

***"A Woman's Place is in the Dome": Gender and the Astronomical Observatory, 1670-1970***

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**Introduction**

The astronomical community prides itself as being not only the oldest science, but in some ways the most inclusive. To this day, unpaid amateurs continue to work alongside professionals, and women have played an important role in this science throughout its history. However, inclusivity does not necessarily equate to equality. It is estimated that 15% of all astronomers today are female, but this percentage varies widely from country to country (AAS). For example, although women earned 46% of the Bachelors degrees in astronomy in 2003, they only received 26% of the Ph.D.s (Ivie and Ray 3). That same year, women represented only 14% of faculty in astronomy departments, and were represented in higher numbers at the lower academic ranks and in departments that did not grant graduate degrees (Ivie and Ray 1). In order to understand the status of women in astronomy today, it is instructional to survey their past participation, and how that participation has (or has not) been documented.

As the Women and Geography Study Group (19) notes, "groups which are disadvantaged, being in some way dominated or oppressed by other groups.... do not figure as prominently in historical accounts as their social significance or sheer weight of numbers would suggest. Often, such groups are barely mentioned at all." In the 1980s, scientists and historians of science joined in a movement to "right the record" of women's contributions to science (e.g., Rossiter; Alic; Abir-am and Outram; Kass-Simon and Farnes). Both broad surveys of the participation of women in science and biographical studies of individual women demonstrate that a major impediment to the success of many women in observational astronomy was a lack of accessibility to research-quality telescopes.

Spain (6-7) argues, "Initial status differences between women and men create certain types of gendered spaces and that institutionalized spatial segregation then reinforces prevailing male advantages." Therefore the barring of women from major observatories suggests that these facilities were (and to some extent still are) considered "male spaces". But what of those women who were successful in observational astronomy? This paper will argue through example that women who have found success in observational astronomy between 1670-1970 were those who have been able to merge the separate spheres of private and public under their own unique terms, and thereby breach the divide between the societal construct of what was considered appropriate (and separate) male and female spheres in science.

**Women in German Astronomy, 1670-1720**

Schiebinger (The Mind 79) reflects, “Between 1650 and 1710 a surprisingly large number of women... worked in German astronomy. All of these women worked in family observatories,” which was the norm at this time. For example, Johannes Hevelius, a wealthy Danzig engraver and amateur astronomer, built a private observatory for cataloging stars with the unaided eye across the roofs of three adjoining houses, including his own. Following the deaths of several assistants, his beautiful (and much younger) second wife, Elisabeth Korpmann (Koopman) (1646-1697?), became his assistant. After ten years of fruitful collaboration, their observatory (and much of the city) was destroyed in a fire in 1679. Hevelius is commonly said to have died “a broken man” eight years later, but Elisabeth saw their work through to publication as the *Firmamentum Sobieskianum*, and the largest star catalog compiled without the use of a telescope, *Prodromus Astronomiae*. During his lifetime, Hevelius immortalized his wife/assistant in a plate in *Machinae Celestae*, where they are both shown observing with a brass sextant. Although Urania, the muse of astronomy, had been widely illustrated, the depiction of a real woman as an active astronomical observer clearly demonstrates the importance of Elisabeth Hevelius’ role in her husband’s observatory.

During the same period, Maria Clara Eimmart (1676-1707) found limited success as an astronomical illustrator, again under the aegis of male family members. The daughter of George Christophe Eimmart, a Nuremberg engraver, painter, and amateur astronomer, her illustrations (done at the telescope) graced her father’s *Micrographia Stellarum Phases Lunae Ultra 300*. She married Johann Heinrich Müller, her father’s assistant engraver, who shared the family’s love of astronomy. Müller became a professor at Altorf, and was “aided by his talented wife” in his depictions of astronomical phenomena (Davis 137).

Perhaps the most successful of the female German amateurs of this period was also the most frustrated in her attempt to climb the ladder of professional acceptance. Maria Margaretha Winkelmann (1670-1720) was the daughter of a minister of the Gospel in Panitzsch (near Leipzig). She learned astronomy from Christoph Arnold, a well-known amateur, who introduced her to Gottfried Kirch, Germany’s leading astronomer. She became Kirch’s second wife in 1692. As Schiebinger (“Maria Winkelmann” 179) reflects,

By marrying Kirch – a man some thirty years her senior – Winkelmann secured her place in astronomy. Knowing she would have no opportunity to practice astronomy as an independent woman, she moved, in typical guild fashion, from being an assistant to Arnold to being an assistant to Kirch.

Although officially her husband’s assistant, Winkelmann made contributions to astronomy in her own right, including calculations for calendars, observations of aurora, and the discovery of a comet in 1702 (Smith 976). Ironically, it was the astronomical success of this husband and wife team which was to ultimately lead

to Winkelmann's professional frustration. Kirch became the official astronomer of the Berlin Observatory, and his observations moved from the attic of the family home to a public institution. As Schiebinger ("Maria Winkelmann") and Sheffield describe, this shift from the private/domestic sphere to the public/professional sphere had disastrous consequences for women in science. Schiebinger writes

With the privatization of the family, husbands and wives ceased to be partners in the family business, and women were increasingly confined to the domestic role of wives and mothers. A wife like Maria Winkelmann-Kirch could no longer become assistant astronomer at a scientific academy through marriage ("Maria Winkelmann" 199-200).

When Gottfried died in 1710, Maria applied for the position of assistant calendar maker, a position for which she was eminently suited, but was careful not to be "so bold as to suggest that I take over completely the office" of astronomer (Schiebinger "Maria Winkelmann" 186). In response, Winkelmann was heartily rebuked by the Council of the Berlin Academy of Science. Internal correspondence among the Council members warned that giving her such an official role "simply will not do. Already during her husband's lifetime, the society was burdened with ridicule because its calendar was prepared by a woman. If she were now to be kept on in such a capacity, mouths would gape even wider" (Schiebinger, "Maria Winkelmann" 187).

After an eighteen month battle over her "unseemly and inadmissible" application, the Council recommended that she be persuaded "to be content and to withdraw of her own accord; otherwise we must definitely say no" (Schiebinger "Maria Winkelmann" 188). In response, Winkelmann, her son Christfried, and eldest daughter Christine, found employment in the private Berlin observatory of Baron Bernhard Friedrich von Krosigk. During her two years there, she issued a number of reports in her name, and prepared the calendars for Nuremberg and Breslau.

In 1716, Christfried Kirch and J.W. Wagner were hired by the Berlin Observatory as the two head observers, and Winkelmann returned as her son's assistant. Unfortunately, she was soon chastised by the Academy for "talking too much to visitors." She was warned to "retire to the background and leave the talking to Wagner and her son." She was soon after accused of "meddling too much" in the Observatory and again warned to "let herself be seen at the observatory as little as possible, especially on *public* occasions." She was finally removed from both the observatory and housing on its grounds, although encouraged to "find a house nearby so that Herr Kirch could continue to eat at her table" (Schiebinger "Maria Winkelmann" 192). Thus, Maria Winkelmann Kirch was forced back into the domestic sphere, effectively ending her astronomical career. Her transgression was to dare to assume that she could continue to act as an astronomer in the public sphere, especially on the same terms as a male astronomer. Over the next two and a half centuries, women in astronomy struggled with the very same restrictions and limitations, and as the rest of this

paper will demonstrate, those who found the greatest success were able to feminize the observatory in some creative and unique way, making it more of a “female space.”

### **Maria Mitchell and the Blossoming of American Astronomy**

Maria Mitchell (1818-1889) of Nantucket Island is widely regarded as the first American woman astronomer. She was the daughter of amateur astronomer William Mitchell and his wife Lydia Coleman, a descendent of the Quakers who founded Nantucket. As in the case of the women previously mentioned, Maria studied astronomy in guild-fashion, as apprentice and assistant to her father, from whom she learned to make careful measurements and calculations of stellar motions and positions, skills desirable by both sailors and astronomers. Mitchell treated the stars as “old friends from whom I had been long parted” and became quite skilled with telescopic observations (Albers 38). In October 1847, this librarian was catapulted to world fame when she discovered a comet with her father’s small refracting telescope, and was eventually awarded a gold medal from the King of Denmark for this feat. Although closely afterwards elected the first woman member of the American Academy of Arts and Sciences, full-time astronomical employment was still beyond her grasp. She was only able to procure part-time employment (at home), as a “computer,” calculating the positions of (appropriately) Venus for the American Ephemeris and Nautical Almanac.

During Mitchell’s prolonged trip to Europe in 1858-9, Elizabeth Peabody of Boston raised funds to have a larger refractor made for Maria, as a gift from “the Women of America.” After the death of her mother in 1861, Maria, William, and the telescope moved to Lynn, Massachusetts, where she continued making astronomical observations in the observatory she had built in the backyard of their new home. In a reversal of gender roles, Maria was able to support their household through her continued computations, savings, and her father’s pension for the next four years. Fortunately, she was soon to take on another role, which would forever cement her reputation as an astronomer.

In the mid-nineteenth century, a number of women’s colleges were founded in America, where women could be educated in a segregated fashion, separated from both “men and from ‘male knowledge’” (Spain 153). Matthew Vassar founded the Poughkeepsie, NY, college that bears his name in 1861, and offered Maria Mitchell the position of Professor of Astronomy and Observatory Director. She was given living quarters for herself and her father, and William Mitchell lived at Vassar with his daughter until his death in 1869. The twelve-inch refracting telescope, which Vassar commissioned, was only slightly smaller than that housed at Harvard, but was plagued with both optical and mounting problems which it took Maria several decades (and sheer will of personality) to have corrected.

Mitchell held her students to high standards, for which she earnestly believed they were eminently well suited. She repeatedly pointed out that a girl's years spent learning domestic tasks prepared her for astronomical work in palpable ways, not only in dealing with meticulous observations with a careful eye and delicate touch, but in dealing with the sheer boredom of repetitive tasks in a gracious manner. As she well understood from her own life, "the girl who can stitch from morning to night would find two or three hours in the observatory a relief" (Lankford 290). In 1873, she joined the women's movement, and became active in the Association for the Advancement of Women (AAW), serving as president at the 1875 convention in Syracuse and 1876 convention in Philadelphia. Later writers would laud her as a "popular symbol of women's emergence from dependent domesticity into the public world of science" (Warner 12); however, much of Mitchell's success was due to her ability to make the observatory a feminine rather than feminist space, namely her ability to bring the observatory back into a private/domestic sphere.

Although she never married, Maria's career mirrored the traditional roles of daughter-caretaker for her aging father and mother to her students. One of her students explained that

Many a girl went to her as to a mother confessor with the mental and moral perplexities of youth, and was lifted into a larger, clearer vision and stronger courage to strive for the best. The Observatory had a home atmosphere from the first.... Simple, open-hearted hospitality was a real part of Miss Mitchell's life as was hard work and devotion to high scientific aims. ("The Nantucket Maria Mitchell Association" 435)

Maria and William's parental roles were acknowledged by Maria herself, who remarked in a letter to the daughter of the college president that some students "had, in a manner, adopted us as stepparents" (Albers 172). Her first group of astronomy students, dubbed "The Hexagon" by William, became especially close with the Mitchells. This relationship was fostered by Maria, who opened her advanced classes with the mantra "We are women studying together."

The special relationship between Mitchell and her students was enhanced by the very geography of Vassar. As Spain describes, women's colleges featured

Large buildings that housed and fed faculty and students in addition to providing space for classrooms, laboratories, chapel, and library under the same roof. Compared to the relative freedom of dispersed surroundings enjoyed by men, women were enclosed and secluded in a single structure that made constant supervision possible." (4)

In Mitchell's case, the combining of her housing with the observatory enabled her to provide her students with an education that can only be described as a true mentoring. In the beginning, however, the quarters were admittedly too tight. Her original sleeping quarters were in the room that also served as the entrance to

the observatory, housing for the astronomical clocks, and the parlor for receiving guests. Her bed was made up as a sofa during the day, but since her students needed access to the astronomical clocks at any hour of the day or night, she had precious little privacy. She did not receive separate sleeping quarters until 1875 (Albers 162). By maintaining an all-female atmosphere (chaperoned by the watchful eye of Mitchell's elderly father), Mitchell and her students were afforded a freedom nearly unheard of in American astronomy – the freedom to use telescopes at all hours of the night without fear of impropriety.

Mitchell was also famous for her annual “Dome Party” in June, a social event complete with poetry and singing, where

All present and former students who are in town receive an invitation to attend.... Two large baize doors then swing open, and the party, mounting a short flight of stairs, find themselves in the dome itself, with the great equatorial telescope overhead, pointing to the sky. Here the repast is served, upon tables arranged in a circle around the walls, a rosebud and a tiny photograph of the dome being laid at each plate. (Parton 329)

In summary, she had taken the geographical segregation imposed by the current theories of women's higher education and turned her dome into a space where women clearly belonged, could contribute openly to the process of science, and gain an education in observational astronomy equal to that of any male student in America. In such a way, Mitchell truly transformed the observatory into a domestic sphere, where women did meaningful science but without seeming to transgress society's gender boundaries. The importance of her astronomical legacy and her direct impact on the lives of women in astronomy cannot be emphasized too greatly. At Vassar, the next three astronomy professors were all former students of hers (or students of her students). Several other students went on to make significant contributions to astronomy, such as Antonia Maury at Harvard and Margaretta Palmer at Yale, although they were constrained to take on the limited roles that the astronomical community soon dictated at the turn of the twentieth century.

### **Technology and the Rise of the “Factory” Observatory**

The role of women in astronomy had evolved over the proceeding centuries. In the sixteenth and seventeenth centuries, women such as Maria Eimmart, and Caroline Herschel, sister of famed amateur astronomer William Herschel, had found a role as the wife, sister or daughter of “Grand amateurs.” This secondary role was clearly non-negotiable, as Winkelmann had discovered in Berlin. In sharp contrast, in the late nineteenth century, several noted husband-wife amateur astronomy teams emerged in which both members were active participants, and the work of the wife was openly noted and appreciated. These include William and Margaret Huggins and Isaac and Dorothea Klumpke Roberts

in England, and Dr. Henry and Anna Palmer Draper in New York. These couples seemed the (quite notable) exception rather than the rule in astronomy.

Toward the end of the nineteenth century, several important advances in astronomy – namely photography, spectroscopy, and the “development of large observatories supported by private philanthropy” – changed the face of astronomy, especially in America, and directly led to the creation of a separate “women’s work” in astronomy (Mack “Straying” 73). As an 1892 article on Harvard College Observatory (which openly referred to “Women’s Work” in its title) noted, “In the average observatory, where men are employed, it is obviously impractical for women to engage in night observing” (Reed 165). The problem of women in observational astronomy was quickly eliminated by removing the women *from* the observatory. With the advent of photography, data analysis could be done in the security of daylight hours, with women “computers” segregated from the professional astronomers in their own separate sphere of “women’s work.” American astronomy saw a clear division of labor, in which the “men observed at the telescope. The women measured, classified, and reduced the data men collected.... The data were then presented to male astronomers to interpret and prepare for publication” (Lankford 290). Women’s work in astronomy therefore met the general criteria for such segregated work found in other fields. Bradley (9) describes this as “usually indoor work, considered to be ‘lighter’ than men’s work; it is clean, safe, physically undemanding, often repetitive and considered boring, requires dexterity rather than ‘skill’.”

Largely through funding provided by Anna Palmer Draper (in order to carry on the spectral classification work she and her husband had done before his untimely death from pneumonia), Harvard College Observatory Director E.C. Pickering hired over forty women. Known colloquially today as “Pickering’s Harem,” some of these women had college degrees in astronomy, but were hired mainly for their “knowledge of ordinary arithmetic, and a legible handwriting... although, of course, the more that is known of languages and mathematics the better” (Mack “Strategies” 66).

Despite its mundane nature, such “computing” jobs were the only real avenue open to Maria Mitchell’s astronomy graduates (other than teaching), and several – most notably Antonia Maury -- chafed under the yoke of being shut out of making meaningful original discoveries in astronomy. In effect, entire areas of astronomy and their practitioners (namely spectral classification, variable stars, and stellar measurements) became feminized or ghettoized, “relegating them to the low-paid, low status occupations within the scientific hierarchy. This was the drudge work of science that the majority of men were not interested in doing” (Sheffield 128). Women were not only segregated in the types of tasks they fulfilled for the observatory, but also in their geographical space. The Brick Building where the photographic plates were analyzed was said to be “like Heaven” in that “there is neither marrying nor giving in marriage there.” Men were noticeable only in their absence (Payne-Gaposchkin 137). Near the end of her

career, Mitchell became “increasingly distressed” with this turn of events, and the unwitting role she played in supplying what were essentially astronomical factory workers (Lankford 339).

It is therefore startling to note that in the first four decades of the twentieth century, one third of American astronomers were women, although half of these had careers of five years or less. These were part-time workers, the “invisible women who swelled the ranks of astronomy but remained forever in its periphery” (Greenstein 444). The most well-known of the Harvard women, Annie Jump Cannon (1863-1941), who classified over 350,000 stars during her four and a half decade career and developed the Harvard Spectral Classes still used with only minor modifications by astronomers today, received no official academic standing at Harvard until 1938. But as Greenstein noted, Cannon “was of the old breed, and she was comfortable with her place. Cecilia Payne-Gaposchkin was the first of the new” (446).

### **“The Best Man in Harvard” - Cecilia Payne-Gaposchkin**

Cecilia Payne (1900-1979) received her B.A. from Newnham College, Cambridge University, where she took it upon herself to resurrect an unused observatory. In her autobiography, Payne writes how she “organized public nights and began to observe variable stars and record their changes” (121). She was awarded a National Research Fellowship to pursue graduate work at Harvard, following the advice that she would have a better chance of doing research in America. A letter of recommendation written by staff member Leslie J. Comrie, who had helped Payne refurbish the Newnham Observatory, described her as “the type of person who, given the opportunity would devote her whole life to astronomy and that she would not want to run away after a few years training to get married” (Bartusiak Through 100). Ironically, Payne did eventually marry, but she became one of the first professional American woman astronomers to successfully combine career and family.

In 1925, Payne received the first Radcliffe/Harvard Ph.D. in astronomy, under Director Harlow Shapley, for an extremely technical analysis of the properties of the atmospheres of stars, and was hired by Harvard as a staff member. The next year she became the youngest “distinguished” astronomer in American Men of Science, and famed astronomer Edwin Hubble referred to her as “the best man in Harvard” (Bartusiak Through 105). That Payne had distinctively male characteristics may have made her presence more palatable to some “purists.” At five-foot ten, she was also “broad shouldered in an era that valued petiteness... At any rate, no one ever accused CHPG of cuteness” (Trimble xvii). In addition to possessing a faint moustache, her masculine appearance was accentuated by the fact that, according to her daughter, “she wore her hair short, rarely set, and she almost never wore makeup.... She dressed conservatively, sometimes mannishly, and had little interest in clothing for its own sake.... She cared little for feminine niceties.... I never saw her cry” (Haramundanis 39-40).

Such descriptions, accurate as they might be, fall into a common trap propagated in twentieth-century popular culture, namely a “negative image of women scientists, depicting them as both atypical scientists and atypical women” (LaFollette 262).

However masculine her outer appearance and demonstrated ability to do theoretical astronomy, Payne hit a wall of discrimination when it came to gaining access to Harvard’s telescopes. Not only was it considered improper for a woman to spend nights alone with men (other than their family members) in an observatory, but many of Harvard’s best telescopes were in isolated areas and foreign countries. Shapley reported that the director of Harvard’s Boyden Station in South Africa “feared that he would not get along well with Payne, and also thought that ‘a lone woman would be in danger from the blacks’” (Kidwell “An Historical Introduction” 26). In 1924, famed Canadian astronomer J.S. Plaskett wrote to equally eminent American astronomer H.N. Russell asking for a recommendation for a position at the Dominion Astrophysical Observatory in British Columbia. To his credit, Russell (who at the time was erroneously discouraging Payne from including in her thesis her result that stars are mainly made of hydrogen and helium) replied that Payne was “quite the best of the young folks in astrophysics.” Plaskett replied, “There would be difficulty about the observing end of it with a woman in this isolated place and I think we can hardly consider her” (Kidwell “An Historical Introduction” 25). The recurring theme of the safety of the isolated astronomical observatory and nighttime observing runs is still found in astronomy today. For example, one of the recommendations of The Baltimore Charter of Women in Astronomy is to address issues of safety, especially for women “who often feel more vulnerable when working alone on campus or in observatories” (AAS [Baltimore](#)).

Although she was routinely compared to the men in her field, in one interesting respect her astronomy was distinctively different. Like Mitchell before her, Payne considered the stars, and even individual lines in their spectra, as “familiar and distinctive friends” (Kidwell “An Historical Introduction” 28). The astronomical style of both Mitchell and Payne is reminiscent of geneticist Barbara McClintock, in their “feeling for the organism.” McClintock’s passion for the difference between biological individuals found its mirror in Payne’s eye for details in peculiar stellar spectra.

Payne differed from other women astronomers at Harvard in another very significant way – in 1934 she married Russian astronomer Sergei Gaposchkin (who had emigrated to America), and not only continued her astronomical career, but collaborated with her husband on variable star research. Unlike other husband and wife teams, Cecilia was indisputably considered the senior scientist and “was widely regarded by their colleagues as the better scientist. At home much of the housework was left to Sergei” (Greenstein 443). Therefore Cecilia continued to play the role of “male astronomer” in some sense, even once married. During her pregnancies, Cecilia followed proper protocol in refraining

from participating in observatory activities, but she refused to cease her research. She once presented a paper at an American Astronomical Society meeting while four months pregnant, and during her third pregnancy scheduled a seminar at Brown University. Harlow Shapley stepped in to stop this unseemly behavior, issuing the edict that “The Observatory administration would be open to severe censure if you went to Providence in your present condition” (Kidwell “Cecilia Payne-Gaposchkin” 232). American social prohibition against the public appearance of a pregnant woman was only breached in a meaningful way in the early 1950s, when Lucille Ball’s pregnancy was grudgingly written into “I Love Lucy.” Both the network and advertising agency responsible for the program had originally responded with “You cannot show a pregnant woman on television,” fearful of offending a segment of their viewing audience (Oppenheimer 198).

Childcare was an ongoing problem for the Gaposchkins, since both parents worked full-time in the observatory. All three children were therefore brought to work as a matter of course, and were allowed by their parents to freely roam the building. One time, while Cecilia was out of town, her department held a formal vote that warned one of the children to refrain from disturbing readers in the library. Upon her return, Cecilia considered the vote a personal insult (Greenstein 443). Although he allowed the Gaposchkins to continue bringing their children to work, Shapley was well aware of the unusual nature of this arrangement, and warned Cecilia not to take her children to work with her when the entire family visited the Mt. Wilson Observatory in California in 1948 (Kidwell “Cecilia Payne-Gaposchkin” 233). Notwithstanding the obvious tensions between Payne and her employer over her unconventional solutions to balancing work and a family life, she was awarded the Radcliffe Alumnae Association’s medal for her ability to “combine scholarly work of rare excellence with the efficient management of a household and the rearing of three children” (Kidwell “Cecilia Payne Gaposchkin” 236).

Payne herself noted in a 1937 talk for the American Association of University Women that “the woman scholar today is expected to live the life of a recluse, as was required of men scholars a hundred years ago. And it is more difficult for women than men to do without a full and happy life” (Kidwell “Cecilia Payne-Gaposchkin” 235). Part of her ongoing struggle was to achieve official recognition at Harvard. Despite her international reputation and prolific scholarly output that spanned over five decades, Payne was not appointed to an academic position until 1938, and did not achieve the rank of Professor of Astronomy until 1956. Therefore, Cecilia Payne-Gaposchkin serves as an interesting case study, a woman who blurred the accepted definitions of masculinity and femininity in many respects, and was able to engender the observatory in her own way as a place where she believed family and children once again belonged.

### **Helen Sawyer Hogg – The Dome as Domestic Sphere**

An informative comparison can be made to Payne's Harvard contemporary Helen Battles Sawyer (1905-1993). Born in Lowell, Massachusetts, Sawyer majored in astronomy at Mount Holyoke College under the mentoring of Dr. Anne Sewell Young (herself the niece of Princeton's eminent astronomy professor Charles Augustus Young). As Maria Mitchell had done at Vassar, Young introduced her all-girls classes to observational astronomy through meaningful observations, including sunspots and variable stars. Sawyer had been swayed from chemistry to astronomy when Young took her class to Connecticut to view a total eclipse of the sun. During Sawyer's senior year, Annie Jump Cannon visited Mount Holyoke and after meeting Sawyer arranged for her to be granted the Edward C. Pickering graduate fellowship. Although she was the fourth person to receive a doctorate in astronomy from Radcliffe/Harvard, Sawyer was the first student to complete work on Shapley's specialty, groupings of old stars called globular clusters. Sawyer's research on globular clusters, and the variable stars they contained, was so prolific that even after her marriage to Harvard astronomy Ph.D. student Frank Hogg in 1930, she continued to publish under Helen Sawyer or Helen Sawyer Hogg.

The following year, Frank Hogg was hired by the Dominion Astrophysical Observatory in British Columbia, and due to Depression-era regulations, Helen was prohibited from receiving an official position at the government-owned observatory. However, Director J.S. Plaskett knew of her accomplishments in astronomy, and she was allowed to use the 72-inch telescope (at that time the second-largest telescope in the world) for her globular cluster research as an unpaid volunteer, the first woman so entrusted with the instrument. In addition, she was the first person use the telescope for photographic research rather than spectroscopy. This feat was all the more remarkable because, while Helen had used Mount Holyoke's 8-inch refractor, she had done no observations while at Harvard but had instead worked directly from photographs taken by others (Ainley 151). The very fact that Helen was able to observe at night with the male technicians was ultimately made possible because of the presence of Frank as a proper chaperone.

In June 1932, the Hogs' first child, Sally, was born, and Helen resumed observing a mere month later. Helen later matter-of-factly recounted that "As I was nursing, this meant that she had to come to the dome with us for the night" (Ainley 152). In doing so, she had successfully moved the observatory dome back into the domestic sphere, where it had squarely been in the 1600s. As Lindberg explains,

Breastfeeding as a visible embodiment of motherhood further conflicts with attitudes at work. Bringing breastfeeding to the workplace challenges the myth of separate worlds in which employment and family exist separately. It erases boundaries between women's private roles as mothers and public roles as workers. (240)

During a visit by the Astronomer Royal of Canada, Sally made a noise which startled the dignitary, and Plaskett had to explain “Oh, that’s the Hoggs’ baby” (Yost 41). Not long afterwards, Plaskett gave Helen a grant he had received from the American National Academy of Sciences, which enabled her to procure live-in childcare. One can only speculate how much influence the Astronomer Royal had on that decision.

In 1935, Frank Hogg was appointed to the staff of the new David Dunlap Observatory at the University of Toronto, which featured an even larger 74-inch telescope. Helen dutifully followed her husband, and once more became an unpaid assistant. Although she was officially hired as a research assistant the following year, her salary was low, and continued to be significantly below that of the men at the Observatory when she became a Lecturer at the University of Toronto in 1941. In other palpable ways she was considered as markedly separate from her male colleagues. In a 1940 interview with the *American Magazine*, she is described as a “housewife’ who was conscientiously attentive to her real responsibilities: ‘Even if her mind is in the sky, Dr. Hogg keeps her feet on the ground. She runs the house for her husband and three kids, collects stamps, makes bedspreads’” (LaFollette 267). In fact, she was probably only hired by the university at that time because most of the men were serving in World War II, with the exception of Frank, who had a heart condition linked to a childhood bout of rheumatic fever. This medical problem unexpectedly took Frank’s life on January 1, 1951.

For Helen Sawyer Hogg, her professional life blossomed after her husband’s death. No longer bound by anti-nepotism rules, she was promoted through the academic ranks, becoming a full professor in 1957. She later reflected that her status as a widow “made all the difference in the world.... I don’t know if I ever would have become full professor being married to a scientist” (Ainley 153). In addition to coming into her own as an academic, Helen also became a noted popularizer of astronomy, continuing her husband’s astronomy column in the *Toronto Star* for an additional three decades after his death. In such a way, she brought a little piece of astronomy back into the domestic sphere through her readers. Her “homespun way” of dealing with students was eulogized after her death, including the numerous gatherings she hosted for staff and students in her home (Pipher 1371). A former student reminisced how

For decades she invited astronomy staff and students to her home for dinners and teas, and on winter days there was always a fire burning in the fireplace. There were many occasions when she brought her freshly baked hermits to functions at the Observatory or to meetings of the Royal Astronomical Society of Canada. (Clement 85)

Helen Sawyer Hogg successfully combined the domestic and professional spheres throughout her career in observational astronomy, and despite serious

restrictions placed upon her by the astronomical establishment, continued research of significance and note.

### **Assaulting “The Monastery” – Margaret Burbidge**

Back in the United States, women struggled against the constrictive reins of the Harvard model of “women’s work” in astronomy. At the same time, astronomer George Ellery Hale found great success in raising money to finance larger and larger telescopes, including the 40-inch Yerkes refractor in 1895 (Wisconsin), the 60-inch (1908) and 100-inch (1917) reflectors at Mt. Wilson (California), and the 200-inch behemoth at Mt. Palomar (California, 1948). From the very foundation of these observatories, women were purposefully excluded. The living quarters for astronomers at Mt. Wilson was dubbed “The Monastery” and Andrew Carnegie, the chief financier of the project, specifically built it with small rooms so that “men would not be bothered by their families” (Stephens 41). Such spatial segregation enhanced the already prevalent gender segregation of astronomy practitioners in America. All the women on staff at Mount Wilson were computers, and were based in a Pasadena office rather than at the Observatory itself. A few women were able to use the Yerkes instrument during World War I because of a lack of male assistants, while at Mt. Wilson and Mt. Palomar, women were prevented from directly using the telescopes until after World War II.

One notable woman who found herself shut out by these discriminatory practices was E. Margaret Peachey Burbidge (1919 - ). The daughter of chemist Stanley John Peachey and former chemistry student Marjorie Stott, she studied physics at the University of London, where she eventually obtained her Ph.D. During World War II, Margaret’s graduate coursework was interrupted, but she was able to utilize the University’s 24-inch reflector to work on her thesis research on hot stars without competition or complaint. As she recounted,

The director had been called to the Admiralty for classified War work.... The first assistant had gone in the Army and the mechanic was in the Air Force repairing airplanes. So, in a junior fashion, I was appointed general caretaker and looker-after of everything there. (Oleck 278)

After the war, Margaret returned to her classroom studies and there met Geoffrey Burbidge in 1947, a graduate student in theoretical physics. They were married the following year, and three years later they left for America searching for, as she called it, “better telescopes, better instruments, clear skies.” For Geoffrey’s part, he explained that “I got into astronomy by marrying an astronomer” (Panek 50). This husband-wife team was described by many colleagues over the years as an “odd couple.” Not only did they differ in disciplines, but she was frequently described in popular level works as beautiful, gracious, and quiet – stereotypically feminine -- while he was overweight and overbearing (“The Stargazer 38; Bartusiak Through 137; Panek 50). According to LaFollette (267) this “overemphasizing researchers’ femininity” was commonly used by

biographers to “cultivate an image of domesticity.” Despite their outward differences, the Burbidges’ scientific collaboration yielded impressive fruit over the succeeding decades. Unfortunately, from the beginning, Margaret’s career was severely hampered by the prevailing attitude of observational astronomy as being outside the realm of “women’s work” in science. She applied for a prestigious Carnegie Fellowship at Mt. Wilson and Mt. Palomar and received an irate letter from the director of the program. Margaret remembered that “He thought I had committed a terrible faux pas by applying.... He thought I should have known women aren’t allowed” (Flam 1604).

In 1955, the Burbidges and famed theoretical physicist William Fowler planned to collaborate in Pasadena, assuming that Margaret would be awarded a Mount Wilson fellowship and Geoffrey a research fellowship at Caltech. However, Margaret was once more rebuked by the director, who cited the single toilet at the observatory as the reason women could not apply. In response, Geoffrey, a theoretical physicist, received the observational astronomy fellowship, and Margaret the physics fellowship. No one was surprised when Margaret consistently accompanied Geoffrey on “his” observing runs (Rubin 915). As explored by Banks, and Cooper and Oldenzel, accessibility to toilets has commonly been used by institutions ranging from the Harvard Divinity School and Virginia Military Institute to railroads as an excuse for denying educational and employment opportunities to women. As women were not allowed to enter “The Monastery” (as recently as the late 1980s), the Burbidges had to stay in the Kapteyn Cottage, a small summer cottage with no hot water, heated by a wood stove, even during the winter (Boesgaard 21). They were also prohibited from sharing meals with the other astronomers in the communal galley, until the night watchman personally invited them (in direct opposition to the Director’s orders).

Their joint observing program on the properties of galaxies was interrupted in April 1956, when Margaret could no longer hide her pregnancy under her clothing, and climbing the observatory ladder became untenable (Burbidge 19). Unlike Hogg, Burbidge did not return to the observatory with daughter in tow (which seems to have never been an option, given the onerous discriminatory restrictions already placed on them), and the couple instead took positions at the Yerkes Observatory (University of Chicago). As seen also in the cases of the Hogg and Gaposchkins, pregnancy and childcare have been roadblocks in the careers of women astronomers in the twentieth century, and continue to be so in the beginning of the 21<sup>st</sup> century. For this reason, the AAS Commission on the Status of Women of Astronomy recommends that institutions who hire astronomers “ensure that a career in research is compatible with having a family,” including flexibility in scheduling and providing employees with childcare and family leave benefits (AAS Pasadena 8)

Due to nepotism rules, only Geoffrey could be hired as a faculty member at Chicago, while Margaret was given an unpaid fellowship. As Margaret later explained, the nepotism rules “are always used against the wife” (“The

Stargazer” 38). After five years, the couple again moved, to the University of California – San Diego, but again faced with nepotism rules, she had to be hired by the Chemistry Department. Throughout this time, Margaret carried out pioneering work on the rotations and masses of galaxies, and played a vital role in the early study of quasars. In recognition of her contributions to observational astronomy, she was awarded the 1971 Annie Jump Cannon prize for notable work by a woman astronomer, but declined the honor, stating that “If my strong feeling is against any kind of discrimination... I have to stretch that to include discrimination for women too” (Flam 1606).

This same year, Margaret was approached about becoming the first female Director of the Royal Greenwich Observatory. The self-effacing Margaret suggested her husband to be a more suitable candidate, but was told that the post would only be given to an observational astronomer (Burbidge 29). Despite her reservations, she took the position as a “service job”, to give back to the field. Unfortunately, the position was political from the first. All of the previous eleven Directors had been given the simultaneous title of Astronomer Royal; however, this honorary but extremely prestigious appointment was given to Sir Martin Ryle. “Gender discrimination” was whispered by more than a few voices. Despite this significant shadow on her appointment, Margaret put her own feminine touches on the grounds of Herstmonceux Castle. She opened the expansive gardens and parks to the public on weekends as well as weekdays, and stopped all fishing and hunting on the grounds (Green 39). Her professional activities were not nearly as successful, and frustrated by the lack of cooperation from peers and Geoffrey’s inability to secure a position in England, she resigned the post after only fifteen months to return to her tenured position at UC-SD.

### **Vera Rubin and Bathroom Politics at Mt. Palomar**

Despite the roadblocks of gender discrimination Burbidge had endured in the field of observational astronomy, her fight directly benefited another famous woman in the discipline -- Vera Cooper Rubin (1928 --). At age fourteen, she built a telescope with her father, Philip, an electrical engineer, and decided on astronomy as a profession while in high school. Her high school physics class was “a boys’ club in which the few girls were politely ignored” and her teacher predicted that she “should do OK [in college] as long as you stay away from science” (Rubin et al. 38-9). Before settling on the astronomy program at Vassar College, she was advised by an admissions officer at Swarthmore College to steer in the “more ladylike” direction of astronomical illustration, a throwback to the time of Maria Eimmart (Bartusiak “The Woman” 89).

In 1947, a year before graduation, Vera requested a graduate catalog from Princeton University, and received instead a letter from Dean Sir Hugh Taylor, who explained that, since women were not allowed in the graduate programs in astronomy and physics, she would not be receiving a catalog. Instead, she married Robert Rubin, a Ph.D. student at Cornell University, and moved to

Ithaca, New York in 1948, where she entered the graduate program under the supervision of Martha Stahr Carpenter. She gave birth to their first child in 1950, a few weeks after completing the oral exams for her Masters degree, and when David was only three weeks old, the family drove to Pennsylvania where Vera gave a paper on her thesis at a meeting of the American Astronomical Society. Her analysis of the hundred or so galactic spectra collected by others at that time (an admittedly small sample size) seemed to show that there was another, “sideways” motion besides the expansion of the universe Edwin Hubble had found in the 1920s. According to Rubin, her unexpected results received “an enormous amount of publicity, almost all negative,” and her paper was rejected by the top astronomy journals (Yount 85-6). The following year, the family moved to Washington, D.C., where Vera’s parents lived, and Robert had been offered a job at the National Bureau of Standards.

Vera initially took on the conventional role of housewife and mother, caring for David and his baby sister Judith, born in 1952, but felt unfulfilled in that position. At Robert’s urging, she registered for a Ph.D. program at Georgetown University, and worked under the tutelage of famed Big Bang cosmologist George Gamow. As Rubin explained years later,

I had two children before receiving my Ph.D. and two afterwards. I had no help except my husband and my parents. I did my thesis work and my research at home from about 7:00 at night to 2:00 in the morning... I didn’t do anything but take care of the children, work, and study. It was very hard, but I wanted to do it, and it was do-able. My husband was very supportive” (Fort 76)

As in the case of the Payne-Gaposchkins, the success of the woman’s career was in part due to the fact that both parents were dedicated scientists who seamlessly shared child-rearing responsibilities. Rubin added that “The children really benefited because they had a very active father who helped raise them” (Stephens 40). All four of the Rubins’ children eventually received Ph.D.s in science or mathematics.

Rubin’s Ph.D. thesis topic was no less controversial than her Master’s topic. In violation of a long-held belief that galaxies and other large scale structures in the universe were randomly and evenly distributed, Rubin found that galaxies were arranged in a lumpy pattern, a discovery virtually ignored for over a decade. After completing her degree in 1954, Rubin’s career languished. She continued to be associated with Georgetown, where she taught and did research, but it was not until 1963 that her career became focused. She and Robert spent a year at the University of California – San Diego, where she came under the mentorship of the Burbidges. Rubin explained that they were the first to “treat me as a real astronomer. Their support and encouragement gave me essential confidence” (Fort 77). The other seminal event of that year was Allan Sandage’s invitation to apply for telescope time at Mt. Palomar. Rubin described afterwards how “I was

sent a proposal form which said, printed, 'Due to limited facilities, it is not possible to accept applications from women.' And someone had penciled in 'usually.' She openly states that she was the first woman to "legally" observe at Palomar, in contrast to the ruse used by the Burbidges at Mt. Wilson (Stephens 40-1).

In 1965 she was hired by the Department of Terrestrial Magnetism in Washington D.C., and soon after began the work which was to become her road to astronomical fame. By capturing and studying the spectra of numerous spiral galaxies like the Milky Way, she was able to determine that they possess more invisible or "dark matter" than visible matter, and this affects the way the galaxies spin. Today it is accepted by the majority of astronomers that dark matter outweighs normal matter by approximately 5-to-1.

As described previously, bathroom facilities have been repeatedly used to deny women access to traditionally male spheres, and change can be slow in coming. In 1992, Rubin reported that "Even today, there is only one toilet on the ground floor at Palomar and it says 'Men'" (Stephens 41). There was, however, a unisex, single-toilet bathroom built into the new control room used in the 1990s. Regardless, she took issue with the "Men" sign on the primary bathroom and "cut a little figure with a skirt and I pasted it up. It stayed for the four days I was there, but it wasn't there the next year" (Stephens 41).

## Conclusion

Rubin continues to be a champion for women in astronomy, although she admits that "we're kidding ourselves if we don't realize that science is still a male-dominated profession, and some of the males enjoy the dominance" (Fort 76). As DeHart (260) notes,

Opponent women seemed to have an acute awareness of the extent to which, even in the modern world of overlapping male and female spheres, public space and private space remain gendered. From their perspective, the public space of the workplace was male space – even when women were attached to or placed within it.

A significant recent technological change in observational astronomy may open the doors further for women in observational astronomy. With improvements in both computer technology and the Internet, many professional grade telescopes can be remotely operated, thus eliminating the necessity for the astronomer to physically inhabit the same space with the telescope. In doing so, issues of safety, child care, and access to travel funds are eliminated. These large instruments and smaller telescopes are also being used in high school and college class rooms to revolutionize astronomy education (Gould, Dussault, and Sadler 127). However, despite the increased access to astronomical data (some of it acquired in real-time), detaching the astronomer from the instrument runs the

risk of having students consider the telescope as merely “a black box sitting somewhere in cyberspace” (Gould, Dussault, and Sadler 133). In doing so, the astronomical observatory may not only become de-gendered, but it also becomes dehumanized as well.

In trying to succeed in a man’s field, many female astronomers are “constrained to comply with a traditional ‘male model’ that rigidly subordinates the personal to the professional” (Etzkowitz et al. 15). But as the women recounted in this paper clearly illustrate, a creative combination of the two spheres provides an alternative route to success. In 1978, she received a cable message from Cerro Tololo Observatory in Chile proudly announcing that on that particular night “four women astronomers are observing... on the four largest telescopes!” (Rubin Bright Galaxies 172) Increasingly, a woman’s place is in the dome, and their presence will continue to blur the lines between private and public, male and female, until such as time as hopefully the only important categories which remain in astronomy are theoretical and observational.

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