his obsessions – perhaps linked to his desire to conquer the skies – and he had been engaged as an assistant astronomer at the observatory for five years from 1878 (Bhathal & Sansom 1988).

A man with a very different professional career was Walter Gale (1865–1945), who rose to become manager at the head office of the State Government Savings Bank. At the age of 19 he built his first 18 cm mirror telescope. Particularly interested in the surface of planets, he was the first person to note some of the topographical features of Mars, which he was convinced supported some form of life. He died in 1945 at the age of 80 while making his nightly telescopic sweep of the sky (Wood 1981).

James Nangle (1868–1941) a multi-talented architect who became Superintendent of Technical Education was a passionate astronomer. He designed an observatory for his Marrickville home, and built the telescopes he used there. Several of his papers and books on astronomy were published, gaining a reputation that resulted in him joining the official expeditions to view eclipses of the sun in 1910 and 1923. He helped re-design the Sydney Observatory and moved his family there after he was appointed honorary government astronomer in 1926 (Cobb 1986).

Sydney-born Thomas Roseby (1844–1918) had a brilliant career in Arts and Law at Sydney University, later becoming an ordained minister of the Congregational church, and a leader of the temperance movement both in New South Wales and New Zealand, where he spent 16 years. In 1888 he became minister at the Marrickville Congregational Church – later known as the Roseby Memorial Church – where he set up an observatory in order to pursue his interests in astronomy. He contributed papers to respected scientific journals, and arranged educational evenings for students at his home observatory, which he later moved to Mosman.

It is notable that a number of these men were clergymen, and from different Christian denominations – Maskelyne, Scott, Clarke, Pigot, Roseby, have been mentioned. By the nineteenth century most Christians accepted the proposition that the Earth revolved around the Sun, although they might still consider that humans were a unique, unchanging species in the universe. These beliefs were further challenged 150 years ago when Charles Darwin published his *Origin of Species*. Unlike many churchmen of his period, Thomas Roseby at Marrickville saw no inherent conflict between religion and science; he held that Darwin's evolutionary theory was not inconsistent with Christian belief, but 'simply a question of Divine method.' (Phillips 1976).

Of course, one reason for the involvement of so many clergymen in studying the natural sciences – including astronomy – during the nineteenth century, is that they tended to be better and more broadly educated than many of their contemporaries, few of whom had progressed beyond an elementary schooling.

Understandably, much of the effort of the early astronomers in Sydney was devoted to the practical needs of a new colony situated at the opposite end of the Empire. Consistent timekeeping, accurate fixing of positions both for navigation and land subdivision, understanding the weather patterns for agricultural purposes or tidal variations for fishermen, were all essential tasks. But this did not preclude plenty of pure scientific discovery as well. A comprehensive star atlas was begun as part of an international project, double stars were identified and measured, magnetic and geodetic surveys were carried out, and notable pioneering work in seismology all contributed to our understanding of natural phenomena.

As we moved deeper into the twentieth century, astrophysics rather than positional astronomy became the focus of most research. After the Second World War, Sydney-based scientific institutions became leaders in the field of radio astronomy, with many significant achievements to their credit. A number of notable physicists and astronomers contributed to these advances, but their careers lie outside the scope of this paper.

In any case, by mid-century optical astronomy had become impractical in Sydney, mainly due to increasing atmospheric pollution, and the brightly illuminated buildings that rendered the night sky all but invisible. Professional astronomers moved to remote rural locations such as Siding Springs near Coonabarabran, leaving enthusiastic amateur astronomical societies as the only regular users of traditional telescopes in the metropolitan area. Sydney Observatory closed for scientific observations in 1982, and has now become an adjunct of the Powerhouse Museum, with informative displays both of historical and contemporary astronomy, so that the achievements of the pioneers have not faded from view like the objects they once observed from that site.

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