

Letters, Gender and Mathematics: a feminist genealogical approach

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Abstract: In this paper, I follow trails of the auto/biographical turn in the field of gender and science, particularly focusing on women mathematicians' epistolary narratives. The paper emerges from a wider Leverhulme funded project of writing a feminist genealogy of «automathographies», tracing women mathematicians' historical emergence as subjects of scientific knowledge, as well as creators of philosophy and culture. What I argue is that letters are important auto/biographical documents in illuminating women's epistemological and intellectual involvement in the making of scientific knowledge, which included the development of mathematical sciences, but was also expanded in the wider cultural formations of the European modernity. In doing so, I deploy the notion of «epistolary sensibility» as a methodological and epistemological approach to archival research with women mathematicians' letters.

Key words: archives; automathographies; epistolary sensibility; women mathematicians.

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I am not surprised at your eagerness to renew conversations that cannot be found elsewhere than in Paris, all the doors are open to you. As I am not allowed to go to any sessions, I find myself almost as foreign to the movement of sciences as if I lived in another country. And yet, I prefer to be here even more than elsewhere because sometimes it happens to me to find by chance an opportunity to instruct myself [...] You would perhaps not believe that being in the middle of Paris I cannot succeed in seeing Monsieur Savart, who has made a thousand interesting experiments: he shows them to people who can make no use of them. These facts are in my domain and mine alone, but they stay hidden. Here is the privilege of the ladies: they obtain compliments and no real advantages¹.

¹ Sophie Germaine to Guglielmo Libri, letter dated 15 September 1826 (in Del Centina 2005, 66).

Writing from Paris on September 15, 1826, to her friend and fellow mathematician Guglielmo Libri, Sophie Germain² boldly expressed her frustration for being marginalised in the Parisian scientific circles, even though she had received the French Academy prize for her research on elasticity in 1816. Her experience was neither unusual, nor unique in the history of women's position in mathematics, but her letters open up vistas in understanding how women mathematicians' epistolary practices chart existential and relational experiences but were also entangled in processes of knowledge production and dissemination in science, philosophy and literature in the long durée of the eighteenth and nineteenth centuries.

In this paper, I follow trails of the auto/biographical turn in the field of gender and science, particularly focusing on women mathematicians' epistolary narratives and practices. The paper emerges from a wider Leverhulme funded project of writing a feminist genealogy of «automathographies», tracing women mathematicians' historical emergence as subjects of scientific knowledge, as well as creators of philosophy and culture³. What I argue is that letters are important auto/biographical documents at throwing light on women's epistemological and intellectual involvement in the making of scientific knowledge, which included the development of mathematical sciences, but was also expanded to the wider cultural formations of modernity. Madeleine Schurch has observed that although women's epistolary writing has been the focus of several studies, its contribution to the production of scientific knowledge has not been adequately explored (2019, 30). It is this gap in the literature that this paper is addressing, by contributing to a wider field acknowledging the diversity of women's letter-writing practices, while also mapping new paths in the area of mathematical correspondences from a gender perspective.

The paper unfolds in four parts: after this introduction, I look at the auto/biographical turn in the history of sciences, particularly focussing on Paul Halmos' influential notion of automathographies, as a trail in the genealogical excavation of women mathematicians' epistolary narratives. Then I present and deploy the notion of «epistolary sensibility» as a methodological and epistemological approach to women mathematicians' letters. By way of conclusion, I situate epistolary analysis within the archive and its troubled gendered histories.

1. On automathographies: genealogical trails in the auto/biographical turn in science

«It may be difficult for those removed from the mores of the scientific community to understand the enormous reticence with which anyone, especially a woman, would make public his or her personal impressions and experiences, particularly if they

² Sophie Germain (1776-1831) was a French mathematician and philosopher and she is known for her work in number theory and her correspondence with Gauss in this field. Although she did not receive any formal education, she was awarded an honorary degree by the university of Göttingen, six years after her death in recognition of her contribution to the mathematical sciences. You can follow the website of the project <https://sites.google.com/view/numbersandnarratives/a-feminist-genealogy-of-automathographies/sophie-germain>

³ For more details about this project, see <https://sites.google.com/view/numbersandnarratives/a-feminist-genealogy-of-automathographies>

reflect negatively on the community» Evelyn Fox Keller wrote drawing on her own auto/biographical experiences. (1977, 90) In its multiple genres, auto/biographical writing violates the rules of disinterest and objectivity, which have been at the core of long held discourses revolving around science and the figure of the scientist. If the latter also happens to be a woman the challenges become even greater, Keller has further commented (90), pointing to the by now recognised argument that «gender shapes the culture of science, just as it shapes any other culture» (Govoni, 2014, 14).

In the wake of «the narrative turns» (Hyvärinen, 2010) however, auto/biographical approaches have emerged and developed in the wider field of science studies, as epistemological modalities of understanding not only the lives of scientists, but also the conditions of possibility for the emergence of scientific problems, concepts, findings and solutions⁴. More than illuminating the histories of science, scientific auto/biographies shed light on the social studies of science, including the moral and political economies of knowledge production and exchange (see Mazzotti, 2014).

But here it has to be noted that the narrative turn in the history of science was not taken easily. As Georgina Ferry has noted, «for historians of science, biography was a troubled and troubling genre, rather than simply a good way to raise the profile of forgotten scientists and to make their science accessible to a general readership» (2014, 59). Moreover, Paola Govoni has discussed dangerous liaisons between biographies and feminism, as underpinning the low epistemic status of the biographical approach to the histories of science, As she has critically observed: «strong arguments against biography are to be sought in the “female” character, which I suspect, is often tacitly attached to biography» (Govoni, 2000, 403). Finally, in the long history of the auto/biographical genre, that goes back to antiquity⁵, there has always been a tension between a focus on heroic scientists and the image of the progress of human reason, framing and indeed constructing the persona of the scientist, as Massimo Mazzotti has pointed out (2014, 119). In his view, the biographical approach to science, has not yet found a recognizable place, either in the discursive spaces of social and cultural histories, or in «the new images of science that came to dominate the intellectual landscape of the mid-twentieth century» (120). Although scientific biography remained in the margins, its role has significantly changed in the last decades of the twentieth century, following Thomas Hankins' pathbreaking defence of biography in the history of science (1979).

The narrative turn in science has now been taken and includes a wide range of genres «from textual analysis to the in-depth survey of field and laboratory work, from contextual reconstruction to subtle debate over historiography», Govoni has observed (2014, 8). Despite this proliferation however, mathematics has been marked as a «devilishly difficult» field for biographical approaches. As Hankins has commented «mathematics seems to have a life unto itself» and while «physical theories reflect

⁴ For a comprehensive review of this body of literature, see Govoni 2014. In this study, Govoni has been using Liz Stanley's (1992) pathbreaking notion of auto/biography to denote the blurring boundaries between autobiography and biography.

⁵ Diogenes Laertius' *Lives and Opinions of Eminent Philosophers*, was compiled sometime early in the 3rd century. See Warren 2007, for a recent discussion of this work.

a world view that has a cultural context [...] mathematics reflects nothing but itself» (1979, 12). In the light of such difficulties regarding auto/biographical approaches to mathematical sciences, I now turn to Paul Halmos' influential intervention in the field.

«I like words more than numbers and I always did» (1985, 3), Halmos wrote in the very first pages of his «automathography, a mathematical biography written by its subject» (3). In Halmos' view, an automathography should not be conflated with an autobiography, «the story of my origins and my life» (3). But is there such a divide or separation possible? Throughout his book Halmos refers to childhood memories, desires, relations with significant others, impressions of places and spaces, as well as political and cultural events that shaped his desire to become a mathematician. Books and languages play a significant part in his automathography: «I read a lot, write a lot, and love languages—and I suppose at bottom it all comes down to liking words» (8) he has emphatically written, highlighting the importance of culture in his automathography. As George Sarton has importantly argued, «the history of mathematics should really be the kernel of the history of culture» (1936, 4).

Halmos is adamant that to become a mathematician, «you must love mathematics more than anything else» (1985, 400). Pure love is not enough of course, «you must work at it hard and without stop, and you must never give up», he has further noted. (400) And yet when it comes to the hierarchy of existential needs, desires and strives, the love of mathematics comes first:

'I am not saying that the love of mathematics is more important than the love of other things. What I am saying is that to the extent that one's loves can be ordered, the greatest love of a mathematician (the way I would like to use the term) is mathematics' (401).

Halmos' automathography is written from the perspective of a male mathematician who followed the networks and opportunities available to his gender in the long run of the twentieth century. This does not mean that he did not face the prejudices of being a Jewish immigrant and of carrying his Hungarian accent, despite the fact that he was educated in the USA: «Then there was the accent. I was a foreigner, with or without pejorative adjectives, I felt like one, and I sounded like one», Halmos has poignantly noted (1985, 15). And yet, while reading his automathography I often wondered how different things would be for a woman becoming a mathematician in the same period. In Chapter Six of his automathography, Halmos fondly remembers the Institute for Advanced Studies at Princeton University, where he became of age as a mathematician:

The Institute was a small, cozy operation when I arrived in Princeton in 1939. The center of the life of all the mathematicians in Princeton, both University and Institute, was Fine Hall (the old Fine Hall), which is still my Platonic ideal of a mathematics building. Dark corridors, leaded windows, heavy furniture, worn carpets; the common room always open, always in use; the library up to date, complete, run with an iron hand by Bunny Shields, tiny, white haired, probably born looking as if she were in her late 50's, severe, but always helpful. (1985, 84)

Halmos has written that he would «virtually lived in the common room», where «early morning or the middle of the night, there was always someone there, and some conversation about mathematics, the war, the quirks of the big shots, or the best nearby restaurant for oyster stew was always going on». (85) There were no such opportunities for knowledge and networking for women mathematicians, since Princeton only admitted women in its graduate courses in mathematics in the late 1960s. (see Schafer 1987, x). Even when women were admitted, they would not always feel welcome and at home. As Alice Shafer has poignantly commented, «at Harvard University, some professors refused to allow women to sit in their classrooms. They were however allowed, to sit in chairs placed just outside the classroom doors, so that they could hear the lectures» (x).

Despite such harsh gendered restrictions, which went on beyond the middle of the twentieth century, the love that Halmos has written about, seems to surpass gender, time and geographical boundaries. In her long engagement with Sofia Kovalevskaya's⁶ life and work, Russian mathematician Pelageva Kochina has chosen «Love and Mathematics» as an encapsulating title for the scientific biography of the first woman to hold a chair in mathematics in modern Europe (Kochina 1985). Love is indeed amongst an array of intense feelings that have arisen from women' auto/biographical writings in the long process of engaging with mathematics, science and philosophy (see Tamboukou, 2023). In addressing such feelings and existential quests, in the long process of becoming a woman mathematician in the early modern period, I have thus configured the plane of my research in the intersection or rather entanglement of mathematics with philosophy, literature, poetry, but also social activism (see Tamboukou, 2022). In gendering Halmos' notion of automathographies', what I argue is that working auto/biographically with women mathematicians is a way of better understanding not only the gendered micro histories of the discipline, but also and perhaps more importantly the slow process of the long way to gender equality, which is still unfolding in our days. In this light automathographies become an important tool in what drawing on Michel Foucault (1986), I configure as «counter-memory studies» — a turn to the past as a way of reconfiguring the present and prefiguring the future of women in mathematics.

Over the years my scholarship, research and publications have revolved around the project of writing genealogies of women's constitution as modern subjects in the areas of education, art, work and more recently forced displacement. I have written extensively about genealogy as a theoretical lens, as well as a methodological approach in socio-cultural analyses of gendered subjectivities (see Tamboukou, 2003). As a theoretical and methodological approach, genealogy in Foucault's philosophical work (1986) investigates the processes, procedures and apparatuses,

⁶ Sofia Vasilyevna Kovalevskaya (1850-1891) was a mathematician and writer who made a valuable contribution to the theory of partial differential equations. She was the first woman in modern Europe to gain a doctorate in mathematics, the first to join the editorial board of a scientific journal, and the first to be appointed professor of mathematics. The French Academy of Sciences awarded her the Prix Bordin in 1888. She also wrote autobiographical pieces, a novel, numerous other literary works, political and social essays, as well as theatrical plays. You can follow the website of the project *Number and Narratives* for more details: <https://sites.google.com/view/numbersandnarratives/a-feminist-genealogy-of-automathographies/sofia-kovalevskaya>

whereby truth and knowledge are produced. Genealogy writes the history of the present: it problematizes the multiple, complex and non-linear configurations of the socio-political and cultural formations of modernity. In the context of a feminist genealogy of automathographies: what were the conditions of possibility for women to be excluded from the world of mathematical sciences, how were they historically constituted as subjects of scientific knowledge and why are they still in the margins of this discipline as students, teachers and/or researchers?

Genealogy as a method of analysis looks into the archive to excavate forgotten stories and documents, which might throw light in the practices and discourses that have excluded and marginalized women from the field of mathematical sciences. But instead of seeing history as a continuous development of an ideal schema, genealogy searches in the maze of dispersed events to trace discontinuities, but also unexpected continuities. Women's ambivalent position in the world of mathematical sciences is a paradigmatic case of uneven historical developments, particularly if we consider that Laura Bassi was the first woman to hold a Chair in Physics in 1732 and it then took more than 150 years for Sofia Kovalevskaya to be appointed Professor of Mathematics at Stockholm University in 1889 (see Tamboukou, 2024). What happened in-between and why women positions in mathematics is still at a sore state in the twenty-first century? Letters as important «documents of life» (Plummer 2000) are crucial in the pursuit of such questions, as I will further discuss in the next section.

2. To the letter

Scientific correspondence was central in processes of knowledge production and dissemination in the eighteenth and nineteenth centuries⁷. As Schurch has aptly observed, the *Philosophical Transactions*, the first peer-reviewed journal, of the Royal Society was largely based on epistolary exchanges between scientists and the editor: «Natural philosophers would address observations and experimental reports to the secretary of the Royal Society, Henry Oldenburg (1619-1677), which he would then publish often verbatim» (2019, 37). Robert Simpson (1687-1768) was the first of the modern mathematicians to engage with the nature of Euclid's Porisms and it was in the *Philosophical Transactions* that he published a paper on this subject in 1723. Throughout his life, Simpson held and maintained an extensive correspondence with many distinguished mathematicians of his time, but only a very small part of it is extant⁸. What is also important to note is the several critical editions of mathematical correspondences that were published in the nineteenth century. According to Maria Teresa Borgato and Irène Passeron, this was «the most prolific period for collected works» to appear (see Borgato and Passeron 2018, vii),

⁷ See amongst others, the Darwin letters project on the importance of letters in Darwin's scientific work, <https://www.darwinproject.ac.uk/> [Accessed 24 July 2022]

⁸ His correspondence with Mathew Stewart (1717-1787) a professor of mathematics at the University of Edinburgh and James Stirling (1692-1770) a mathematician, who was a Fellow of the Royal Society, was a topic of discussion in the Edinburgh Mathematical Society, as early as in 1902. (see McKay 1903)

although the trend went on in the twentieth century and has now reached the days of the digital revolution, with important major editorial projects still being in the making⁹.

Mapping the contemporary field of mathematical correspondences, as well as their critical editions, Borgato and Passeron have argued that letter writing continues to be important in the spreading of scientific ideas 'even in times of a great number of specialized journals (2018, vii). Moreover, mathematical correspondences display a great variety of topics beyond the remit of mathematical sciences, including «letters between mathematicians and from mathematicians to politicians, publishers, and men and women of culture» (vii). Finally, it is not only the letters of famous mathematicians that are of interest in the history of mathematics; contributions from lesser known mathematicians become a component of a wider assemblage «in the reconstruction of biographies, as well as the genesis of scientific ideas, in analyzing relations and debates and, ultimately, in the correct dating and interpretation of various memoirs» (vii). Overall, the on-going digitization of mathematical works and correspondences «is of major interest in the field of the history of mathematics» (viii).

In the context of epistolary worlds and the digital turn in archival research (see Moore et al., 2016), letters have become particularly important at throwing light in women's engagement with science in the eighteenth and nineteenth centuries and there is an increasing interest in scientific correspondences through a gendered lens¹⁰. Women have often studied mathematics in domestic settings, given their exclusion from universities and other formal scientific societies and institutions up until the turn of the nineteenth century. Moreover, cultural historians have been interested in women's epistemological and intellectual involvement in the making of scientific knowledge, which included the development of mathematical sciences, but was also expanded in the wider cultural formations of modernity. As Schurch has persuasively argued, «the methods of scientific pursuit, literary creativity and cultural productivity were enmeshed and could, at moments, elide with each other» (2019, 18-19).

In thus looking at the letters that women mathematicians wrote, I trace ways in which women's epistolary writing, contributed to knowledge and research in mathematical sciences, but also reveal the minutiae of their constitution as subjects in science. In doing so I am interested in how the literary structures, persistent patterns, as well as formal characteristics of the letter, what Janet Altman (1982) has theorised as «epistolary», are entangled in cultural assemblages in mathematics. Here, the notion of the assemblage is taken from Deleuze and Guattari's philosophical vocabulary (1988) as a configuration denoting the complexity of discursive and non-discursive components and formations in the constitution of knowledge, culture, as well as gendered subjectivities in mathematics.

Altman deployed «epistolary» as a frame for reading, arguing that the stylistic properties of the letter «significantly influence the way meaning is consciously and

⁹ See amongst others: Newton's correspondence in the Newton Project: <https://www.newtonproject.ox.ac.uk/texts/correspondence/all> ; the Leibniz Correspondents and Acquaintances project (LCA), <https://www.leibnitiana.eu/> ; The Correspondence of the mathematician Bernoulli project: <https://tcdh.uni-trier.de/en/projekt/correspondence-mathematician-bernoulli>

¹⁰ See George 2011 and Schurch 2019 for an overview of the literature.

unconsciously constructed by writers and readers of epistolary works». (4) Detaching «epistolary» from the letter form itself, Schurch has meticulously studied its influence «on textual, cultural and epistemological productions» (21) in the eighteenth-century scientific scene. Schurch has focused on how epistolary qualities blend with other forms of writing in the creative process of knowledge production and dissemination. In this light, epistolary is «a mobile concept» in Schurch's analysis that focuses on the creative qualities of the form, without necessarily turning it into a genre. It thus becomes an analytical tool, «a way of examining the creativity and functionality of letters and other types of text» (23) that present epistolary qualities, such as «direct address, the exchange of loose sheets of paper, and the text as a site of experiential expression» (9).

In deploying epistolary as a way of reading, understanding and analysing women mathematicians' letters in their interrelation with other auto/biographical documents, I have thus configured the notion of «epistolary sensibility» (Tamboukou, 2020) as a methodological move that goes against the dominant trend of using letters as mere «sources» or «data» in socio-historical research and analysis. While recognizing the evidentiary value of letters, the analysis is deeply engaged with pertinent ontological, epistemological and ethical questions revolving around what it is exactly that we do when using letters and correspondences to derive meaning about subjects, their lived experiences, their relation to the world and others, as well as their entanglement in processes of knowledge production and circulation. How is this «epistolary sensibility» to be configured? Drawing on my work with women's letters in different social, cultural and historical contexts, I have made a cartography of epistolary sensibility that includes amongst other practices, a striving for understandings that are driven by the letters and collections under investigation, considering the content, form and context of letters and analysing them in their interrelation.

On this plane of analysis, letters are analysed as important auto/biographical documents and not as mere illustrations, or as captions of images and other visual artefacts. Since letters are always, already dialogic, there is a particular analytical interest in the I/you/we epistolary relation and on how this relation shapes the emergence, development and dissemination of mathematical knowledge. Epistolary exchanges usually imply distance and therefore linguistic, cultural and in the case of women mathematicians' correspondence, gender differences. The problematics of language and translation therefore become central in the search for meaning and understanding, particularly if we consider that the majority of eighteenth and nineteenth century women mathematicians' philosophical and literary writings, as well as their letters, autobiographies, journals and diaries have not been translated in English.

In the light of the epistolary sensibility, as briefly configured above, the letters women mathematicians wrote either to fellow mathematicians, teachers, doctoral supervisors and even lovers, family members and friends carry traces of complex entanglements between science, culture and affects in their dynamic «intra-actions». Here again, the notion of intra-actions comes from Karen Barad (2007), a feminist philosopher and atomic scientist who has coined the term as a theoretical juxtaposition to the usual notion of «interactions». The significant difference lies in the fact that

while interactions occur between already established and separate entities, intra-actions emerge as relations between components. Entities, such as mathematics, culture, epistolary practices, and/or knowledge formations actually emerge as an effect of intra-actions between minor components, such as the materiality of writing, the darkness of a corridor, the subdued atmosphere of the library, a chat in the common room, or a walk in the country.

In the light of dynamic «intra-actions», as discussed above, Andrea del Centina and Alessandra Fiocca have noted that Sophie Germain's letters «have a twofold importance, as they provide a better understanding of not only her scientific interests and mathematical achievements, but also her personality and life» (2018, 147). Women used mathematical correspondence to question, challenge, and position themselves with regards to forms of mathematical knowledge. In this way they imagined and indeed constituted themselves as mathematicians in the scientific networks and communities of their time, but the epistolary boundaries between «the private» and «the public» were always open and fluid.

Emilie du Châtelet¹¹ in the company of Voltaire created a scientific abode in the chateau of Cirey, where they spent many months «Newtonizing» -as they called their discussions of Newton's theories- reading, thinking, writing and conducting experiments, while at the same time inviting friends and organizing a range of social activities, including dinner parties, philosophical discussions over coffee, theatrical performances, masquerades, opera singing and card games (see Zinsser, 2006). Writing from Cirey to the famous mathematician Pierre Louis Moreau de Maupertuis, who was also her tutor in Paris, du Châtelet paints the way philosophy, culture and mathematics were entangled in her lived experiences, in a letter dated, December 1, 1736:

We have used your absence to render the people who inhabit Cirey worthy of you, for one does not lose hope of seeing you here one day. We have become real philosophers. The companion of my solitude has written an introduction to the philosophy of M. Newton, which he has dedicated to me and the frontispiece of which I send you. I believe that you will find the verses worthy of the philosopher of whom they speak, and of the poet who made them. You will find this almost printed on your return. If you had been in this part of the world, one would have asked for your advice. You have for a very long time wanted to make a philosopher of the first of our poets and you have succeeded, for your advice contributed to his determination to give himself up to his thirst for knowledge. As for me, you know more or less the dose of physics and mathematics I can take. I enjoy a great advantage over the greatest philosophers: that of having had you as my master. I am yet more proud, if possible, to see that you have not forgotten me (in Kölving and Brown 2018, vol.1, 235).

¹¹ Émilie Du Châtelet (1706-1749) was a French natural philosopher and mathematician, but also translator of influential works, most importantly of Newton's *Principia*. Her magnum opus, *Institutions de Physique*, first published in 1740, was circulated widely, generated heated debates, and was republished and translated into several other languages. You can follow the website of the project *Number and Narratives* for more details: <https://sites.google.com/view/numbersandnarratives/a-feminist-genealogy-of-automathographies/emilie-du-chatelet>

Such social gatherings at Cirey offer an exemplary case of Gillian Russell's concept of «domiciliary sociability», a plane encompassing the private and the public, as a way of intervening in the cultural and political formations of modernity (Russell, 2007, 11), which also incorporated the production of scientific knowledge. In this light, women mathematicians through their letters -mostly written in domestic settings- were opening spaces of «domiciliary» scientific sociability, either by inviting friends or exchanging ideas that had emerged in the space of their gatherings. Germain first met the Italian mathematician Guglielmo Libri in Paris in 1825, at one of the parties that the astronomer François Arago used to hold at the Observatory every Thursday evening. The two mathematicians became friends, Germain invited Libri to her home for lunch, and they began a correspondence that went on through the end of her life. This correspondence has been important in the appreciation of Germain's contributions to mathematical sciences, but it is also revealing of her personal life and philosophical thought, as already noted above (see Del Centina, 2005).

Here however, we have to note that «domiciliary sociability» was not always welcomed by women mathematicians. Maria Gaetana Agnesi¹², got quite tired by the soirées her father was organising in their Palacio in Milan to display his daughter's extraordinary abilities in philosophical and scientific debates, and thus transform her knowledge into spectacle «for educated travellers passing through Italy from northern Europe» (Cavazza 2014, 74). Although these gatherings, which were part of the overall «culture of scientific spectacle¹³», made Agnesi famous in eighteenth century Europe, they actually intervened and disrupted her desire of working with mathematics in isolation and tranquillity, her own way of esoteric mediation and intellectual exercise, according to Mazzotti (2014, 131).

As Marta Cavazza has noted however, young women reacted differently in the scientific culture of the spectacle, they were thrown into, «constructing novel gender identities for themselves» (2014, 74). Through various modalities of sociable practices -which were however underpinned by serious and solitary study- elite women mathematicians, like Agnesi, du Châtelet, or Germain, were able to position themselves as active agents in the making of scientific knowledge, even if their status was not always officially recognised. Through the Pope's recommendations, Agnesi was proclaimed Honorary Professor in Mathematics at the University of Bologna in 1750, but never took up this position (see Mazzotti, 2007, 122). Despite being the first woman to publish a paper in the proceedings of the Paris Academy of Sciences, du Châtelet was never admitted in its circles, although she became a member of the

¹² Maria Gaetana Agnesi (1718-1799) was an Italian mathematician and philosopher. She was, the first woman in the Western world to write a mathematics handbook, the *Istituzioni* and to have achieved a reputation in mathematics. She spoke Latin, Greek, Hebrew, and several modern languages at an early age, and her father liked to host gatherings where she could display her knowledge. Although she was appointed to a chair of Mathematics in Bologna in 1750, she never took this position and preferred to live a solitary life, devoted to the study of mathematics and humanitarian activities. You can follow the website of the project (<https://sites.google.com/view/numbersandnarratives/a-feminist-genealogy-of-automathographies/maria-gaetana-agnesi>).

¹³ For a discussion of the European culture of scientific spectacle, see Cavazza 2009, and Schurch 2019, 47.

Bologna Academy of Sciences, in 1746 (see Zinsser, 2006, 209). As already noted in the introduction, Germain received the French Academy prize for her research on elasticity in 1816 and yet she remained in the margins of the academic mathematical networks, working «in almost total isolation, often without being guaranteed access to the scientific information and debates within the Academy» (see del Centina and Fiocca, 2018, 161).

In light of the above, women mathematicians' letters had both a communicative and pedagogical function: they provided their writers with a familiar and easily accessible form of communicating mathematical ideas, problems, solutions and errors. At the same time, mathematical correspondence gave women the opportunity to participate in the scientific debates and discourses of their time, particularly given the fact that travelling abroad was a harsh gendered restriction for them, irrespective of their social class and status. As Del Centina and Fiocca have noted, Germain's correspondence with Gauss, was «a possibility of escaping from the bell jar under which she felt herself eternally banished rather than protected» (2018, 161).

Letters also carry traces of socio-economic, historical and political experiences, formations and circumstances. Liz Stanley (2017) has drawn on letters to look into the long process of racialization in South Africa, while Margaretta Jolly (2008) has studied the use of letters in contemporary feminism. As Mary Favret has argued the epistolary form acquired a public voice in the eighteenth century, while «epistolary characters entered the discourse of the age and became the property of cultural history» (1993, 13). Favret has further pointed to «the complicated history of the letter between the eighteenth and twentieth centuries, a period during which the structure and practice of personal correspondence were repeatedly rewritten through political and social change» (15). The production and dissemination of mathematical knowledge was part and parcel of such histories and women mathematicians often wrote and debated about culture, science and politics in their personal, as well as scientific correspondence, thus exposing «relationships between functionality, creativity, fictionality and history» as Schurch has aptly observed (2019, 24).

While preparing for her first appointment as a *privat docent* [lecturer] at Stockholm University, Kovalevskaya wrote to her friend and social activist G. Folmar about the difficulties of being a woman mathematician trying to establish herself in the European social and scientific circles. Kovalevskaya was well aware of «the peculiarities of my personal circumstances, which could make my position unpleasant in a really bourgeois society» (Kovalevskaya, 1951, 265). Such peculiarities included political suspicions, the fact that «I am Russian and thus suspicious of nihilism (which in this case is not far from the reality)» (267), as well as personal circumstances: «I don't live with my husband, and every woman, for whatever reasons separated from her husband is an ambiguous and suspicious person in the eyes of every good and well-meaning matron. And in such cases learned women are judged more harshly than others» (265).

Kovalevskaya's «othering» circumstances had an impact on her reception in the Parisian mathematical circles. While she felt that the local mathematicians «shower me with kindness and compliments» (266), they would not introduce her to their wives and therefore excluded her from the social networks, which as we have seen were important in creating and sustaining relationships and collaborations in the

context «of domiciliary sociability». As she was explicitly told by a woman friend in the Parisian circles: «Madame Hermite (wife of the most prominent local mathematician) would never accept in her living room a young woman who lives alone, without her husband, in furnished rooms» (266).

While Kovalevskaya felt that «similar nonsense here in Paris affects me very little», she was concerned that «in Stockholm this could be completely different» (266). When she eventually moved there shortly after her husband's death, it was her relationship with her daughter that was fiercely criticised in the closed Swedish society (see Koblitz, 1989). We can see how the personal, the political, the cultural and the scientific create an assemblage of affects, existential anxieties, but also career and scientific impediments in the life and work of a young woman mathematician. Letters carry traces of such experiences, which are impossible to be disentangled, as Halmos (1985) would have it in the configuration of his automathography, as we have already seen in the previous section.

But apart from inscribing «othering» experiences, letters also function as educational and pedagogical tools in the circuit of knowledge production and dissemination. In considering the pedagogical aspects of letter writing and correspondences, Anne Bruder (2011) has highlighted the importance of epistolary education by looking at the Boston based «Society to Encourage Studies at home» between 1873 and 1895. In this context letters are configured as «flexible spaces of self-definition, spaces of encouragement and disguise that came to mediate -and enable- a new kind of women's education» (2011, 590). Such spaces were also effective in erasing or rather bracketing race, class and age differences, Bruder has commented: «the Society offered a singularly egalitarian pedagogical experience premised upon the generic invisibility of the physical body, which allowed letter-writing students and teachers to form intimate fellowships with one another» (606). If we consider that Germain was able to hide her gender identity in her mathematical correspondence with Carl Friedrich Gauss, we can understand how epistolarity was a space of scientific communication, but at the same time a hideout for gender differences that could jeopardise a young woman's possibility to imagine herself as a member of the mathematics «republic of letters» (Schurch, 2019, 52). Gauss' letter to Sofia -written in response to the disclosure of her true identity on 30 April 1807- is telling of how the epistolary form nurtured a mathematical correspondence and communication that would have been impossible under the gender biases and prejudices of their time:

But how can I describe my astonishment and admiration on seeing my esteemed correspondent M. Le Blanc metamorphosed into this celebrated person, yielding a copy so brilliant it is hard to believe? The taste for the abstract sciences in general and, above all, for the mysteries of numbers, is very rare: this is not surprising, since the charms of this sublime science in all their beauty reveal themselves only to those who have the courage to fathom them. But when a woman, because of her sex, our customs and prejudices, encounters infinitely more obstacles than men in familiarising herself with their knotty problems, yet overcomes these fetters and penetrates that which is most hidden, she doubtless has the noblest courage, extraordinary talent, and superior genius ...

The scientific notes with which your letters are so richly filled have given me a thousand pleasures. I have studied them with attention and I admire the ease with which you penetrate all branches of arithmetic, and the wisdom with which you generalize and perfect¹⁴.

Gauss' enthusiastic acknowledgment of Sofie's mathematical mind is also a sign of the importance of discursive and formalistic practices of the epistolary pedagogy, as Bruder has commented (2011, 607). Moreover, their correspondence is an exemplary case of complex interplays between networks of mathematicians across Europe, revealing the cultural contingency of the conditions of the production and dissemination of mathematical knowledge, through imaginary belongings in the «republic of letters» (Goodman 1994). Apart from her correspondence with Gauss, Germain exchanged letters with several mathematicians and scientists, including Legendre, Lagrange, Fourier, Poinsoot, Cauchy, as well as her friend and fellow mathematician, Guglielmo Libri (see Del Centina and Fiocca, 2018, 147) and yet, her correspondence is an isolated case in the male dominated grand editorial projects of mathematical works and correspondences (see Borgato and Passeron, 2018, xv).

Meritxell Simon-Martin has further drawn on «epistolary education» to explore «the significance of letter-exchanges in acting as informal sources of education for girls and women in the context of English mid-Victorian bourgeois families» (2020, 13), by focusing on the correspondence of Barbara Bodichon (1827-1891), a leading figure in the UK movement for women's higher education. Letters are «lifelong educational instruments» in Simon-Martin's analysis, in an overall take of education as *Bildung*, «the life-time process of self-cultivation». (14) Following trails of «domiciliary sociability», Bodichon «learned by means of her active socialization, going to soirées, attending public lectures and engaging in philanthropic endeavours -most notably school visiting» Simon-Martin has noted, to the point of positioning herself as «scholar at home» in the 1851 census of Hastings (31).

Women mathematicians role in the production and dissemination of knowledge through publications, as well as correspondence, private conversations and social gatherings thus become components of an assemblage of epistemological, philosophical and literary practices in the intellectual worlds of the eighteenth and nineteenth centuries. Their letters both educated and connected them with the mathematical networks and circles of their time, although they were never enough to fill the gaps of their exclusion from the formal academic institutions that their male colleagues had free access to. The limits of the epistolary communication is bitterly expressed in Germain's last extant letter to Gauss, dated 28 March 1829:

I regret that I am deprived of the advantage that I would find in enjoying your learned conversation, as Mr. Bader does. What he told me does not astonish me, but it is an object of my envy. Apart from what I could learn from you, I regret again that I can't submit for your judgement so many ideas that I have not

¹⁴ Transcript of the Gauss-Germaine correspondence, translated by Raymond Flood, available at: <https://www.gresham.ac.uk/watch-now/gauss-and-germain> [Accessed July 23, 2022]

published, and that would be too long to explain in letter form. (in Del Centina and Fiocca, 2018, 161).

Germain's letters to Gauss would have been lost if it were not for Libri and his interest in documenting the history of science. (see Del Centina, 2005) In this light, the archive is at the heart of the paper's underpinning research research, which has been contextualised in the wake of the «archival turn», that is the vast surge of interest in archives, memory and traces of the past that has occurred among both popular and academic audiences over the last few decades, as I will discuss next, by way of conclusion.

3. Archival worlds and the work of memory

Looking back at the historiography of encyclopaedic and biographical references of Italian women scientists in early modern Europe, Paula Findlen (2014) has pointed to the absences, silences and deselections in the work of early biographers and therefore in the current state of the archives: «we cannot understand the visible center of how the woman of science emerged in the eighteenth century without exploring all of these other genealogies that do not become the subject of biography but belong to a very different kind of history», Findlen has argued (2014, 114).

In their meticulous study of Germain's correspondence, Andrea Del Centina and Alessandra Fiocca have discussed how her letters were dispersed after her death, while the process of their rediscovery, which started in the late 1870s is still on-going. (2018, 148) Libri had to flee Paris after the 1848 revolution and a large part of his archive, which included some of Germain's letters were confiscated, although they are now housed at the *Bibliothèque Nationale*. Some of the manuscripts and letters that Libri took with him, were later sold at an auction that he held in London in 1859. (152) In the same year the French academy received another part of Germain's archive as a donation from her sister and her nephew (152). When Libri died, ten years later his archive and therefore Germain's papers, manuscripts and letters were dispersed. As I have written elsewhere at length, women did not get the opportunity to have collections of their papers or *fonds* created, in the archival tradition, whether they were literary theorists, artists, activists or scientists. Their papers are usually included in the *fonds* of famous men, dispersed in different archives around the world, if at all (see author). Du Châtelet's amorous correspondence with Voltaire for example has not been preserved, despite the huge literature, archival work and secondary literature on his life and work¹⁵. It therefore falls to women historians of science and/or culture to reconstitute lost or dispersed archives, in many cases creating «meta-archives» of existing sources in different forms and geographical locations.

In engaging myself with Sofia Kovalevskaya's «meta-archive», I have pointed to a multiplicity of scattered auto/biographical documents with different and often

¹⁵ See The Voltaire Foundation at Oxford for this immense body of literature and archival editions and publications, both analogical and digital <http://www.voltaire.ox.ac.uk/> [Accessed September 14, 2022]

competing translations, fragments of lines, extracts and passages from her letters, diary entries, as well as novels and plays that create palimpsests of traces of the self. While addressing questions arising from working with fragments and traces of the self, I have further considered the importance of creative imagination in forming entanglements between the researcher and her archival figures. In this light archival research is configured as a process of doing, learning and understanding, an ongoing becoming emerging after layers of documents have been assembled, organized, reordered, read, transcribed, translated and effectively rewritten (see author).

Moreover, in the light of the archival turn and the digital revolution, important epistemological questions raise around provenance, as well as on reassembling epistolary documents within the archive and beyond, particularly re-imagining the extant letters alongside those that were, burnt, lost or destroyed and thus acknowledging the epistemological gaps of the absent side of the correspondence, as already discussed above. In this light, while it is important to challenge and interrogate existing archival ordering of letters and mathematical correspondences, as well as edited collections of letters, there is also a need to keep excavating the archive for more unearthed, hidden and forgotten letters and correspondences, ultimately making cartographies of letters and other auto/biographical texts, in the on-going process of the work of memory.

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