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MELBOURNE OBSERVATORY'S ASTROGRAPHIC WOMEN: STAR MEASURERS AND COMPUTERS

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Abstract: In Australia a significant number of women were employed to measure, log and calculate the position of stars for the Astrographic Catalogue at Adelaide, Sydney, Melbourne and Perth Observatories. In the late nineteenth and early twentieth centuries the Astrographic Catalogue was considered the most important astronomical work in Australia.

This paper provides a background to the social, legal and gender-specific barriers women faced and then focuses on the first women employed at Melbourne Observatory to measure the stars on glass plate negatives and calculate their relative positions. Charlotte Peel, Lillian Lewis, Muriel Heagney and Sarah Noonan, who worked for various periods of time on the Astrographic Catalogue between 1898 and 1918, are case studied.

Rather than an anonymous group of 'female computers' this paper presents these four female computers as representative of the individual nature of the women and their range of skills, aptitudes and opportunities to produce new research. Examples of where the women had agency within the Observatory and influenced the physical workplaces and social environment are provided.

Keywords: Astrographic Catalogue, Carte du Ciel, female computers, Melbourne Observatory, Sydney Observatory, Adelaide Observatory, Muriel Heagney, Bureaux des measures, women in astronomy.

1 INTRODUCTION

This paper is about the women who worked on the Astrographic Catalogue at Melbourne Observatory. First, I provide a background to the AC and how the women became a crucial part of producing the data for the catalogue. I examine the relationship between the acknowledgement of women in astronomy more broadly, and the standardised work method for the Astrographic Catalogue. Finally, I focus more closely on the role women played in the production of the Astrographic Catalogue at Melbourne Observatory and case-study four women and their individual stories. For Australian observatories mentioned here see Figure 1.

When I began researching the Carte du Ciel and Astrographic Catalogue in Australia for my doctoral thesis in museology I focussed on the astronomers, telescopes, instruments and buildings. I knew about the women who I had heard called 'computers' who worked in Australian observatories because they were acknowledged for their toil (e.g. see Bhathal, 2001; Haynes et al., 1996; Lomb and Pickett, 2001; Russell, 2008). In the most part it appeared that the women were doing rudimentary work, meticulous but repetitive in nature, and that they had little individuality or agency in the workplace.

As I thumbed through pages of letters, observing logbooks, star ledgers and attendance books held in state archives and other places a new story about the scope of work performed by women and their individuality came into view. I adjusted my focus towards the women and found that for several decades from the 1890s the women employed by a network of observatories around the globe had been essential to producing the first all-sky catalogue and the individual stories of the women who worked in Australia began to emerge.

2 A GLOBAL AMBITION TO PRODUCE A STAR CATALOGUE FROM PHOTOGRAPHS OF THE STARS

In the late Nineteenth Century there were few observatories located in the Southern Hemisphere. There were a number of professional observatories in Australia developed during what Wayne Orchiston (2017) has called the Classical Era or 'golden age' of astronomy in Australia. Robert Ellery, Government Astronomer for Victoria, and Henry Chamberlain Russell, NSW Government Astronomer, were invited to participate in a photography-based Astrographic Catalogue and a Carte du Ciel, or chart of the sky (Chinnici, 1999; Turner, 1912; Wood, 1958; 1971). Russell, as one of 56 astronomers from 36 nations, attended the first Carte du Ciel Congress held in Paris in 1887. The initial project, the Carte du Ciel, was to be completed for stars with a brightness down to magnitude 14, the Astrographic Catalogue was to produce a catalogue of stars brighter than magnitude 11. Russell had Ellery's full support, and that of the respective colonial governments, to commit Sydney and Melbourne Observatories to participate as part of the British network of observatories in what was initially the Carte du Ciel but the scheme became two projects with the Astrographic Catalogue the

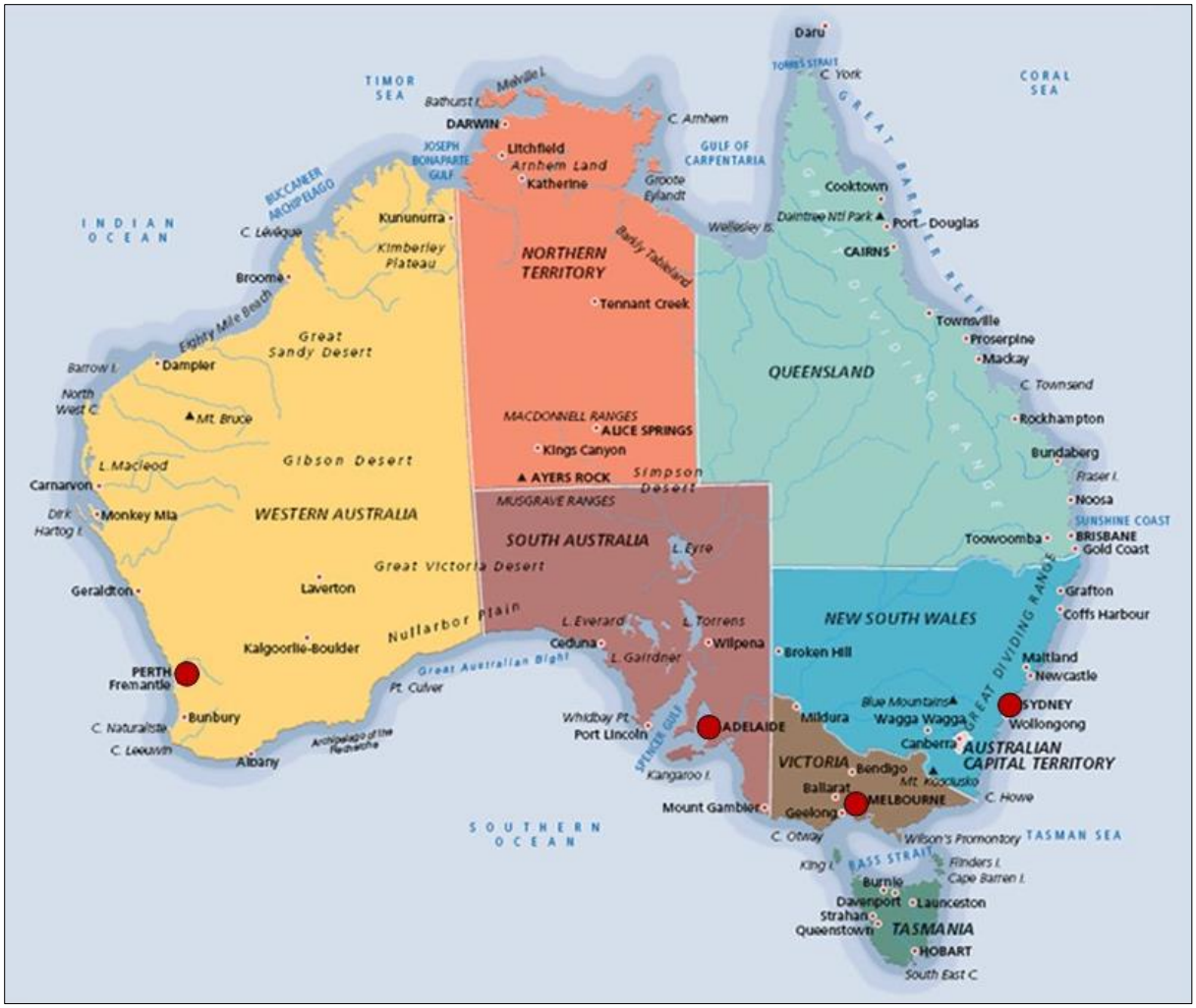

Figure 1: Australian observatories mentioned in the text (map: Wayne Orchiston).

most important to complete (Bhathal, 2001; Haynes et al., 1996; Lomb and Pickett, 2001; White, 1988; Wood, 1971). As it turned out both projects required the design of new equipment, new work methods, a new workforce structure and the construction of new buildings, requiring significant investment from the respective state governments.

When the Astrographic Catalogue (henceforth AC) and Carte du Ciel (henceforth CdC) were agreed the colonies in Australia were experiencing a boom time due to the discovery of gold and other positive economic forces which increased investment in science. Unfortunately, by the late nineteenth century a major financial depression had developed, especially in Victoria and to a lesser extent in New South Wales (Coghlan, 1918).

According to Clark (2015) and Orchiston (2017) the shifting of the scarce resources at Melbourne Observatory to positional astronomy for the AC severely diminished the development of astrophysics. Arguably this was the case. Nonetheless the Government astronomers, Russell, Ellery and the Western Australia Government astronomer William Ernest Cooke, saw the AC as a progressive science, advancing civilisation through objective means. Furthermore, embedded within Federation, was the determination that astronomy and meteorology would be controlled by the Commonwealth Government and at this and other volatile times, when the position of the state observatories after Federation was uncertain, there were political advantages in being part of the global AC network and under obligation to complete the catalogue. There is evidence that, at critical times, Sydney Observatory was supported by the Government due to the commitment made to the AC (Stevenson, 2015a).

3 DIVISION OF THE CELESTIAL SPHERE

The AC required photographs of the stars down to 11th magnitude to be taken with exposures of 6 minutes, 3 minutes and 20 seconds. To achieve this the celestial sphere was divided

into eighteen sections (Russell, 1895). After agreeing to the terms of participation, Melbourne Observatory was allocated zone –65° to the south celestial pole and Sydney Observatory –52° to –64°. Perth Observatory actively sought to participate in this prestigious project from 1898 and in 1900 officially accepted the zone –32° to –40° (Cooke, 1906).

Altogether the work of the three Australian Observatories accounted for 18% of the entire project (White, 1988). Adelaide Observatory had a significant role in providing positional stars for the Melbourne and Sydney Zones and arguably the first woman employed in a publicly funded observatory, Mary Emma Greayer, was responsible for observing and computing a significant catalogue of reference stars (Stevenson, 2014).

The aspiration for the AC and CdC was that photography and factory-like mechanisation would eliminate much of the human error found in the old star catalogues, which had in the past been produced reliant on an astronomer's eyesight (Hearnshaw, 1996; Russell, 1894; Turner, 1912). This was a push for objectivity and the accurately measured co-ordinates of the stars, which looked like small dark dots on the glass-plate negative, would produce the first consistent and complete log of stars in the celestial sphere at a single epoch.

4 MEASUREMENT TO BE DONE LOCALLY

At an astrographic congress held in 1892 it was decided by the Permanent Committee of the CdC, that, rather than establish a central bureau in Paris to measure and reduce all the zones, each observatory would make its own arrangements for measurement and preparation for publication (Tisserand, 1892). This significantly changed the terms of participation and was a momentous decision for colonial science. No longer were the observatories sending back their 'observations', to the colonial power, they were being asked to process and interpret these on home soil.

5 THE RICHEST SECTION OF THE SKY

The Australian observatories had the richest section of sky to contend with as the zones included the Milky Way. The Sydney zone was the most star-dense. The measurement of this concentration of stars was, as expressed by Lomb and Pickett (2001: 35), the "… real brake on the project."

It was not until 1898 that agreement was reached in how the measuring and computing would be done locally. The driving force was Pietro Baracchi, by then the Government Astronomer for Victoria, who wrote to Russell suggesting that they combine their resources. After meetings and much correspondence about the costs and arrangements Baracchi and Russell's proposal for Melbourne Observatory to measure the Sydney and Melbourne zones was accepted by the Astronomer Royal William Christie, and the Permanent Organising Committee.

In 1900 Russell and Baracchi produced a combined report estimating that the 1,500,000 stars could be measured within the next decade:

> … with three efficient measuring machines and six observers employed seven hours per day, the task may be accomplished in about six or seven years. (Russell and Baracchi, 1900).

The reality was that the Sydney and Melbourne zones were not completely published until 1964 (Wood, 1973).

The measurement, error checking and computation to produce the catalogue is generally recognised as the major barrier to efficient production of the catalogue (Bigg, 2000; Haynes et al., 1996; Hearnshaw, 1996; Lomb and Pickett, 2002).

6 ORGANISING THE STARS

The Victorian State Archives hold Baracchi's work books for the AC which include a carefully gridded plan for the photography of the plates. This diagram illustrates how the overlap edges of the plates were determined and the location of positional stars. This map provides insight into the number and importance of positional stars of which there were insufficient for those stars viewed from the Southern Hemisphere. There is much other evidence of the extensive planning process and the detailed level of organisation for the project.

Baracchi requested Adelaide Observatory begin observing, notating and computing positional stars from at least as early as 1892. He actively contacted Paris, Greenwich and Oxford Observatories about all matters, and, as relevant for this paper, the measurement methods. The determination of magnitudes was one of the most difficult aspects as, until the AC, this was measured in different ways. According to Hearnshaw (1996), who has researched the history of astrometry extensively, Norman Pogson was a significant influence in standardising magnitude measurement and the Pogson scale was adopted in the 1880s. The application of the Pogson scale for the AC ensured globally standardised magnitude measurement but how the magnitudes were measured differed greatly.

Table 1: Stars measured for the Australian Astrographic Catalogue zones by paid female computers.

Name of Observatory	Number of Stars	Number of Plates	Number of Female Computers	Start and Finish	Number of Years*
Adelaide	6818	0	2	1891 /1898	8
Sydney	740,000	1400	22	1916 /1963	174
Melbourne	392,615	1149	26	1898 /1930	104
Perth	228,000	944	10	1907 / 1912	23
Edinburgh	194,000	139	12	1908 / 1914	35**

* Whole years even if only part of the year was worked.
** Estimate of stars measured and time taken by Royal Observatory Edinburgh which was charged with completing the Perth zone.

I have found that there were over seventy women employed for the zones undertaken by Australian Observatories, of these twelve women were employed in Royal Observatory Edinburgh to complete the Perth zone (Table 1). Adelaide Observatory employed two female computers, one of whom also became an observer and computer to determine positional stars for the Melbourne zone from 1890 to 1898. Twenty-six women worked at Melbourne Observatory during the period 1898 to 1930. These are among the first women paid to work in professional astronomy in Australia but there has been little detailed research or acknowledgement of them and I will now examine why.

7 HISTORY AND HERSTORY: GENDER AND THE PAST

> I would venture to guess than Anon, who wrote so many poems without signing them, was often a woman. (Woolf, 1929: 51).

Sociologists and science historians researching women in astronomy in North America and Britain, including well-known historians of science and gender studies academics, found common reasons as to why women were 'hidden' within the history of astronomy (Benjamin, 1991; Brück, 2009; Mack, 1990; Pang, 1996; Rossiter, 1980; 1983; Werteim, 1995). These reasons for the historic lack of attribution of women's work included restrictions placed on women's careers because of their gender and the stereotypical nature of the work to which women were assigned. Physical isolation of the women who worked within the Observatory meant that the exclusivity of telescopes to males was one of the major impediments to women pursuing more research-based work in observatories in North America and in Britain (Brück, 2009; Larsen, 2009).

One of the reasons many of the AC female computers ceased work was to marry. A married woman was not able to be employed in state government funded roles, such as teaching, until after 1956 (Kramar, 1990). Historical records about women in general reflect other societal prejudices such as restrictions on women's access to education and unequal pay. With these findings in mind I will now examine more closely the women who worked on the AC in Australia beginning with the low wages women were paid.

8 A CHEAP SOURCE OF LABOUR

The Astrographic Catalogue coincided with an exciting time for women in Australia. Within the previous twenty years women had increased access to higher education. Female franchise was granted to women in 1902 and in the Federal election of 1903 women voted for the first time and were able to vote in the Victorian State elections from 1908. Paid work was becoming more possible for women to obtain but work for equal pay was not to become a reality for more than half a century (Kramar, 1990).

In Australia in the early twentieth century women were generally paid 54–64% that of a male salary when the work was specifically identified as 'women's work'. This ratio persisted until 1950 when the ratio of women's pay to men's pay for a similar position increased to 75% and there was no longer the need to define what 'women's work' was. The low wages when resources were tight and a substantial workforce was required made women attractive as a cheap source of labour for the AC. The significant number of women who were employed for the AC were paid at a lower rate than the small number of male astronomers. In 1902 an anonymous journalist commented about the women who worked at Melbourne Observatory:

> Their hours are from 9am to 5pm on weekdays and to noon on Saturdays, an hour being allowed for lunch. Their salary is £40 a year. (The editor has only one remark … no man would undertake it at more than double the amount). (Anon, The Women's Corner, Brisbane Courier: 1902)

Even at this low rate of pay it is likely that paid work in occupations such as teaching, switch board operators or working in an observatory gave women more, although not complete, fin-

ancial independence.

9 THE QUALITIES OF A STAR MEASURER

The first female measuring and computational bureau for the AC was established at Paris Observatory and Dr Dorothea Klumpke was the supervisor of other women, under direction of a male astronomer (Klumpke, 1895). This measuring bureau set the standards for others to be established.

To enter the Melbourne Observatory workforce the women sat for a public service exam and in 1898 Baracchi wrote to Russell about his progress in employing suitably skilled women:

> I have been trying a lot of girls to ascertain their aptitude for the work. We are going to have six of them for six months, and four afterwards … You may imagine what a good time I am having.

The 'aptitude' Baracchi was seeking from the women was accuracy, speed, mathematical ability and neat handwriting. He described the women he had employed on probation:

> These three are very promising: Miss Peel (public school teacher), Miss Lewis and Miss Hall (matriculated with honours in mathematics).
>
> These promise to be fairly good at observing; but are bad at computing: Miss Phillips, Miss Harper, Miss Skoglund … the conditions are that these girls' services can be dispensed with at a week's notice … (Baracchi, 1898).

The work was eye-straining so the standard method was that the women worked in pairs and every thirty minutes they would swap positions, one measuring, the other notating. The measuring machines were very important in determining the speed and accuracy that was possible.

10 A FEMALE 'STAR' FACTORY

The roles of photography and measurement of the resulting glass plate negatives were separated by gender. There were male 'computers' prior to and at the time of the AC but after the female measuring bureaux were established the photography, telescope and publication of research was typically what the men did and the measurement and standard computation was the work the women did. The idea of establishing a measuring bureau consisting of women who were roughly the same age, and with similar attributes was a feature of fundamental change in the observatory workplace along the same lines as the industrialised factory. Charlotte Bigg (2000) has called this a 'modernist revolution' within astronomy.

Locally in Melbourne there was excitement that there would be women employed at Melbourne Observatory as demonstrated by an excerpt from a poem that appeared in the Melbourne based labour newspaper, *The Tocsin* (1897) at the time that Baracchi was considering employing women for the AC:

> The official visitors to the Melbourne Observatory recommend the employment of a staff of young ladies to conduct astronomical work:
> The jewel-sprinkled skies
> Throw many nasty slurs
> Upon the jaundiced eyes
> Of male astronomers
>
> The music of the spheres
> The price of Saturn's rings
> Through all these dreary years
> Have been forgotten things.
>
> The heavenly influence
> Of Venus upon Mars
> Is quite beyond the sense
> Of men who count the stars.
>
> A vaunt, all men who mar
> And make the heavens drear,
> Each world, each sun, each star,
> Is henceforth woman's sphere."
> (Anonymous, *The Tocsin,* 1897)

The measuring machines mainly used by the Melbourne measuring bureau were made by Repsold (Figure 2) and the design was developed by David Gill, one of the key instigators of the CdC and AC and Director of the Royal Observatory at the Cape of Good Hope in South Africa. The Repsold design was modelled on the Gautier designed machines used at Paris Observatory. Repsold I and Repsold 2 were used by the first women measurers at Melbourne Observatory. When Sydney Observatory took over the plate measurement from Melbourne these machines were sent to Sydney Observatory to continue and complete the star measurement and they are now in the Museum of Applied Arts and Sciences Collection (Stevenson, 2015).

The women were perceived as human measuring and computing machines and meticulous records were kept detailing a systematic method of establishing errors and recording efficiencies. For example, an examination of Melbourne Observatory Astrographic Plate #1795 shows that it was photographed in 1896 by 'W' (assistant astronomer William Wallace) and measured in 1908 by E.H. (Evelyn Hockin) and N. (Vicki Noonan) using the R2 (Repsold 2) micrometer and 'P' (Charlotte Peel) checked the

work of the other women.

The popular press was very interested in the women, the measurement process, the selection of the women, how they were trained and the accuracy expected, as reported by Sutherland (1901):

> Each lady has a microscope with spider-web threads stretched across the field of view, so as to divide it into minute squares. Fine screws move the plate up or down, to right or left, and then the position of the star can be read off. Each young lady has to pass the matriculation examination before she begins this observatory work, and she requires about six months before she acquires a satisfactory facility at it. Then she ought to be able to measure and catalogue about 400 stars a day, or about 1,500 a week, for the bureau. At this rate it will take three or four years for Melbourne to accomplish its share.

Figure 2: Photograph taken at Melbourne Observatory ca. 1900 showing the Repsold Machine and one of the first women employed as a star measurer and computer (courtesy: Collection Museums Victoria).

According to reports made to the Board of Visitors the measurement work at Melbourne Observatory appears to have initially been done in the weights and measures building. In 1901 Baracchi officially complained that a separate space was required for the female star measurers and a new wing adjacent to the Astrograph Building and part of the Main Observatory was designed and completed by 1903. There were no toilet facilities for the women and Baracchi reported to the Board that new outhouses (toilets) were constructed in 1903 but not connected until 1913. It is unclear how the women managed in these conditions (Stevenson, 2012; 2014; 2015).

In the next Section four of the earliest women employed in astronomy in Australia are case studied. These have been chosen because they represent some of the similarities and the individual differences between the women who were employed for the AC.

10.1 Charlotte Emily Fforde Peel (1876–1974)

Charlotte Emily Fforde Peel had a career at Melbourne Observatory spanning twenty years, from 1898 to 1918. In 1896 Peel passed the Victorian State Government public service exam for non-clerical positions and switch operators. She was appointed to teach at Patyah School and then transferred to Melbourne Observatory in 1898 at age twenty-two.

Peel was one of the six original measurers for the Melbourne Zone of the AC. In 1900 Peel was the first woman in Australia to be made a permanent staff member in astronomy, as reported by Baracchi to the Board of Visitors:

> Miss C. Peel, who was temporarily transferred from the Education Department to the Observatory on 2nd November, 1898, was permanently appointed to the position of assistant astronomical computer on the 9th of November, 1900. (Baracchi, 1901).

According to research conducted by Dr Barry Clark (2012) a photograph of Melbourne staff was taken ca. 1914 (Figure 3) and the woman on the right is Peel and on the left is meteorologist Miss Moroney. From the archived books it is clear that Peel had a senior position overseeing the work of the computing bureau in much the same way as Dorothea Klumpke (1895) had at Paris Observatory (Lamy, 2006). She calibrated the measuring instruments and the logbooks show that she tested the other female 'computers' for errors and her corrections show her senior position.

Peel was selected to work alongside James Baldwin, the Government Astronomer for Victoria on comet observations. Comet C/1913 YI (Delavan), which was discovered in December

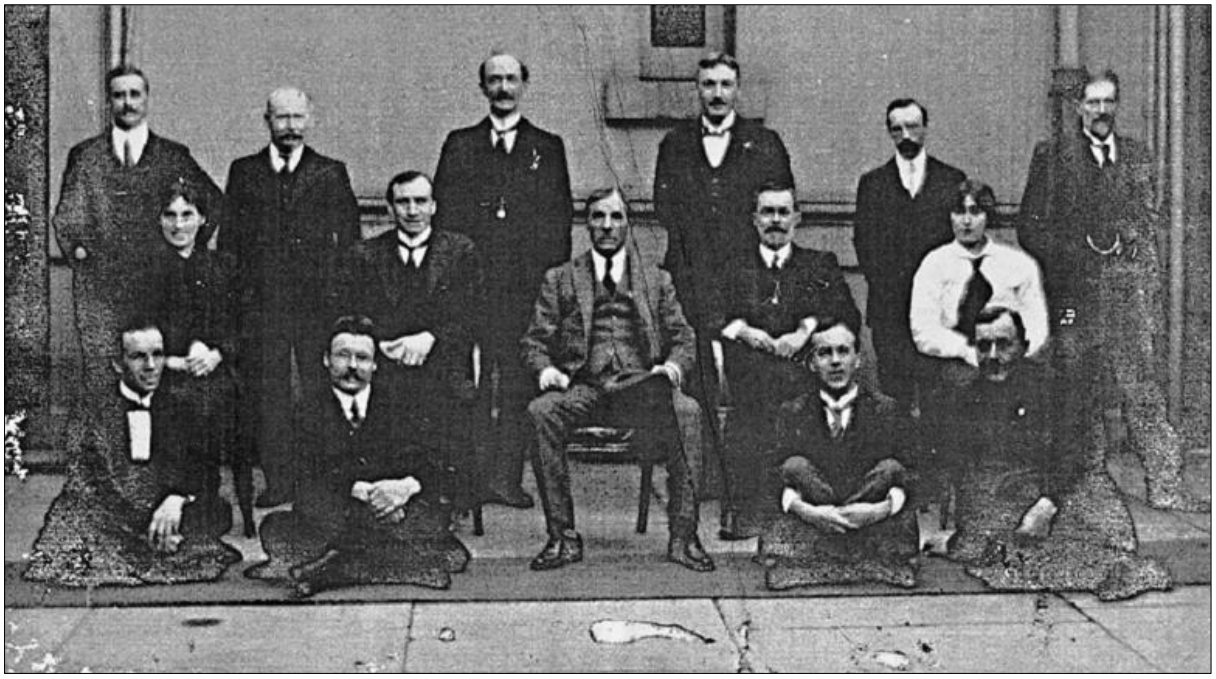

Figure 3: Melbourne Observatory staff ca. 1914 (courtesy: Barry A.J. Clark and Diane Ferguson).

June 1. Good nucleus, mag. 8½; easy to observe, but definition and steadiness poor. Extensive coma. Bright moonlight.

June 2. Faint bright patch in tail. Nucleus 8·5; spot extremely faint.

Photographic Observations.

Instrument: astrograph. Observer: J. M. Baldwin. Measurer: C. Peel.

Comet 1913f (Delavan).

	Melbourne Mean Time.	Astrographic Positions. α_{1915}	Astrographic Positions. δ_{1915}	Annual Aberration. $d\alpha$.	Annual Aberration. $d\delta$.	Parallax Factors. $\log p\Delta$.	Parallax Factors. $\log p'\Delta$.	Catalogue.
1915	h m s	h m s	° ′ ″	s	″			
May 6	9 10 30	17 2 33·83	−51 30 21·4	+1·85	+ 3·7	9·8569n	0·2815n	Cp. Ast$_{00}$.
,, 17	7 53 48	16 35 36·30	−53 47 15·2	+2·21	+ 0·4	9·8828n	0·2683n	Gou.
June 1	6 47 23	15 56 38·33	−55 17 25·7	+2·32	− 5·1	9·8800n	9·9846n	Gou.
July 1	9 10 49	15 0 38·05	−54 14 13·9	+1·41	−12·5	9·1791	0·3816	Gou.
,, 13	10 57 56	14 50 26·28	−53 17 45·8	+0·92	−13·2	9·7878	9·3277	Gou.

Comet 1915a (Mellish).

1915	h m s	h m s	° ′ ″	s	″			
July 3	6 30 13	5 42 52·54	−48 5 8·7	−1·98	+ 4·6	9·8084	0·7433n	Cp. Ast$_{07}$.

The astrographic positions are referred to the equator and equinox of 1915·0, and are corrected for the part of the aberration due to the earth's motion.

Melbourne Observatory:
1917 *Jan.* 22.

Figure 4: An excerpt from "Comet Observations made at Melbourne Observatory in 1915" showing J.M. Baldwin as the 'Observer' and C. Peel as the 'Measurer' (after Baldwin, 1917: 477).

1913, was the second brightest comet of the twentieth century. Images of it were taken with the Melbourne astrograph by Baldwin, and Peel measured Comet C/1913 YI (Delavan) and Comet C/1915 CI (Mellish). She was acknowledged in a paper that Baldwin (1917) published in *Monthly Notices of the Royal Astronomical Society* (Figure 4).

Figure 5: A photograph by P.J. Melotte of Comet C/1913 YI Delevan in 1914 taken at the Royal Observatory Greenwich (Science Museum Collection).

Comet Delavan was photographed by Philibert Jacques Melotte at the Royal Observatory Greenwich in 1914 (Figure 5), and it was visible in the Southern Hemisphere for nine months (van Biersbroeck, 1927).

In 1918 Peel resigned her position in order to marry Robert Sangster, the Librarian and Clerk at Melbourne Observatory. After Peel resigned, her job was advertised in the 1919 *Victoria Gazette* as follows:

> Assistant Computer (Female) Class "I", professional Division, Observatory. Qualifications: A knowledge of elementary algebra and trigonometry: accuracy and speed in computing, combined with a neatness of work; good eyesight; to be not less than age 24 years.

This advertisement confirms that the work was

gender specific and age-dependent, criteria that are not acceptable in today's society.

Peel and Sangster lived in Caulfield, Melbourne where Peel died in 1974 at age 98. The next woman worked for a much shorter period than Peel, but her interest in astronomy continued after she left employment at Melbourne Observatory.

10.2 Lillian Emblad Lewis (b. 1878)

Lillian Lewis was an astrographic measurer and computer from 1898 to 1903. She was employed in the same group as Charlotte Peel and also was considered by Baracchi as 'promising'.

Lewis left the Observatory after four years and the next period of her life is, at the time of writing, a mystery. There is evidence that Lillian Lewis was a keen amateur astronomer nineteen years later when the Astronomical Society of Victoria (ASV) was formed.

As reported in the Melbourne *Herald* newspaper in a section about women in astronomy (Anonymous, 1949), Lewis was the only woman admitted as a foundation member of the ASV when it was formed in 1922. She owned and regularly used a 3-inch refractor telescope. She was elected as an office bearer and Assistant Secretary. Lewis was highly active attending meetings and she was appointed as the ASV Librarian from 1931 to 1949. This role was fairly demanding as the ASV had regular subscriptions and encouraged members to borrow the books.

Lewis' membership of an amateur society is not unique. Women were keen members of astronomy societies when they were formed in the late 1800s in Adelaide and Sydney and some of these women were also employed to work on the AC. It is also possible that Lewis, or another female computer, may have been involved in an earlier society formed for a short period in Victoria as a local branch of the British Astronomical Association (for details of early amateur astronomical societies in Australia see Orchiston, 1998, and Orchiston and Perdrix, 2002), but there is no evidence found of this.

The next woman also worked at Melbourne Observatory for a few years, but her life after leaving the Observatory has been well documented.

10.3 Muriel Agnes Heagney (1885–1974), Advocate for Women's Equal Pay

Muriel Heagney (Figure 6) was employed as an astrographic measurer and computer at Melbourne Observatory from November 1906 until August 1910. Heagney is best known and acknowledged as a pioneer of women's rights and equal pay, a feminist and trade unionist (Francis, 2011) but for four formative years, from the age of 21, she calculated the position of stars and determined their magnitudes for the AC.

Heagney's employment at Melbourne Observatory came after her matriculation from the Faithful Companions of Jesus Convent School in Richmond. Like Charlotte Peel, Heagney was trained as a primary school teacher and was offered a job at Melbourne Observatory after sitting an exam. She was the daughter of Patrick Reginald Heagney, one of the founders of the Australian Labor Party, and Muriel Heagney was already a member of the Labor Party and active in the Labor movement when she joined the Observatory.

Figure 6: Muriel Heagney in 1933 *(Anonymous, Australian Women's Weekly*; enhanced).

In the star catalogue and notebooks she left her insignia 'M.H.'. The logbooks held by the Museum of Applied Arts and Sciences and State Records in NSW and Victoria revealed that Heagney's work was mainly measuring the stars photographed by Sydney Observatory. Eileen Sheldon was one of Heagney's regular measuring partners. Sheldon demonstrated high speed and consistent accuracy but Heagney's skill at measurement was not exceptional.

Heagney left her work in astronomy to pursue a career campaigning for women's rights, spurred on by an initiative to form a Labor Women's Committee. In 1909 she became a delegate and from this initiative the involvement of the Labor Party in women's rights escalated and a year later Heagney resigned her position at Melbourne Observatory.

From 1914, Heagney was the press secretary for a branch of the Labor Party and she held

a number of positions. She actively campaigned for women to have equal employment rights and pay, and to be able to maintain their employment after marriage. Heagney's rationale in her papers and speeches included statistical analysis. She travelled to Russia and the United States, established and worked for many Women's Movement organisations, wrote articles and gave 'Town Hall' style presentations based on her observations and analysis, articulating the economic relationship between women's income, or lack thereof, and poverty.

In 1972 women were granted equal pay to men through the Equal Pay Decision 1972 (Kramar, 1990: 4). In 1975 Heagney was posthumously featured in the *Canberra Times*:

> … the person who worked hardest and longest for equal pay in Australia died in May last year. Tiny, redoubtable Muriel Heagney stood for women's rights … all her life she was a rebel and a fighter. (Browning, 1975).

Heagney's four rigorous years of work at Melbourne Observatory, as one of the first women employed in astronomy in Australia, was not included in information about her contribution to the Labor movement (Ranald, 1979; Symons, 1997) nor in a publication commissioned by the Australian Heritage Commission (see Nugent, 2002).

There is no proof that the precision required for the Astrographic Catalogue, Heagney's use of mathematical formulae, or her employment conditions influenced her life once she left the Observatory. Her social and scientific connection to astronomy, and its impact on her work for women's equal pay may yet have potential for further detailed research.

The final woman case studied appears to have left the Observatory to socialise and start a family.

10.4 Sarah Victoria (Vicki) Noonan (1887–1973)

Bill Neal has provided information about his grandmother, Vicki Noonan, who worked at Melbourne Observatory from 1907 to 1909. Noonan grew up in St Kilda and attended the Presentation Convent in Windsor. She was 20 when she commenced work at Melbourne Observatory and is known as 'N' in the Astrographic Catalogue. One of the archival documents shows that Vickie worked on 3 plates, each measured in September, October and November 1908 with 'E.S.' Eileen Sheldon, as her measuring partner. She also worked with Evelyn Hockin 'E.H.' and Muriel Heagney 'M.H.'.

Bill Neal has an illustrated album that his grandmother kept from the years 1906 to 1910 where friends have made entries. Her album shows that she had a highly active social life and there are entries from her Melbourne Observatory colleagues Sheldon, Hockin and Heagney. Particularly insightful is this popular saying of the day, quoted by Sheldon: 'Love many, trust few, always paddle your own canoe'. It is not clear why Noonan resigned from Melbourne Observatory in 1909.

In 1912 at the age of 25, she married Doctor Thomas Murphy, many years her senior. She is pictured on her wedding day (Figure 7). They had ten children, two of whom, Alison and Brendan, attended the seminar held on 24 November 2014 for the 150th anniversary of Melbourne Observatory.

11 ORIGINAL WORK

Photographs of the women who measured and computed the stars were featured in many newspaper articles, always with their heads down, busy at work, and rarely can you see their faces or know their names (Figure 8) although it is highly feasible that Peel and Lewis are in this photograph. The lasting impression from this image is that the star measuring and computing was not original work.

But this was not necessarily the case as is seen by Peel's work with Baldwin on comet measurement.

12 CONCLUSION

Participation in the Astrographic Catalogue connected the colonial state government astronomers with new methods of astronomy and provided the stimulus for government investment in equipment, buildings and the employment of a female workforce. It provided opportunities for international co-operation and collaboration.

Even though the AC was influential in bringing women into the astronomical workforce, this did not bring with it recognition or long-term careers in astronomy. This was due to a lack of attribution of women's work, restrictions placed on women's careers because of their gender and the nature of the work to which women were assigned was gender-specific. At Melbourne Observatory the women were also physically isolated from the male astronomers. The women were attributed in the catalogues, but except for a few exceptions, in related scientific papers. Other gender-related prejudices reflected broader societal values such as unequal pay for women.

Figure 7: Victoria (Vicki) Noonan on her wedding day in 1912 (photograph courtesy: Bill Neal).

Figure 8: The Melbourne Observatory Astrographic Bureau photographed in 1901 for an article about the work at the Observatory, and published in *The Australasian* newspaper on 27 April 1901.

The logbooks, letters and reports demonstrate that in contrast to popular opinion, these women had considerable agency and the more senior women took on supervisory roles, calibrated instruments and advised on process improvements and other aspects of the work.

All of the State Observatories in Australia have now ceased scientific research. Melbourne Observatory ceased research in 1945; Adelaide Observatory ceased operations in 1952 and was demolished; Sydney Observatory in 1982 and Perth Observatory in 2013. Nonetheless their social and scientific legacy lives on in the records, the instruments and the buildings. This heritage has great potential for new social sciences research.

All the logbooks of the women who worked on the AC are in the distributed collection of the State Records Office, NSW and the Museum of Applied Arts and Sciences collection. At Melbourne Observatory the computing room and some of the furniture still exist. I am hoping my research will inspire others to also adjust their focus to see the women who measured and computed the stars as important to the history and development of astronomy in Australia.

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