

STARS, PLANETS, AND GENDER: A FRAMEWORK FOR A FEMINIST ASTRONOMY

Abstract

Understood broadly as the scientific study of the “stars,” astronomy ranks among the oldest of human fascinations, studies, and knowledges. Still, the relationships among science, gender, and astronomy, however, have gone under-investigated. Masculinist approaches to epistemology, science, and astronomy, as well as gendered and colonialist systems of knowledge production and verification, have excluded and marginalized knowledges, narratives, and ways of knowing from women, indigenous people, and other sources outside the Western-centric, androcentric scientific paradigm. To remedy this problem, this paper proposes a framework for feminist astronomy that (1) critically examines knowledge production in astronomy and the sciences, (2) recognizes gendered and colonialist approaches to astronomical knowledge, (3) challenges these systems of scientific domination, and (4) provides alternative knowledge sources and research methods for astronomy. Feminist astronomy draws upon feminist theory, postcolonial theory, and feminist political ecology to analyze while challenging and disrupting masculinist hegemony within astronomy and the natural sciences, leading to more inclusive, diverse, and equitable astronomy more focused upon human relationships to the stars.

Keywords

feminist astronomy, feminist science studies, postcolonial science studies, astrology, astronomy

I. Introduction

Human beings' longest-standing meaningful relationship may be with the night sky and the stars, planets, galaxies, and other luminous or reflecting objects contained within it. The historical and modern scientific study of the bodies and phenomena that fill the sky and define these deep, ancient, rich and multifaceted relationships with humankind is known as *astronomy*. As a result, astronomy arises from and evokes a central human fascination that has touched literally every culture in human history; it has influenced planning and the organization of society; served as a basis for storytelling, myth-making, fortune-telling; and been an enduring sense of transcendent wonder.

Running contrary to this expansive view, astronomers steeped in the Western scientific tradition are likely to embrace a reductivist and (neo)essentialist view of astronomical bodies with a single narrative that reduces and constrains them to chemical and physical properties removed from their human significance. In this Western-centric, limited way of viewing and interacting with astronomical knowledges, human relationships are often neglected, ignored, and marginalized. The “objects” of the night sky which have captivated human beings for as long as we could look up and wonder are reduced in pursuit of scientific objectivity, and thus astronomical objects are no longer seen as an intrinsic, meaningful, inextricable and deeply significant part of human society. Nevertheless, they are historical and narrative-laden phenomena that, when viewed through our cultural framing of stars, planets, and other phenomena of astronomical interest (including comets, supernovae, eclipses, and meteors) across time and space, cease to be objectified and are instead seen as living, affective, and human-related. Having been excluded from scientific inquiry, these human-centric narratives and knowledges about stars and other astronomical features are typically investigated under the term *astrology* and are routinely dismissed from astronomy.

Nothing in this exclusionary habit surprises for it is not uncommon to the Western scientific tradition to exclude alternative, indigenous, and marginalized knowledges, even *within* astrology (Haraway 1988; Harding 2009). Nonetheless, such dismissive arrogance, which is typical in dominant

Western scientific discourses, misunderstands astrology and its role in connecting the astronomical with the human, as revealed by the very etymological roots of the word “astrology.” Astrology is derived from the Greek roots *astros*, meaning star, and *logos*, meaning “the logic of.” Thus, astrology can be understood etymologically from its foundation as the “logic of stars,” and this is meant as applied to their relationships with each other, humanity, and cultures. Astrologies and the fundamental logics by which they are engaged are universal within indigenous cultures and all cultures outside of the Western scientific tradition, and yet they have been and continue to be unjustly excluded from astronomy via colonialist, imperialist, capitalist, and masculinist attitudes, methodologies, and epistemologies favored within the context of the Western-situated scientific tradition (Haraway 1988; Merchant 1980; Plumwood 1993).

Dominant lines of exclusionary thought are intrinsic to the androcentric context in which science and thus astronomy itself is rendered gendered, and so too are the masculinist biases of detachment, objectivity, descriptiveness, instrumentalism, categorization, and objectification which have seeped into astronomy's methodological and epistemological approaches. With them, astronomy has suffered the corrosion of the richness of the human context of our ancient relationship with stars (Harding 2009; Plumwood 1993). Entrenched masculinist tropes in astronomy are also therefore unsurprising given that they are endemic within and structurally constitutive of the Western scientific tradition tracing back to our earliest attempts to measure, classify, and objectify virtually everything in the “scientific” pursuit of “objective truth,” as well as allegedly rich “Enlightenment” projects which sought to comprehend and contextualize these ideas while inextricably situating them in the Western philosophical tradition (Harding 2009). With astronomy in particular, the objectifying nature of a masculinist approach to knowledges is more deeply embedded than in many other sciences, as researchers leer voyeuristically at distant “astronomical objects” through telescopes and, though uninvited, investigate them via robotic probes.

Colonialism also has deeper roots in astronomy than in many other sciences, the obvious aspect

of the colonialist context of astronomy being revealed within the intersection of the enduring masculinist trope of pioneering exploration and discovery and the perpetual manifest destiny that sees virgin and indigenous landscapes as fair for the taking and colonizing (Merchant 1980; Plumwood 1993). Our ambitions with space exploration perfectly reflect this rapacious aspect of colonialism within astronomy: we seek to build space stations (in which to colonize space); to fill our near-Earth environment with our satellites (and space junk); to visit, exploit, and eventually colonize the Moon and Mars; to harvest, mine, and exploit asteroids; to send probes to distant planets, moons, and into interstellar space; and to technocolonize other rocky bodies in our Solar System by placing exploratory rovers upon their soils. Less obviously, but more consequentially, astronomy engages in scientific colonialism in the overt ways in which the Western scientific tradition is treated as the only viable scientific study of astronomy, excluding and marginalizing alternative and indigenous knowledges, ways of knowing, and narrative-making (Haraway 1988; Merchant 1980; Plumwood 1993).

What androcentric and masculinist approaches to astronomy fail to apprehend through androcentric blinkering is that stars, star-gazing, and stories about stars have had and still have enormous cross-cultural, social/sociocultural impacts that reach beyond descriptive models and data, and the narratives we weave about stars shape cultures. Masculinist Western scientific attitudes have thereby marginalized venerated avenues to knowledges, and Western culture more generally has largely rejected such narratives except in the attempt to exploit them for capitalist gain. Unsurprisingly, many of the knowledges lost through marginalization are possessed by and transmitted through the generations by women, particularly within indigenous cultures. This leads us back to a call for deeper and renewed investigation into the narratives, contributions, and knowledges that marginalized cultures have made about stars and into the meanings they ascribe as a part of the “*logos* of stars” that has been removed from masculinist, colonialist astronomy.

There therefore persists a need for a deeper multidisciplinary and nonsynthetic exploration of the relationship between gender and stars, seen not merely as a male/female or Western/non-Western

binary but in the context of a wider range of social and knowledge-based possibilities. This inquiry also raises concerns about justice, inequality, and power as it applies to the acquisition of knowledges about stars, planets, and astronomical bodies in the context of astronomy and in their relationships with humans and cultures. Doing so, however, must succeed without falling into the simplistic trap of reducing astronomy and alternative astronomies to yet another binary, which would but perpetuate gendering and colonialism in science (cf. Carey et al. 2016).

Feminist and postcolonial perspectives are ideal for this purpose in the wide-ranging ways they challenge and disrupt dominant assumptions. These allow us to move beyond gender and colonialist assumptions and disrupt them in all their manifestations (Harding 2009). Feminist perspectives, particularly, empower us to increase justice, equality, and balance within systems of power and domination in the realms of science and culture (Carey et al. 2016). Drawing upon wide-ranging literature and following in its footsteps, this paper therefore introduces *feminist astronomy* to meet these goals and to reveal the under-examined history and exposed the gendered nature of astronomical knowledge and the widespread roots of masculinity, patriarchy, and colonialism within the astronomical sciences.

II. A Need for Feminist Astronomy

Feminist astronomy systematically interrogates that which constitutes astronomical knowledge and critically (re)examines the processes and social milieu in which that knowledge is taken to be epistemologically grounded. It places special attention within astronomical inquiry upon knowledge related to stars, constellations, nebulae, planets, the relative movements of planets and other astronomical bodies, and astronomical events of sociocultural significance across cultures and particularly situated within marginalized systems of knowledge pushed out of traditional astronomy. In particular, it asks about the human meanings, affective relationships, and dynamic significances of stars, planets, and other astronomical matters while seeking to destabilize underlying gendered

assumptions to “undo gender” within science and scientific investigation into astronomical topics (Kelan 2009; Powell, Bagilhole, and Dainty 2008). By (un)doing so, it reveals, undermines, and dismantles boundaries, and undoes binaries while disrupting expectations.

One enduring problem feminist astronomy seeks to address is that women have *always* been marginalized by sexism in science, not least in the astronomical sciences and almost completely (until very recently) in space exploration and related sciences (Barthelemy, McCormick, and Henderson 2016; Flam 1991; Lawler 2003). They have also been exploited despite their marginalization, as Nathalia Holt (2016) documents throughout *Rise of the Rocket Girls: The Women Who Propelled Us, from Missiles to the Moon to Mars*. Holt details the underappreciated contributions of women “calculators” working for NASA in the 1940s, whose contributions laid much of the groundwork for contemporary space exploration. This view of marginalization and exploitation is corroborated and amplified considerably by Margot Lee Shetterly's (2016) book *Hidden Figures: The American Dream and the Untold Story of the Black Women Mathematicians Who Helped Win the Space Race*. The feminist lens is therefore a critical element to revealing the centrality of gender and patriarchy constituting astronomy as it has historically been and still is encountered today. A feminist analysis highlights and encourages an awakening to astronomically and globally marginalized knowledges and narratives about stars, planets, and the meanings of their relative movements in the night sky.

Furthermore, feminist approaches to astronomy recognize that the problematic systems and patterns in how astronomical knowledges are produced matter. It cannot be ignored *vis-à-vis* masculinist science that nearly all astronomical research has arisen from knowledge produced by men (mostly white men) situated within masculinist discourses that saturate the sciences (“Astronomy Gender Gap Revealed” 2016; McCartney 2017, pp. 1036–1037; Shielbinger 2014). These discourses have traditionally excluded women and female perspectives from science, especially astronomy, and create hostile working and conference environments for female astronomers and female astronomy students (McComb 2012; Shielbinger 2014). As Harding (2009, p. 408) notes, the relative paucity of

women in science fundamentally shapes “the selection of scientific problems, hypotheses to be tested, what constituted relevant data to be collected, how it was collected and interpreted, the dissemination and consequences of the results of research, and who was credited with the scientific and technological work.”

Furthermore, the gendered nature of astronomical knowledge itself has been a persistent cultural trope across history and geography. Space exploration is portrayed as dangerous, manly, adventurous, technical, and pioneering, both directly and in media portrayals (McPhee and Charles 2009), and scientific work in general is organized to favor men and masculinist approaches to research (Shielbinger 2014). So deeply entrenched and problematic are these concerns that gendered systems of domination persist even within alternative approaches to astronomical knowledge, including astrologies. In Angela Voss's analysis of the 15th century Florentine philosopher Marsilio Ficino, she critiques Ficino's (ultimately Catholic) “vehement” rejection of the practices of astrologers as expounded upon in his *Disputatio contra Iudicium Astrologorum* (Voss 2001; Ficino 1949, pp. 11–76). Like the Catholics, tracing back to Augustine, astrologies were excluded from astronomical knowledge by masculinist discourses seeking to assert that the mind of God, thus access to power in a patriarchal religion, cannot be knowable by divination (Veenstra 1997, pp. 184–185). Voss (2001) notes the sort of knowledges this masculinist, Western bias systematically excludes from the human, intuitive, and emotive aspects of knowledge:

Through “dreams and signs” such as “birds, entrails, inspiration and the sacred oak” divinatory practices would seem to facilitate a mode of knowing which is at once temporal, in that man is observing an event in time, and eternal, in that his *faculty of perception* transcends time and space. In the divinatory moment, these two orders would seem to be aligned as the physical event coincides with an insight which is deeply meaningful for that person, at that time, allowing him to “see” at a level which transcends and thus unites subjective and objective categories of experience. (emphasis

original)

Masculinist, objectifying discourses in the natural sciences are thoroughly disinterested in such subjective, emotive, and transcendent epistemologies and the knowledges produced by them (Harding 2009; Shielbinger 2014). Thus, even before the advent of mature Western science, we see a hegemonically masculinist approach to proto-scientific discourse excluding alternative knowledges and narratives about stars and planets for reasons that amount to maintaining patriarchal control of women, knowledge, marginalized groups, and ways of knowing (cf. Kosuta 2016).

Implicit sexism in science worsened after the introduction of contemporary androcentric approaches to the natural sciences, and astronomy in particular has been a space of considerable gendered assumptions, sexism, and misogyny. In the late 19th century, for example, Caroline Herschel made considerable and noteworthy advances in astronomy, including discovering several comets and nebulae and drawing praise from notables including the King of Prussia and London's Royal Astronomical Society, and yet she was considered, even by herself, to be a “tool” of her famous brother's, astronomer William Herschel (McNeil 2016). “I have done nothing at all,” she remarked, “all I am, all I know, I owe to my brother. I am the tool which he has shaped to his use” (McNeil 2016). But why would Herschel diminish her view of herself via such a lens of internalized misogyny? She clearly understood what her brother and masculinist science could not: that given license to do astronomy in her own dynamic way and on her own scientific terms, she'd have done differently than she was forced to do. Among other problematic trends persistent throughout the androcentric natural sciences, then, Herschel's enslavement to masculinist scientific expectations draws us to theoretical considerations which point to long-standing and deeply embedded sexism and misogyny in astronomy and in astronomical discourses. Notably, astronomy remains one of the few scientific fields to rely directly upon sexist Greek and Roman mythological narratives for its nomenclature. McNeil (2016) therefore aptly summarizes the problem that constrained Herschel and that has not yet been remedied even up

until the present: “Today, the skies are filtered through this tradition of mythic misogyny. ... [C]hange must begin with the recognition that astronomy's self-image is built upon an age-old habit of telling stories about the abuse of women.”

Even where the masculinist problems leave off, traditional sciences are co-constituted with colonialist agendas (Schnabel 2014). The colonialist and ultimately imperialist approach to science is deeply problematic in its continual marginalization and oppression of women, indigenous perspectives, and alternative knowledges. It is epitomized in our goal to colonize space, moons, and other planets (including by terraforming them to radically remake their native ecosystems to be more suitable to human and capitalist exploitation [Scharping 2016]), and by our military interest in dominance of the near-Earth space environment, which was a central goal in imperialistic Cold War militarism. Consider, for example, the “Star Wars” program attempted under President Ronald Reagan in the 1980s, which sought to fill the near-Earth environment with laser-based and other anti-missile tools of war for the purpose of thwarting potential nuclear attacks from the Soviet Union (Miller and Van Evera 1986). Though lesser-known, another example is the “Rods from God” program—clearly phallocentric in every regard—which sought to install military high-orbit satellites that downwardly launch telephone pole-sized tungsten javelins at precise geolocations at many times faster than the speed of sound. These “rods from God” would have the capacity to strike the Earth as if from Heaven with the destructive force of a nuclear weapon (but without the fallout) while providing the specialized capability of destroying deep underground bunkers of the enemies of US military agendas (Antoun et al. 2006; Weiner 2005). The explicit purposes of these programs, whether to colonize space or to achieve military dominance, are perfectly in line with the Western (and intrinsically masculinist) colonialist and imperialist visions that marginalize non-Western peoples by dominating both space and native lands and exerting Western hegemony around the world and above it (Dean 2003; Farish 2010).

Colonialism is no mere aberration in astronomy, however; it is intrinsic to the human fascination with space. The most overt and successful space colonization effort humanity has

undertaken is the profuse population of the near-Earth environment with satellites, most launched into orbit for one of three ultimately neoliberal purposes: militarism, capitalism, or scientific research. Of these three, scientific research, including the installation of space telescopes like Hubble and Chandra, falls nearest to the purposes of feminist astronomy and is the least obviously masculinist and colonialist in nature, but consider that satellites have only been *alleged* to give researchers greater objectivity and a removed perspective unavailable by interacting from Earth's surface. As revealed by Haraway (1988; cf. Shapin 1998), however, rather than providing objectivity, satellites deceive researchers about objectivity via the “god trick of seeing everything from nowhere,” thus perpetuating hegemonic ideas that exclude human-centered alternative knowledges (Haraway 1988, p. 581). The view provided by satellites to astronomy researchers, therefore, is irredeemably masculinist in nature in that it is intrinsically pornographic and yet still contaminated by the limits of male subjectivity.

Within the sciences and astronomy, then, gender and colonialism are co-constituted systems of systematized oppression that extend historically and persist in marginalizing alternative discourses through the present day (Hanson and Buechler 2015), so feminist astronomy offers a corrective by building itself from the meeting place of critical feminist scholarship and postcolonial science studies. It challenges dominant situated knowledges, critically examines gender dynamics in astronomy, and enriches astronomy by re-introducing alternative knowledges, myths, and narratives about stars into and otherwise masculinist field dominated by the gendered assumptions of Western science (Harding 2009). In so doing, it renders astronomy more just, more equal, and more inclusive, while making it less colonial, less imperialist, less oppressive, and less situated in the outdated, biased, masculinist scientific “ideal.”

Ultimately, the interaction of feminist political ecology and feminist astronomy produce nontraditional traditionalist alternative ways of knowing, as seen from a traditional understanding of traditionalism. In other words, feminist astronomy recognizes, honors, and elevates the unique perspective of women and diverse knowledges about the myth and “folk magic” of the stars. This

interaction usefully and justly unsettles Western and Eurocentric assumptions and hegemonic claims to knowledges and a diversification of methodologies available to astronomers by incorporating mythology, global astrologies and other astrological narratives, storytelling, poetry, and the everyday lived experiences and marginalized wisdom of women and indigenous peoples (Harris 2015; Mack et al. 2012). Feminist astronomy is therefore a justified need for the unmaking and for a feminist-postcolonial remaking of the astronomical sciences.

III. Masculinist production of knowledges

Astronomy has always been dominated by men and masculinity, especially but not limited to endeavors in human space exploration. Astronomical research and space exploration, consistently with science, technology, engineering, and math (STEM)—especially physics, geophysics, geochemistry, engineering, computing, and mathematics—have all been culturally characterized and constituted by masculinist and colonialist discourses and approaches to education and to knowledge (Parson 2016; Pollack 2013; Powell, Bagilhole, and Dainty 2008). The dominant themes of the field, including exploration, space imperialism, environmental conquest, and extraterrestrial colonization, are central to policy and research agendas with space and space sciences (Logsdon 2011), thus these themes and tropes are paradigmatic of astronomy research and research within related fields of science, engineering, and technology.

Some women have been involved in space science and astronomy, of course, and the discourses and social constructs around gender, space, and technology have shifted somewhat over time. Notable exceptions to the male-dominated nature of the astronaut program include Soviet cosmonaut Valentina Tereshkova (first woman in space, 1963), Sally Ride (first American woman in space, 1983), Peggy Whitson (U.S. astronaut with current longest time spent in space), and Geraldyn (“Jerrie”) Cobb (the first woman to demonstrate that women can endure the same challenges as men in astronaut training, 1960). While these women were overcoming masculinist and patriarchal assumptions about women

and space exploration, however, they were also subject to them. Sally Ride, Judith Resnik, Kathryn Sullivan, Anna Fisher, Margaret Rhea Seddon, and Shannon Lucid, were all members of the 1978 astronaut class, which was designated by the code acronym TFNG (“Thirty-Five New *Guys*,” emphasis added), the first astronaut class to include women (NASA 2013). Jerrie Cobb, while not designated a “guy,” was invited by William Randolph Lovelace to “undergo the same rigorous challenges as the men,” a decidedly masculinist qualifier whose explicit comparative nature is openly female-exclusionary and patriarchal (NASA 2005).

The masculine dominance at NASA has persisted as a public-influencing media trope as well. The 1978 astronaut “New Guys” program “garnered much attention from the media and the public” (NASA 2013). Kathryn Sullivan spoke to the gendered nature of space exploration, remarking, “We didn't want to become 'the girl astronauts,' distinct and separate from the guys. ... All of us had been interested in places that were not highly female, and just wanted to succeed in the environment, at the tasks, and at all the other dimensions of the challenge” (NASA 2013). As an aside, though Sullivan clearly imported some elements of a dominant masculinist discourse about space exploration, she also provided an expressly feminist disruption to the astronaut program by seeking to undo gender in space exploration (cf. Powell, Bagilhole, and Dainty 2008). Due to prevailing masculinist narratives and assumptions in culture, science, and government, however, NASA officials either did not agree, did not understand, or merely dismissed the perspective of the “New Guy” women astronauts. As Sally Ride noted, “The engineers at NASA, in their infinite wisdom, decided that women astronauts would want makeup—so they designed a makeup kit. A makeup kit brought to you by NASA engineers. ... You can just imagine the discussions amongst the predominantly male engineers about what should go in a makeup kit” (NASA 2013).

In these vignettes, we see through a clear window into the gendered nature of space exploration and, by extension, astronomy more generally. Male astronauts are treated as though they are explorers, adventurers, and other sorts of manly men with agency over their fate and over the vision of the nation

and world; women were portrayed as curiosities, victims of their own emotions, and subject to the whims of apparent female nature, as demonstrated by the design of NASA makeup kits for the female “New Guys” in the 1978 astronaut program.

Problematic gender injustices also persist in astronomy outside of space exploration. For example, women experience sexism in research astronomy as demonstrated by the fact that women publish fewer papers in research astronomy than men, and there has been a significant lag in correcting this gap from any historical hangover from pre-feminist periods (“Astronomy Gender Gap Revealed” 2016; Kuo 2017). Women also face an exclusionary and hostile environment working in male-dominated astronomy departments and attending male-dominated professional and academic conferences in astronomy (Clancy et al. 2017). Epitomizing this problem, in 2014 the European Space Agency (ESA) successfully completed a ten-year mission (Rosetta) to land a probe (the Philae lander) on the surface of a comet (Comet67P/Churyumov–Gerasimenko) for the first time in human history. In the media appearance of the tense moments when mission success or failure would be determined, ESA mission leader Matt Taylor appeared and was interviewed wearing a “stylish” button-down collared shirt emblazoned with many semi-pornographic images of scantily clad and exaggeratedly buxom female comic characters, which ignited an enormous controversy within the space exploration and astronomical communities, amongst feminists, as well as within the broader public (e.g., Plante and Duhaime-Ross 2014). While slightly tangential, this controversy typifies the hostile masculinist and female exclusionary working environments of professional astronomers even in the middle 2010s, and the public discourse that arose, thematically concerned with Taylor's technoscientific accomplishment rather than the messages he was portraying to women in and/or interested in the field and related STEM fields, illustrates the hegemony with which masculinist discourses continue to dominate astronomy and cultural discourses within and about astronomy.

Despite these challenges, there are programs for getting young women involved in astronomy and space exploration. For example, a project headed by South Africa's Meta Economic Development

Organization (MEDO) in conjunction with Morehead State University in the U.S. has teenage women being trained by satellite engineers from Cape Peninsula University of Technology to design, build, and eventually launch Africa's first private satellite (Gbadamosl 2017). Of course, such programs should be expanded and remain restricted to young women only because, “These experiences and insights are critical for women in a field in which men typically run the graduate programs, edit the journals, and peer review the majority of papers (Hulbe et al. 2010)” (Carey et al. 2016).

Knowledge production in astronomy therefore needs more inclusion and diversification. Other means superior to the natural sciences exist to extract alternative knowledges about stars and enriching astronomy, including ethnography and other social science methodologies, careful examination of the intersection of extant astrologies from around the globe, incorporation of mythological narratives and modern feminist analysis of them, feminist interpretative dance (especially with regard to the movements of the stars and their astrological significance), and direct application of feminist and postcolonial discourses concerning alternative knowledges and cultural narratives (see, e.g., Barad 2007; Harding 2009; Ingold 2011; Kosuta 2016; Latour 2004; Livingstone 2003; Mack et al. 2012; Waterhouse, Otterstad, and Jensen 2015). Ultimately, dominant gendered and colonialist attitudes about knowledge production in astronomy marginalize the potential contributions of women, marginalized identity groups, and indigenous peoples to develop, produce, share, and honor alternative scientific knowledges about stars and the movements of astronomical bodies, and their meanings (Ryan 2008; cf. Aikenhead and Elliott 2010). Generally, focusing upon Western science ignores these alternative knowledges (primarily, it seems, about how women feel about stars, planetary movements, astrologies, space exploration, space colonization, and astronomy [cf. McKinley and Stewart 2011]). It thus reveals the disconnect between Western science and alternative knowledges, which ends up being hastily dismissive when applied to determining priorities regarding these and other astronomical objects.

IV. Gendered science and colonialist knowledge

While it is obviously problematic that astronomy is rife with sexism and the erasure of women and indigenous groups, then, the deeper problem with astronomy as it stands historically and today is that science itself is gendered, both in its methods and results. Accordingly, the more profound goal of feminist astronomy is to disrupt this gendered (and colonialist) system of scientific domination.

Over the past several decades, feminist scholars have rightly been critiquing the Baconian view of knowledge and the ways in which it leads to gendered dimensions in the sciences (Haraway 1988; Merchant 1980; Plumwood 1993). The Baconian view can be summarized as an attitude that the primary purpose of scientific inquiry is to mechanize natural systems in an attempt to measure, model, and predict phenomena in the natural world, or to assign rigid classifications to organic spectra of being. Scholars of feminist science have observed the ways in which the Baconian view is ultimately masculinist in nature, primarily in that it sees the dynamic and chaotic nature of nature via an objectifying lens with the explicit purpose of dominating and controlling the natural world (Buck et al. 2014). Baconian science seeks to assert man over nature rather than to enable the full dynamism of systems that posit humanity within nature.

The ultimate goal of masculinist and androcentric approaches to science and the application of science and technology to the natural world and governmental policy, such as are derived from the Baconian approach, has been termed “technoscientific control” (e.g., Carey et al. 2016). This trope implicitly imbues the scientific project, as seen *without* the feminist lens, with fatal masculinist biases toward scientific discourse, knowledge, and epistemology. Even scientific taxonomy, which seeks to categorize and thereby objectify organic phenomena in the world, reflects the constitutive nature of the trope of technoscientific control in dominant scientific discourses. In present-day and traditional hegemonic astronomy discourses, for instance, there is much heated and divisive debate about how to classify solar system objects (Weintraub 2007). Is Pluto a planet, dwarf planet, or Kuiper Belt Object? (Similar unresolvable and fruitless taxonomical debates arise between star classifications, galaxy classifications, and so on, and mirror similar essentializing taxonomies in other sciences and Western

culture more broadly.) Nowhere, however, in contemporary astronomical discourse arises the possibility that such designations are ultimately essentialist and reductionist in a forceful and masculinist way with regard to classification, and so the true nature of Pluto qua Pluto is lost to masculinist hegemony. Feminist astronomy is situated in a way that potentially enables it to provide the necessary tools, such as demarginalizing narrative, myth, storytelling, and other alternative means of astronomical knowledge production, including astrological appreciations of Pluto, to correct these deficiencies (Harris 2015; cf. Jones 2014).

The unwelcome fruit of the Baconian approach to science is to constitute science by masculinist attitudes and power dynamics of domination (Buck et al. 2014). As with other sciences reliant upon the Baconian tradition, thus masculinist in nature, astronomy suffers tremendous cultural barriers to entry for women (Barthelemy, McCormick, and Henderson 2016; Clancy et al. 2017), and further excludes them by largely portraying the focus of astronomical research within observational astronomy, which is fetishized above other astronomical research because of the arrays of stunning photographic imagery it produces of stars, planets, nebulae, and so on. Obviously, the exaggerated promotion of these astronomically “sexy” images is inherently masculinist in the usual pornographic way of capitalizing upon objectifying views from afar, views obtained by leering through telescopes at innocence positioned at a distance (cf. Haraway 1988). This exaggerated focus and interest upon observational astronomy and the imagery it produces entrenches sexism by situating the ideal astronomer as voyeur rather than intimate participant.

In addition to implicit gendered barriers to entry into astronomy, there are profound class barriers to consider, and these marginalize oppressed and indigenous communities most. As previously noted, Africa is still seeking to launch its *first* private satellite (Gbadamosl 2017). Even in the capitalist West, owning a modest backyard telescope, having ready access to dark skies (inaccessible from inner cities), or attending Space Camp are bourgeois luxuries that limit early accessibility to space and astronomy to the affluent, thus carrying injustices against women and marginalized racial groups into

astronomy. Obviously, alternative knowledges and practices, like those available in the many indigenous and historical astrologies, can be accomplished through alternative means of knowledge production that do not require special equipment or even observing the night sky. Astrological charts require only knowing certain facts of one's birth, for example. More poignantly, in Standard Thai Astrology, though the discourses remain immensely biased against women, people, particularly women, are able to come to know themselves better through consultation with the relationship with the Moon, seen as both a real and metaphorical object (Kosuta 2016). Such approaches are categorically excluded from masculinist scientific environments. This puts unnecessary and harmful limits upon methodologies, epistemologies, practitioners, and thus results available to traditional masculinist astronomy.

The worth of astrology, especially approaches to astrology that are disruptive to oppressive power dynamics in science and culture, is therefore paradigmatic within the case for feminist astronomy. Throughout all masculinist approaches to astronomy, all astrological systems are systematically excluded and marginalized. Astrologies, however, seek to create narratives that fuse people and stars and set human dramas within the metaphorical backdrop of planetary movements against the constellations. Consider three examples.

First, as feminist and queer astrologer Corina Dross reflects, astrology is “one part science and one part art” that connects the astronomical and the human in one coherent matrix in that “in the search for clarity about what our lives mean, and how we are connected to the larger cosmos, astrology is continually adapting its tools and theories to our changing times” (Dross 2017). Second, the fundamentally human and revolutionary qualities of astrology, marginalized from masculinist approaches to astronomy, is further strengthened by feminist and queer astrologer Chani Nicholas, “Far too often healing is geared towards elevating attributes that are deemed valuable by the status quo. I believe that what makes us different informs our humanity and that our humanity is our greatest asset” (Nicholas 2017). Third, as Olesen (2014, p. 9) indicates, “Queer subjects who combine anti-essentialist

notions and an emphasis on lived experiences with astrology's belief in celestial elements' influence upon life might, then, be generators of feminist knowledge: they navigate the paradoxical and the self-contradictory," which she backs with an example from Chani Nicholas (2014) about how feminist astrology "places equal importance on anti-capitalism (social critique) and on the calling of the moon (mysticism/determinism)." Taken together, these examples provide that feminist and queer astrologies produce scientific knowledges that disrupt the hegemonic influences reinforcing masculine themes constitutive of Western science and culture, and they cast the nebula of mythological, metaphorical, emotional, personal, healing, and affective context into the space of masculinist astronomy.

Of course, not all astrologies constitute legitimate alternative knowledges. For example, while feminist and queer astrologies prove valuable, and the Celtic, Nadi, and Sri Lankan astrological system of indigenous groups in Ireland, India, and South Asia, respectively, represent valued alternative knowledges to feminist astronomy, when uncoupled from feminist or queer theory, contemporary horoscopic Western astrology—which is heavily reliant upon sexist Greek and Roman mythological narratives and other masculinist discourses (Lopez 2017; McNeil 2016)—bears only faint relevance in that it is mostly an indulgence of white middle-class and upper-middle-class (mostly white) people that confers little depth or epistemologically sound knowledges to even the broadest conceptualization of feminist astronomy. Furthermore, without feminist and queer theoretic correctives, horoscopic astrology is itself deeply gendered and problematic (e.g., Beusman 2015; Olesen 2014; Sojwal 2017). Lopez (2017) explains, "the denial of this feminine force in the astrological vocabulary necessarily proves the sexist and patriarchal subjectivity that has been carried on for centuries without us noticing it." Because of their inherently disruptive nature within astrology and the applicability of this gender-disrupting power to astronomy, exceptions must be made for queer astrology and feminist discourses about (contemporary Western) astrology. This is because they constitute situated knowledge systematically marginalized by and challenging to masculinist approaches to astronomy and simultaneously provide valued insights into the lived experiences, values, and humanity of women and

queer people. Still, on balance, indigenous and historical astrologies are more relevant sources of alternative knowledge production for feminist astrology than are contemporary and largely dubious horoscopic divinatory astrology.

V. Disrupting Scientific Domination

The generative purpose of feminist astronomy is to reveal and dismantle the influences of gender, power, and inequality within systems of scientific domination (Schiebinger 2014). To achieve this goal, it utilizes the combined approaches of feminist postcolonial science studies and feminist political ecology (Phillips and Phillips 2010). By engaging with these tools, feminist astronomy can open the astronomical sciences to a broader and more inclusive representation from women, the developing world, marginalized non-wealthy populations, and indigenous communities while incorporating alternative knowledges, narratives, and discourses into the science of astronomy (Mack et al. 2012).

To address this problem, no lens is better for overcoming scientific hegemony than the feminist lens. It is ideally situated, particularly when equipped with contemporary postcolonial insights and discourses from intersectional feminism, to identify the ways in which unjust power imbalances perpetuate and manifest throughout the natural sciences and astronomy, with a particular emphasis upon gender inequality and marginalization of alternative knowledges (Haraway 1988; Harding 2009). In this way, the feminist approach empowered with postcolonial criticism has the best chance of fundamentally remaking science in a more inclusive image.

Feminist thinking and epistemology make marginalized knowledges available while critically examining and dismantling structures of domination that work to marginalize views outside of the masculinist hegemony. Human beings have lived under the stars and tracked the stories told by the night skies for all of human history and have produced incredible quantities of detailed alternative-scientific astronomical and astrological knowledges. Usually, masculinist astronomy classifies all such folk-astronomical pursuits under the single pejorative taxonomy “astrology” and then systemically

excludes them from astronomy. Feminist astronomy reverses this problematic trend and seeks to enhance knowledge the contemporary astronomical community considers scientific. It achieves this by incorporating certain astrologies and discourses about astrologies of the many peoples and cultures throughout history and around the globe that have been marginalized as “unscientific.” In so doing, feminist astronomy enriches astronomy and diversifies its epistemological base while correcting masculinist and androcentric power imbalances that currently bias the field and its results.

One contemporary example of redemptive but marginalized astronomical knowledge is available in the ascendant queer astrology movement. This movement, which hosts its own conferences and has peer-reviewed papers, talks, and books dedicated to its scholarship (e.g., Jones 2014; Olesen 2014), is so thoroughly marginalized from the mainstream of astronomical, scientific, and academic research that to research it requires seeking out non-mainstream academic source material, mostly on the Internet. The formal queer astrology movement began in 2012 when a group of queer professional astrologers met at a conference in New Orleans and challenges dominant assumptions about the gender binary using astrology as a lens and queer theory as a tool (Beusman 2015). Queer astrology provides astronomy access to assumption-challenging insights like, “according to an old cliché, men are from Mars and women are from Venus. But, as any reasonably enlightened person can tell you, this adage upholds an antiquated and restrictive gender binary. In other words, Mars and Venus are social constructs” (Beusman 2015).

Rhea Wolf, queer “feminist witch astrologer,” author, and faculty at the Portland School of Astrology, captured the essence of the value of feminist approaches to astronomy in an interview for *Vice* in 2015. She said, “For me, astrology has always been a tool of liberation, and queer theory likewise seeks to liberate people from the language of oppression,” as well as noting that enduring and frustrating sexism is present even in astrologies marginalized from masculinist astronomy, “Starting out, I had to translate a lot of sexist language in astrology textbooks, which pissed me off” (Beusman 2015). Entailed in her statement is that there are layers of masculinist, androcentric, and patriarchal

thinking applicable to astronomical knowledges, including astrological knowledges, and yet only within feminist and queer astrology do we see the tools being readily applied to disrupting these co-constituted systems of power. Queer astrology, like feminist astrology, challenges masculinist and colonialist approaches to astronomy at their core, as it recognizes “the idea that all astrological practices, from all cultures, are equal” (Beusman 2015).

These sorts of insights in queer astrology indicate that marginalized knowledges could expand astronomy in beneficial ways by connecting the astronomical to the human. Queer feminist astrologer Chani Nicholas has noted, “My job as a human being and as an astrologer is to be questioning my own way of viewing the world and to wonder how I may not be witnessing something or need to learn more about another person’s point of view. The tool that I’m using can be a positive, reflective tool for people” (Sojwal 2017). At a queer astrology conference in San Francisco in 2013, titled “Ecosexuality: Liberating the Venus within Pluto,” queer astrologer Erica Jones epitomized the underlying goal of feminist astronomy that constitutively eludes masculinist astronomy: “I must underscore that I am not privileging the modern industrial development or any Western-flavored worldviews over others, nor am I making any claims of superlative worth or value over and above other worldviews and ways of interacting with Earth and cosmos” (Jones 2014, pp. 100–101). Similar insights, not just about stars and planets, but about humanity, gender, and culture, alien to Western scientific astronomy, are also common, for example, within the rich vein of astrology-infused literature in the American Feminist Spirituality movement (cf. Eller 1995). The natural result is that incorporating queer astrology into astronomy could lead to a more inclusive, reflective, open-minded study of astronomical bodies that disrupts hegemonic norms, broadens knowledges, and unprivileges the masculinist Baconian approach currently limiting the natural sciences like astronomy.

Blinkered and disinterested in such, astronomers today make the mistake of attempting to measure the various properties—mass, velocity, orbital period, inclination, luminosity, and so on—of astronomical objects in an attempt to understand the underlying physics, geophysics, chemistry, and

cosmology of the universe at large. By contrast, indigenous astrologies portray human relationships with the stars, planets, and other astronomical bodies and events, and thus do not see the sky in such a masculinist, objectifying, removed (pornographic) way. Feminist astronomy therefore, by means of incorporating indigenous, feminist, and queer astrologies, seeks not to replace androcentric science with gynocentric science, thus perpetuating a gendered binary, but to broaden science by making the astronomical more human, thus improving and contextualizing our human relationships with the stars. These human relationships can be equally practical as the data sets that intrigue astronomers today while also benefiting from being liberatory and healing for oppressed identities. As queer astrologer and medium Jessica Lanyadoo notes, “My queer lens allows me to sidestep a lot of conventional assumptions. Not all guys are sexual tops. Not all girls want to make babies. ... I seek to empower people to accept who and what they are, so they can make healthy and self-appropriate life choices. Astrology is an invaluable tool for doing that” (Beusman 2015).

The central and conscious request of feminist astronomy, then, is that astronomers come to recognize their efforts are biased by embedded systems of domination. Secondary and corollary to this need is for a pluralization of astronomical and astrological knowledges that constitute a more strongly objective astronomy, in the Hardingian sense (Harding 1992). All systems of knowledge are embedded, infused, and constituted by systems of power and domination. Thus all results and knowledge are subject to the marginalizing, essentializing, totalizing, and minimizing forces characterized by unjust social relations and the power discrepancies that perpetuate them. Feminist astronomy offers the insight that multiple knowledges exist behind these injustices and tropes, and each is valid within its own epistemological context as a contributor to more broad, comprehensive, diverse, inclusive, and humble astronomical knowledges.

VI. Alternative Astronomies

While some alternative astronomies to the masculinist have been discussed, potentialities are generally

most available through feminist, queer, and indigenous astrologies as well as through mythological systems. Perfectly demonstrating this point, Jyotir Vijñāna, a form of traditional Hindu Vedic Astrology, was reintroduced into the Indian education system in 2001 by the University Grants Commission and the Ministry of Human Resource Development of the Government in India because “vedic astrology is not only one of the main subjects of our traditional and classical knowledge but this is the discipline, which lets us know the events happening in human life and in universe on time scale” (Times of India 2001). This reintroduction of excluded traditional knowledge marginalized from astronomy met protests and pushback from the masculinist scientific community, leading the all-male Supreme Court of India to call the decision “a giant leap backwards, undermining whatever scientific credibility the country has achieved so far” (Times of India 2001). We see clearly, then, that in India, a former colony of the British Empire, “scientific credibility” relies entirely upon colonizing and Westernized assumptions underlying legitimacy in knowledge production. As a result, the vivid stories and alternative representations of astronomical and astrological knowledge in Jyotir Vijñāna are routinely marginalized from astronomy for the reason of failing scientific testing by masculinist standards without considering other standards (Narlikar 2013). This shows the importance of a postcolonialist perspective in understanding that alternative astronomies should be understood on their own terms, not tested and excluded—narratives, voices, and knowledges connect the astronomical to the human. Thus, they bind the unfathomably remote to the immediately present, an approach to knowledge overshadowed in masculinist Western science.

Western assumptions must be challenged and dismantled to achieve a truly inclusive science. Narratives and epistemologies that favor and privilege the natural sciences are inherently masculinist and colonialist (Harding 2009) and require critical re-evaluation that open the door to discourses from diverse local perspectives, especially those of women, queer people, indigenous people, and other people situated in marginalized communities (Israel and Sachs 2013; Mack et al. 2012). Feminist astronomy relies upon the tools of feminist political ecology to accomplish these goals by calling for

broadening the research methodologies of astronomy to include personal and folk narrative, mythology, and the many astrologies to take astronomy “beyond gender” (Harris 2015). Feminist astronomy endorses alternative astronomical knowledges like astrologies, particularly feminist, queer, and indigenous astrological systems (including Jyotir Vijñāna from India, West African Orisha Astrology, Mayan Astrology, Celtic Astrology, and Standard Thai Astrology), and it incorporates storytelling to connect these alternative knowledges with the human context in which they are situated.

As a pointed aside, the intersection of feminist studies and indigenous astrologies itself proves a particularly fruitful vein of critical feminist exploration that serves as a model upon which feminist astronomy can build. Gender roles, norms, and expectations can be directly challenged in culture through studying contemporary feminist disruptions of gender binaries, norms, and expectations embedded in astrologies, as they are in Standard Thai Astrology. Though non-Western and a rich source of alternative astronomy knowledge, Standard Thai Astrology has historically been deeply gendered, this in turn informing and perpetuating gender binaries in traditional Thai culture (Kosuta 2016). This problematic masculinism is currently being disrupted due to feminist scholarship led by feminist Thai astrologers that overturn gendered assumptions that marginalize women (e.g., that women cannot be ordained as nuns in Thai Buddhism and that having a “weak moon” makes one less of a woman in Thai culture) and are thus a model for feminist astronomy research and implementation (Kosuta 2016).

Embracing alternative knowledges, narratives, myths, and astrologies within astronomy, as feminist astronomy sees as central to its objective accomplishes many feminist and postcolonial goals at the same time. Androcentric Western science is challenged while being made more diverse, inclusive, and welcoming, especially to women, marginalized identities, and indigenous people. Dominant masculinist power structures, including masculinity itself, are disrupted in favor of human interaction, alternative knowledges, different ways of knowing, and narratives about lived experience under the stars. Baconian thinking is decentered from the natural sciences, opening a wider door to feminist, queer, and other marginalized discourses and epistemologies to establish themselves within

the core values, approaches, and results of scientific inquiry.

VII. Conclusions

Astronomical knowledge is not objective or neutral. It is profoundly gendered by reliance upon masculinist discourses, methods, and epistemologies, and colonialist in its aims, interests, and knowledges, and so its view of nature shares these constitutive biases. The feminist astronomy framework raises awareness of the patterns of domination, patriarchy, sexism, misogyny, colonialism, militarism, capitalism, and imperialism epitomizing astronomical science. Feminist astronomy challenges and disrupts entrenched and hegemonic masculinist forces and opens astronomy to a wider range of human perspectives, knowledges, discourses, and narratives including mythologies, astrologies, and artistic expressions.

The call for feminist astronomy therefore reaches far beyond the planets and the stars. It calls for a radical remaking of the galaxy of astronomical, physical, geophysical, chemical, and cosmological sciences, as well as in the natural sciences more broadly. It amplifies the feminist demand for increased presence of perspectives from humanities and the social sciences within astronomy so that the human impacts of stars and human-star-planetary relationships are not excluded. Feminist astronomy seeks to open astronomy and the masculinist natural sciences further to alternative knowledges and narratives that recognize and honor the full complexities of human relationships with one another and with the stars we all live under and gaze up upon. It seeks to disrupt binaries and undo agendas of capitalistic, militaristic, colonizing, and imperialistic domination and fetishization in the natural sciences, technology, engineering, and math and instead to cultivate a thriving human relationship with astronomical knowledge.

Most importantly, feminist astrology seeks to infuse astronomical scientific knowledge in the traditionally masculinist sense with alternative perspectives from indigenous peoples, mythologies, and the marginalized knowledges of feminist and queer astrologers. Feminist astronomy has the capacity to

remake astronomy in the liberatory project at the center of the feminist agenda and make it a tool not only for producing and sharing astronomical knowledges of all types from all cultures but also for disrupting damaging and oppressive power dynamics in scientific communities and culture more broadly. Feminist astronomy is a wiser, warmer, more inclusive astronomy.

Astronomers must recognize more-than-scientific and non-Western ways of knowing, epistemologies, narratives, and discourses about astronomical phenomena. In particular, they must recognize the human relationships all peoples have with bodies of astronomical interest and relinquish the hegemonic influence of masculinist modes of thinking in favor of a more balanced, just, objective, and inclusive feminist astronomy.

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