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Article

Domesticities and the Sciences

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Abstract: The ubiquity and yet distinctiveness of domestic sites for scientific research have attracted an unprecedented focus in recent years, especially in studies concerned with the gendering of science and the rise of citizen science movements of the late twentieth century. It is fair to say this "new" subfield has now entered a stage of maturity, even as it continues to grow and adopt new theoretical perspectives. Following an historiographical shift we might call the "domestic turn" in histories of science, "domesticities" emerges as a critical, analytical lens through which to view scientific developments in a range of historical contexts globally. The emphasis in the literature has moved from one on the "house of experiment" to one on the "laboratory of domesticity", attending particularly to the permeability, plasticity, portability, and plurality of instances of entanglement between domesticities and science. In view of the emergence of new empirical cases and theoretical perspectives, this paper revisits the status of domesticities within histories of science to consider the current status of the historiography and to suggest even further directions for new research.

Keywords: domesticities; homes; households; domestic science; private science; amateurs; women; families; gender

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1. Introduction

> In a solitary chamber, or rather cell, at the top of the house, and separated from all other apartments by a gallery and staircase, I kept my workshop of filthy creation.
>
> (Shelley 1992, p. 38)

A durable leitmotif in stories of science's past is the romantic idea that creative genius is a solitary endeavor that takes place in a dedicated site, set apart from quotidian distractions and social interactions. Mary Shelley employed this leitmotif in her iconic 1818 literary portrayal of Victor Frankenstein, a Gothic interpretation of the possibilities offered by the emerging sciences of electricity and physiology at the end of Europe's Enlightenment, and yet she faithfully reproduced the operant "habitus" of science that was at once scholarly and domestic.[1] As Gadi Algazi (2003) argued, from the sixteenth century onwards, this involved an organization of "the house of learning"—earlier defined in terms of celibacy and the masculine, communal settings of universities and monasteries (see also Noble 1992; MacDonald 1995)—in contexts involving marriage, family, and domestic concerns that required divisions of both household labor and space, but rarely secured in complete isolation from other household intrusions. Shelly's imagery represented well an idealized form of this habitus of scientific genius, making clear her contemporary understanding of that occurring in a domestic space, "at the top of the house". If such a scene was, in fact, standard for learned life, at least from the sixteenth century to Shelley's time, then why has our historiography, until recent decades, remained silent on the entanglements of science with "domesticities" (Dowling and Power 2013)? And, after the growth of a now robust literature, what can be said of the lessons we learned from a reinsertion of the *domus scientiae*, as it were, into the historiography?

In this article, I present two arguments in response to these fundamental questions for histories of science. First, a neglect of domesticities in histories of science followed from the influences of two mutually reinforcing narrative traditions about science's past: one tradition privileging public, communal forums for research and its dissemination—universities, academies, patronage systems, correspondence networks, publications, and the like; and a second tradition mythologizing exceptions in "private" realms as products of solitary geniuses at-work. It was not until sociologist Steven Shapin (1988) argued for the critical importance of accounting for knowledge making on each side of, and across, the "threshold" (p. 374) demarcating public from private that the privacy of the natural philosopher's house became an unprecedented focus of historical inquiry. This development was part and parcel of the so-called "spatial turn" in history of science (Finnegan 2008), and more specifically for my subject, it signaled a decidedly "domestic turn" (cf. Burke 2014, p. 10; Cavallo 2020, p. 455). Gradually, the field experienced an historiographical boon in domestic studies that both entered the "experimental household" (e.g., Harkness 1997) and traced the interrelationships between domestic-based and civic-placed sciences (e.g., Outram 1996; Findlen 1999). Characteristically, the new studies also attended to the gendering of space, roles, and practices.

Historians of science attending to domesticities thenceforth illuminated houses as containers full of rich practices, cells in complex networks, and "heterotopias" (Foucault 1984), where science interacted with cultures of gender performance, sexuality, education, labor, housekeeping, family life, religion, statecraft, and colonialism. Scholars also advanced new theoretical perspectives that gave domesticities potent explanatory functions, not only in analyses of particular home-based practices but also more general historical patterns—indeed, catalyzing whole new bodies of scholarship. And yet, as a second point, I contend that this new historiography beckons for further, critical examination of the historical malleability—or "plasticity" as Deborah Coen (2021, p. 331) recently suggested—of scientific domestic sites and those domesticities that infused scientific cultures, whether located in homes or other places. Put another way, I would ask: how were domesticities and science imbricated and co-constructed in historically-contextualized ways? And what sorts of products resulted from the enmeshments of domesticities and science that bore distinctive "domestic" characteristics? A few recent studies have addressed these very questions, and I highlight these works further below. Where relevant, I cite new contributions to the historiography and the innovative directions they forge for this burgeoning area of inquiry.

2. The "Domestic Turn" in Histories of Science

An image of science created in the twentieth-century context of "Large-Scale Science" (Weinberg 1961) seemed to encourage science writers and historians to look backward for the origins of this very form of "big" science. Those origins could be more readily found not in households but rather in those institutions that gave birth to the modern laboratories. In a sense, a laboratory habitus had cast a long shadow over the pre-professional past, obscuring the complexity of everyday scientific practices and their varied sites as an undifferentiated private, "amateur" tradition, and the exceptional cases described in any depth offered amusing curiosities ("moldering in an attic"), good for familiarizing "little" science to public audiences (Price 1963, p. 3), but not so good at historically explaining practices in context. A case-in-point is the nineteenth-century English gentleman-physicist, John William Strutt, third Baron Rayleigh, constructed by his biographers as a kind of emblem of the "great 'sealing-wax and string' individual researchers" (Howard 1964, p. 1100; for a fuller discussion, see Opitz 2012b). This view of amateur science was also, as Bruno Strasser and his colleagues recently argued, positioned as an historically inaccurate precedent to late-twentieth-century "citizen science": amateur-gentlemen were hardly the analogous forerunners of twentieth-century volunteer "citizen scientists", and in both contexts, private initiatives in crowdsourcing data occurred in vastly different organizational structures—the former lacking a "professional" culture (being a twentieth-century creation) that was

characteristic of the latter (Strasser et al. 2019, pp. 58–60). Historians scrutinizing networks of amateurs in past centuries emphasized their public networks, variable social identities, and class-based dynamics, as illustrated in works by David Allen (1976), Anne Secord (1994), and others. Yet meanwhile, the domestic sphere—by definition a private one according to the historical separation of spheres of life in Europe (see Perrot 1990)—attracted minor notice amid an historical mindset that associated the growth of science with public matters.[2] In sum, the historiography acknowledged domestic-based science in discussions of "little" science, but serious historical inquiry into those contexts awaited a major historiographical shift.

This came with the arrival of a "spatial turn" in the history of science (Finnegan 2008), provoked by perspectives from the sociology of scientific knowledge and the influential essay by Steven Shapin (1988) on the seventeenth-century "house of experiment" of Robert Boyle, famous for his air-pump experiments. The new place-based perspectives advanced by Shapin and others constituted one of the two major contributions to what I will refer to here as the "domestic turn" in the history of science, analogous to that in the history of medicine, as suggested by Cavallo (2020, p. 455), with the other contributing perspectives coming from gender studies of science. Interestingly, the streams of new research flowing from these two wellsprings had only occasional confluences, one being the exceptional essay on the eighteenth-century Dee household by Deborah Harkness (1997), who wedded perspectives from Shapin's work with those from women's history on households. In the realm of gender studies, the pioneering collection of essays edited by Abir-Am and Outram (1987) explicitly sought to "challenge the assumption implicit in most work in the history of science, that the personal lives of scientific practitioners are of no explanatory value for the nature of their work" (p. 2). The volume advanced a key thesis that the privatization of family life during the rise of the middle classes, and the coterminous professionalization of the sciences, resulted in the marginalization of scientific activities performed at home, precisely those by women: " ... the gender structure of modern science ... [comes] from the exclusion of the domestic realm from science, and the incidental concomitant exclusion of women" (pp. 3–4). Speaking to this thesis, the volume's essays, taken together, demonstrated the potential for comparative studies that took seriously the private sphere in relation to the more commonly-studied public sphere of science. Its authors considered sites of practice ("botany in the breakfast room"), familial and marital dynamics, and informal social institutions such as salons conducted from homes (as examples, see Shteir 1987; Ogilvie 1987; Outram 1987). The volume stimulated a trajectory of research attending to scientific couples (Pycior et al. 1996; Lykknes et al. 2012; Fölsing 1999; Berg et al. 2011) and families (Coen 2007; Bergwik 2014; Cooper 2021; Winterburn 2022).[3] Other works in the burgeoning field of gender history of science highlighted women's contributions coming from the domestic realm, for instance, Schiebinger (1989, esp. Chapter 3: "Scientific Women in the Craft Tradition"), Peterson (1989), and the special issue by Von Oertzen et al. (2013), which offered houses as one of the "surprising places" where women, typically excluded from more public realms, could be found doing science.

Whether or not explicitly concerned with the agendas of sociology of scientific knowledge and/or gender studies, literature focusing specifically on domestic sites, domestic-based practices, and households (inclusive of families and domestic laborers) ballooned in the ensuing years. Certain gaps persisted, especially in "rural areas" and an underclass of technicians, assistants, and apprentices (Kühn 2020, pp. 136–37). Even so, a few excellent studies revealed the possibilities. Simon Schaffer (1998) emphasized "pastoralism" in physics in his analysis of scientific Victorian country houses, setting individual cases such as Lord Rayleigh in a much broader, shared cultural context that was both agrarian and hierarchical. de Chadarevian (1996) extended the idea of a distinctive "country house science" approach in biology to argue for competing English and German styles of experimental study during the rise of academic laboratories in the late nineteenth century. Granular studies of the laborers involved in domestic and domesticated settings have also signaled the potential for this focus, though the emphasis has been on male assistants (Gay 1996, 2008,

pp. 61–63; Johnston 2021). Several historians questioned the fate of domestic (and amateur) practices amid the so-called "professionalization" of the sciences in the late-nineteenth century, my own works specifically arguing for the persistence of a domestic model of research, even amid change, into the twentieth century (Opitz 2006, 2011). Historians attending to the gendering of domestic-based sites and practices have added a wealth of studies illuminating patterns in a range of technosciences from the early modern period onwards. A sampling of the studies show the range of disciplines addressed: natural history and biology (Opitz 2004; Richmond 2006; Ekerholm 2015; Tonn 2018; Coen 2021; Hünniger 2021; Hutcheson 2022); anatomy and medicine (Hunter 1997; Guerrini 2016; Cavallo 2020); horticulture and related crafts (Secord 2007; Shteir 2007; Hickman 2014; Rabe 2016; Hannan 2018; LaBouff 2021; Serrano 2022); the physical sciences (Iliffe and Willmoth 1997; Opitz 2012b; Werrett 2019, esp. Chapter 2; Winterburn 2022; Bernardi 2022); and meteorology (Naylor 2019).[4]

Many of these works adopted perspectives that placed domestic and domesticated sites of research within networks that included other types of institutions, emphasizing the reality that home-based practices did not thrive in isolation from the rest of scientific society. Such a perspective has been explicit in the works of Terrall (1995), Outram (1996), Findlen (1999), and others. With a view on the fuller home environment, many have also emphasized the value of companionate labor in household management, home education systems, and various forms of "care" work for the production of knowledge (see Lindsay 1998; Coen 2014; Kohlstedt 2012). White's (1996) study of Thomas and Henrietta Huxley focused on this very theme.

3. What Have We Learned?

Signaling this field's maturity, there are now several surveys of the literature, and many of the introductions to individual studies also offer short refrains of the past research, particularly germane to their topics. Cooper's (2006) pioneering survey focused on the early modern period, and this may be complemented by my own review that extended the chronology into the twentieth century and offered an updated accounting of the newer works (Opitz 2016). Coen's (2014) review, appearing around the same time, emphasized the theme of "domestic intimacy" amid scientific families, primarily in Europe. Kühn (2020) summarized the key historiographical influences coming from the sociological and gender studies literature and, with a renewed analysis of the eighteenth-century Kirch household, illustrated several prominent themes—especially those concerning social hierarchies and dynamics—present both in the Kirch case and the more general historiography. Werrett (2020) recently offered a brief overview that also returned to the early modern period, emphasizing themes of economy and materiality in domestic experimental practices. These various overviews are uneven in surveying the "familial" dimension of the historiography, despite citations to relevant studies or mentions of new research; this includes our introduction to *Domesticity in the Making of Modern Science* (Opitz et al. 2016) and now this current essay. A dedicated, comprehensive review of the historiography on "scientific families" awaits to be written.

Taking stock of the robust literature on domesticities in histories of science, we can identify a few major take-aways. First, the rich array of studies has demonstrated that virtually every form of science imaginable has had a domestic life or was influenced by its imbrication with domestic life. The analyses of particular cases have trended in the direction of destabilizing the scientific home as a fixed entity existing in a permanent place, emphasizing instead the mobility of domestic forms of practice, whether in reproductions of domesticity during expeditions, at field stations, in colonial settlements (e.g., Pang 1996; Tonn 2018; Albuquerque and Martins 2018), or in extensions of European "domestic science" in imperial, civilizing agendas (e.g., Hancock 2001).[5] The historiography has gradually shifted from an emphasis on the "house of experiment" to something akin to the "laboratory of domesticity", to borrow Jenna Tonn's (2018) phrase: the construction of a "temporary scientific household" at field stations such as one in Bermuda that "structured knowledge

production in biology and contributed to other forms of labor, including identity formation, marriage and family life, and social critique", and "where biologists experimented with new ideas and practices related to science, gender, and race" (p. 232). More recently, Coen (2021) has added a multi-species perspective to scientific households, extending what cultural geographers earlier observed more generally about domesticities involving the presence of non-human species, including pests, pets, and plants, in human-occupied domiciles (Dowling and Power 2013, p. 298). These points impress the idea of scientific houses and households as more dynamic, malleable, and perhaps even ephemeral than our histories have previously suggested, aligning with an approach emphasizing the "co-construction" of domesticity and science within particular historical and geographical contexts (Morris and Endfield 2016).

This shift toward a more dynamic and complex conceptualization of domesticities yielded a second major lesson: domestic sites were (and are) incredibly variable. Architectural designs were driven by matters of domesticity, science, and civic concerns (Hannaway 1986), and those designs shifted depending on location in town or country, the activities to be housed, and the social makeup of the occupants. Domestic sites could be private residences separate and remote from other scientific institutions or indeed built into complexes that also housed laboratories, libraries, museums, and lecture halls. The Nobel Institute for Physical Chemistry in Stockholm, Sweden, offers a case in point, analyzed in depth by Bergwik (2014). The compartmentalization of domestic space also involved variations; rooms and other spaces could be single- or multi-purposed. Such nuancing of domestic space is clear in recent histories of science that have paid attention to social and cultural histories of the home and household, and Simon Werrett's *Thrifty* Science (2019) may be cited as exemplary in this regard.

But what of the forms of knowledge? de Chadarevian (1996) pioneered the suggestion that different experimental methods between home-based and university-based sites of research could be distinguished and therefore influential for the outcomes of scientific debates and standards of credibility. Historians troubling the laboratory revolution similarly compared amateur and field-based practices alongside those of the new "professional", laboratory-based methods (Nyhart 1996; Allen 1998). Yet the question remained whether distinctive forms of knowledge arose from the nexus of science and home, resulting in an intertwinement distinguishable from knowledge produced elsewhere. Paul White (2016) argued for an evolutionary science of domesticity that Darwin carried out by making observations of his family at home and then reported in *The Descent of Man* (Darwin 1871). Meanwhile, domestic advice writers such as Catharine Beecher proposed models of domesticity that drew on the concepts of contemporary physiology (Parry 2021; see also Hamlin 2014). Recent studies emphasizing the enmeshments of the "sociomaterial" in domestic contexts have added a decidedly material dimension to our conceptualizations of domestic-based sciences (Bittel et al. 2019, p. 2). Guerrini (2016), Leong (2018), Hannan (2018), and again Werrett (2019) demonstrated the possibilities of distinctive knowledge created precisely through the application of home-based utensils, practices, and social scripts, forming what Leong suggested as "'household science'—that is, quotidian home-based investigation of the natural world" (p. 4). These perspectives added to an earlier historiography emphasizing forms of "familiar science" that science writers and pedagogues tailored specifically for the domestic context and family engagement but generally considered as branches of popular science or home-based educational movements (Secord 1985; Gee 1989; Myers 1989; Shteir 1996; Keene 2014).

4. Questions for Future Studies

Taken together, the trends in the historiography—only a few highlighted here—encourage a view of "household science" that is permeable, plastic, portable, and pluralistically inhabited ("multi-species").[6] Taking cues from cultural geographers and historians, our histories of domestic-based science are historicizing and troubling (if not altogether dissolving) binary frameworks such as the public/private, professional/amateur, pro-

ductive/reproductive, and indeed cultural/natural. Instead, historians of science are increasingly approaching domesticities "not in terms of dualism but in terms of interstices" (Dowling and Power 2013, p. 294). A scene as depicted in Figure 1 invites such interpretations. To stimulate our imagination of future directions, I pose the following set of questions: What is the effect of variations among scientific households when we "queer" their social compositions?[7] What can we learn by building into our historiographies more global, decolonial, and postcolonial studies, particularly of non-European and Indigenous co-constructions of domesticities and knowledges and their interactions with European and settler forms? How would our conceptions of domestic scientific knowledges be enriched by more fully attending to the moral and spiritual dimensions through our methodologies, whether principally "spatial", "sociomaterial", "co-constructionist", or otherwise?[8] To what extent have we contextualized the very phenomenon of "household science" amid the broader ecologies of scientific knowledge making, or alternatively, have we yet put *household* "science in its place" (Livingstone 2003)?

Figure 1. Frontispiece in Friedrich Christian Lesser, *Insecto-Theologia*, third expanded edition (Leipzig: Groß, 1758), Universitätsbibliothek Erlangen-Nürnberg, H61/TREW.Hx 718, online: https://nbn-resolving.org/urn:nbn:de:bvb:29-bv009185335-9 (accessed 18 July 2022). Public Domain Mark 1.0.

In sum, I invite us to critically rethink the cultural statuses of domesticities, scientific knowledges, and their interrelationships in a variety of geographical and transnational contexts globally. Throughout the imperial, colonial, and postcolonial systems that gave rise to and, in turn, were bolstered by modern Western sciences, household knowledge economies relied on infrastructures of labor premised on a range of gender-, class-, and race-based hierarchies. Slaveholding households, as so poignantly highlighted by Deidre Cooper Owens (2022), sustained forms of "haptic intelligence" as exercised by white medical men who—under scientific and legal authority—experimented on the bodies of Black enslaved women, ostensibly in advancing the field of gynecology.[9] So, too, could Western scientific domesticity serve as a "barometer of civilization" in campaigns carried out by white settler women to assimilate North American Indigenous peoples, as analyzed by Jane Simonsen (2006, p. 72), suggesting a rather oppressive side to "household science" that, despite benevolent, progressive rhetoric, disrupted homes and household forms judged to retard evolutionary progress. Such examples as these beckon for reassessments of domesticities in relationship to the sciences to more fully illuminate the historical contingencies, cultural variabilities, and power dynamics that should remind us of how "the home is a contested zone" (Smith 1993)—particularly so as sites of knowledge making.

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Notes

1 On domesticity in the Gothic novel, see Ellis (1989); on women's literary images of science leading up to Shelley, see Hutton (2011). Drawing on Bourdieu (1980), Algazi (2003) defined *habitus* as "a structure of acquired, durable dispositions underlying particular practices" (p. 13, n. 10). For more on Bourdieu in relation to histories of science, see Tampakis (2016).

2 Kühn (2020, p. 136) also aptly notes that the "so-called Zilsel thesis" provoked relevant studies on artisans, but as Cooper (2006, p. 224) pointed out, this did not always translate to a focus on domestic sites: "Few historians of science have paid attention to these kinds of 'private' spaces".

3 See also Opitz et al. (2016), section on "Familial Science: Sustaining Knowledge across Generations and Distances".

4 This sampling is by no means exhaustive. Further examples appear in Opitz et al. (2016) and Bittel et al. (2019), and for citizen science examples, Strasser et al. (2019).

5 This brings to mind also the field of "domestic science" (or, "domestic economy", "household science", "home economics", and later, "family social science" and its variations) that is the focus of an expansive literature, particularly as its scope has progressively included horticulture and small-scale agriculture. Especially for British and North American contexts, historians have dealt with debates over the subject's value in the science education of girls and women (Dyhouse 1977; Manthorpe 1986), its role in imperialism (Carter 2016), and its changing status in the twentieth century (Rossiter 1980; Stage and Vincenti 1997; Goldstein 2012; Nickols and Kay 2015). The historiography in this area is quite extensive, beckoning for its own survey; the literature tends to cluster around geographical locations, disciplinary emphases, and historical approaches. Closely related is the rise of domestic technologies and their impacts on gendered experiences (Cowan 1983; Bray 2008; Gooday 2008). For a disability studies perspective, see Virdi (2020).

6 For studies focusing on visiting practices at scientific homes which illustrate the idea of permeability, see, e.g., Carroll (2004) and Bernardi (2022).

7 With an emphasis on "homosexual couples", I analyzed the domestic environments of Edward Carpenter's several queer households (Opitz 2012a), and there I also cited earlier studies of other queer scientific households. Scholars in other fields have paid more attention to queer domesticities (Gorman-Murray 2006; Cook 2014; Vider 2021), but their relevance for constructions of scientific knowledge still remains relatively unexplored.

[8] I am thinking here of actors' experiences and performances of domestic-based moralities and spiritualities and how those commingled with their constructions of domestic-based scientific knowledges. To some degree, the sociologically informed analyses of home-based experimental philosophies of the early modern period address the moral question in relation to knowledge construction, but much more can be done to account for spiritualities' interplays with domestic practices. For my contribution to this approach, see Opitz (2006). Werrett (2019) accounts for the role of spiritual principles and values in habits of experimental economy. For an approach concerned with gardens that is suggestive for houses as well, see Cunningham (1996).

[9] A robust literature may be cited on this point, which also extends to violations of Black enslaved men's bodies; see, particularly, Fett (2002) and Foster (2019). I thank one of the anonymous reviewers for the recommendation to bring out more explicitly the "oppressive" side to "household science".

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