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The Mechanics of the Social: Sophie Germain's Adventures in Microsociology

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Abstract

This paper traces a genealogical line of microsociology in the theoretical ideas of Sophie Germain, a 19th-century French mathematician and philosopher. While her contributions to mathematics have been rediscovered and reevaluated in recent years, her theoretical writings remain largely overlooked. To address this gap, I examine Germain's contributions to the history of ideas, with a particular focus on her reflections on the social, political, and cultural issues of her time. I argue that Germain's ideas should be recognized as part of a genealogical tradition of process-oriented approaches to sociology and social theory. In doing so, I make connections between her work and Gabriel Tarde's microsociology.

Key words: mechanics, microsociology, process, science, transdisciplinarity, women mathematicians

> We would imperfectly appreciate the high range of Mademoiselle Sophie Germain, if we limited ourselves to consider her as a mathematician [géomètre], whatever the eminent merit she demonstrated in mathematics. Her excellent posthumous discourse, published in 1833, on the state of science and the letters in the different periods of their culture, indicates in her a very lofty philosophy, both wise and energetic, of which very few superior minds have such a clear and profound feeling today. I will always attach the highest value to the general conformity that I saw in this writing with my own way of conceiving the whole intellectual development of humanity. (Comte 1835, 604n1)

Auguste Comte included this lengthy reference to Sophie Germain's unfinished treatise *Considérations Generales Sur l'Etat Des Sciences Et Des Lettres Aux Différentes Époques de leur Culture* [General considerations on the state of the sciences and the letters at different times of their culture], in the second volume of his major corpus *Cours de Philosophy Positive,* first published in 1835, only four years after Germain's untimely death in 1831. What made the founder of sociology to praise so highly a woman, who was mostly known as a mathematician in the Parisian academic circles in the first half of the nineteenth century? While forgotten after her death, Germain's contribution to the mathematical sciences has been revisited in recent years with a small but growing body of literature revolving around her life and mathematical work.[1] Even in this literature however, her posthumously published *Considérations* remain broadly undiscussed, and they have not been translated in English yet.[2]

In addressing this gap in the literature, in this paper I revisit Germain's contribution to the history of ideas, particularly focussing on her writings on social, political and cultural

questions of her time. The paper unfolds in five parts: following this introduction, I paint Germain's intellectual portrait, with a focus on the turbulent social and political conditions that shaped her upbringing, life, and work. Next, I examine her unfinished treatise, *Considérations Générales* (Germain 1896), as a unique perspective on politics, culture, and society. In the subsequent section, I explore the connections between her work and Gabriel Tarde's microsociology, arguing that Germain's *Considérations* represents a neglected genealogical emergence within processual sociologies. Finally, I conclude by considering Germain's contributions as a significant transdisciplinary approach to sociology and social theory.

Within Germain's biographical matrix

Sophie Germain's (1776-1831) life has been told and retold from several angles and in different genres and media over the years. Almost all renditions of her life however draw on two historical sources, both written in the nineteenth century. The first biographical note came from her friend, Guglielmo Libri, an Italian mathematician and member of the French Academy of Sciences. Libri first wrote Germain's obituary in the *Journal Des Débats* on 18 May 1832, almost one year after her passing and it was then included in the preliminaries of the first publication of her philosophical work, *Considérations Générales* in 1833. The second was written by Jean-Léon-Hippolyte Stupuy, a poet, playwright and literary figure. His study first appeared in the 1879 publication of her *Œuvres philosophiques* and was included again in its second edition in 1896. What I have found interesting in studying these first two biographical sources is the unacknowledged iterations that slip from the first to the second, eventually creating a biographical matrix, within which all subsequent biographies are entangled.

'Events and political discussions have prevented us from drawing public attention to the loss which some time ago, the mathematical sciences suffered in the person of M^{lle} Sophie Germain' (1832, 1), Libri wrote in the very beginning of his obituary, referring to the uprisings, which shook Paris throughout 1831. As Dora Musielak has noted, political upheavals marked Germain's life from the beginning of her life till the very end. Let us go to the beginning then.

Germain was thirteen years old, when the French revolution erupted literally at her doorstep, since the house of her childhood was in the rue St Denis, at the heart of Paris. But it was not only the spatial proximity to the revolution that marked her childhood, but perhaps more importantly her father's involvement in it. Her father's activities and the political discussions in her family home must have 'left an indelible imprint on her mind', as Stupuy has commented. (1832, 5) Most importantly she had a first-hand experience of the socio-political, cultural and intellectual forces that shook France at the turn of the eighteenth century and she wrote about them in her *Considérations,* later in life.

Revolutions however can also be frightening and uncertain events, particularly if we consider a very young girl living through the dark days of the *Reign of Terror* that followed the initial revolutionary excitement and jubilations. As both of her biographers note, her father's library became Germain's refuge, as 'she felt that a strong and sustained occupation could be a diversion from her fears' (Libri 1832, 1). And afraid she was, not only through the first years

of the French Revolution, but even more so throughout the *Reign of Terror*. This was a difficult time not only for political opponents, but also for scientists in an overall inimical ambience for science: 'the Republic has no need for geniuses [La République n'a pas besoin de savants'], a judge of the power regime had famously declared during Antoine Lavoisier's tribunal, when he was sentenced to death, in 1749. (see Jones 2016)

Given that as a woman, Germain was also excluded from all formal educational institutions for higher studies—before, as well as after the revolution—the library also became the site of her self-education, while mathematics was chosen as her favourite discipline. Germain's mathematical education started at home but was by no means restricted within it. When the École Polytechnique open its doors in 1794—for men only of course—she managed to get access to the professors' lecture notes and what is more, she also found a way of submitting her written responses and observations at the end of their courses, as it was required at the time. Her method was old and well-rehearsed in the gendered politics of the European cultural history: adopting a male penname. It was thus as M. LeBlanc, the name of a student at the École Polytechnique, that she first wrote to the famous Lagrange, professor of analysis at the École, who got interested in the student's comments and was thereafter introduced to the real author. Through this detour, Germain soon became acquainted with the Parisian scientific world. When Carl Friedrich Gauss published his *Disquisitiones Arithmetica*e in 1801, Germain 'was struck by the originality of his work' (Libri 1832, 1) and this is how her interest in number theory found 'a new stimulus towards this genre of analysis' (ibid.), which would later culminate in her work with Fermat's last theorem.[3]

Germain's correspondence with Gauss has been well documented and extensively discussed,[4] and is framed within turbulent times, when France had passed from the First Republic to the First Empire. During this period, Germain had witnessed the social chaos of what Victor Hugo has influentially depicted in *Les Misérables,* but she had also lived through the anxiety and uncertainty of the Napoleonic wars. It was during this period that her interest in finding the mathematical laws underpinning the physics of acoustics, also developed, culminating to the unprecedented achievement of winning a prestigious prize in mathematics by the French Academy of Sciences in 1816. Both historical biographies have highlighted this achievement as 'a remarkable opportunity, which made her known as an author' (Libri 1831, 1). Germain conducted this work in the midst of huge geopolitical events and it was on such turbulent experiences that her philosophical ideas about the nature of social and political relations were being formed, as I will discuss in the next section.

Rethinking the social and the political within revolutionary times

In his introduction to Considérations Générales in 1833, Jacques-Amant Lherbette, the editor of Sophie Germain's treatise, explained: "These pages, found among Mademoiselle Germain's papers, were not intended for printing. She wrote them during moments when the severe pains from which she ultimately succumbed prevented her from dedicating herself to the mathematical sciences that had made her famous" (Germain 1833, 5). To Lherbette, Germain's essay was an incomplete effort, a stand-in for her 'true' scientific work, which she could no longer pursue in the final months of her life as she suffered from breast cancer. He attributed the work's unfinished state to her 'lack of time' (5).

Libri, Sophie Germain's first biographer, appears to echo Lherbette's assessment of her treatise, mentioning it only briefly in his obituary. He wrote: "We have also found in her papers, immense works on history, on geography, particularly that of the ancients, and on the natural sciences, as well as very fine philosophical reflections, for she had been much occupied with metaphysics" (1832, 2). From this brief reference, it seems likely that the selection of pages initially published in 1833, were part of the 'immense works' Libri mentioned.

Unlike Libri, who makes only a brief mention of Germain's philosophical work, Stupuy delves into her posthumous writings in much greater depth, even criticizing Libri for excluding her *Considérations* from his obituary (1896, 45). In contrast to Lherbette's perspective, Stupuy posits that Germain's philosophical endeavours likely commenced much earlier than her final months. He notably highlights her shift in focus toward 'the how and no longer the why' (56). Viewed through this lens, the question of when Germain composed her treatise becomes less pertinent, as it imposes a linear framework on her creative process. What truly matters is the *durée* of her theoretical ideas—their evolution over time, both in her own era and in ours, where they continue to resonate.

Focusing on the *durée* of Germain's work, we can begin by examining its structure. Her unfinished essay is composed of two chapters. In the first, she lays out a clear thesis: the human mind functions according to certain laws, and the essence of truth is grounded in a natural feeling of order and proportion. She asserts that 'a deep feeling of order and proportion becomes for us the trait of truth in all things' (78). This instinct, common to both the sciences and the humanities, implies that order, proportion, and simplicity are intellectual necessities that ultimately guide us toward a universal understanding of beauty and truth. For Germain, the tripartite schema of 'order, proportion, and simplicity' serves as a universal system for comprehending the world, individuals, human relationships, and the various forms of knowledge that have emerged in relation to them.

Following her statement of this principle, Germain compares the impressions we derive from both fictional and scientific works, ultimately concluding that there are no significant differences between the two. She argues that 'the human mind is guided in all its conceptions by the foresight of certain results, towards which all its efforts are directed' (81), and thus operates in accordance with 'the laws of its own existence' (97). In this context, what we find appealing in the traits of genius—whether in eloquence, the sciences, the fine arts, or literature—is the discovery of numerous relationships that we had not previously perceived (82).

In these comparisons, the author carefully reveals the shared intellectual processes between poetry and science, emphasizing the continuous interplay of emotion, imagination, and rational thought in both disciplines. For the poet, there is 'a tumultuous struggle' of abstract images and conflicting ideas until a clear, simple concept emerges (82). Likewise, for the mathematician, a straightforward yet 'fruitful idea' arises from the challenge of framing a new problem within well-established and familiar domains.

Germain draws a parallel between the creative processes in poetry and science, emphasizing the importance of a central guiding idea in both fields. For poets, this central idea gives unity to their work, creating beauty, while for mathematicians, a 'happy idea' drives their research, leading to a chain of truths. Germain also highlights the importance of stylistic choices in both disciplines. Just as writers carefully select words and structure to achieve harmony, mathematicians must consider the aesthetic quality of their calculations, as the elegance of mathematical expressions varies between authors.

In concluding the first chapter of her essay, Germain exclaims: 'Ah! We can no longer doubt it, the sciences, letters, and fine arts were born from the same feeling.' The concept of 'feeling' [sentiment] is central to Germain's philosophical essay, appearing in various forms and contexts throughout the text and it is frequently intertwined with the notion of happiness, as I have written elsewhere at length. (see Tamboukou 2023a)

In the second chapter, Germain embarks on a historical exploration of her principles across various periods of science and culture. She reflects on how, under the reign of imagination, poetry initially recounted significant events and depicted the grandeur of nature. The poet would later turn to imagined actions, she observes, but soon felt the need to discover rules, which became the precepts of art: 'unity of action, unity of interest, and clarity of exposition' (92). As man found himself 'cast to the earth amid the immensity of things,' he marvelled at his own existence, projecting his image onto the world and personifying both inanimate and intellectual beings as 'children of his imagination' (92). In this way, the human form became universal, as 'faithful to his constant thought, man has never ceased to regard his own existence as the model for all other existences' (94).

Germain then traces the process of universalization in the works of the antiquity and the Middle Ages: from the first astronomical knowledge, up to the foundation of Cartesian geometry and Newton's discoveries, amidst 'the thousand deviations' of reason that the history of science has pointed to. (113) Here she highlights the importance of mathematics in offering truth and nothing but the truth: 'From their birth, the mathematical sciences have offered the human mind the full realization of this type of truth, the object of its dearest affections.' (118) The reason is simple: while philosophical language was at times 'even more obscure than the ideas it was intended to convey' (122), the language of 'the exact sciences' has always been precise and clear.

Given the clarity of the language of the 'exact sciences' and their consecutive prevalent position in seeking 'the truth', it is no wonder that Germain made the study of science in general and the mathematical sciences in particular, central to her philosophical propositions. Thus, while showing the alliance between mathematics and the natural sciences, Germain also extended the importance of calculus to social, moral and political questions. Being firmly convinced that the laws of being do not only govern the facts which are in the field of sciences, she argues that these laws also apply to the social, political and cultural domains: 'It is in approaching more and more the type of being or the true, source of all our real knowledge, that the theories perfect, morality is purified, that politics light up, that metaphysics ceases to go astray, that the literature and the fine arts realize the rules they have practiced and the great effects they have produced'. (142-3) Thus drawing on the theorem relating to the short duration of the action of disturbing causes, she explains how

the true and the just constantly tend to remove the obstacles that oppose their manifestation. She further demonstrates the progressive tendencies towards the annihilation of actions, which disturb the natural order in all moral, social and political phenomena:

> In politics, one would distinguish, among the causes which act on the system, which are those which, due to ever-increasing forces will eventually predominate; while others, accidental, whose effect is very great at a given moment, will entirely cease their action after a more or less long time. (144)

This is the point of the most interesting connections she draws between 'rational mechanics' (145) and social and political science, by juxtaposing the two cases of stable and unstable equilibrium. When a system is idle she notes, this may be due to essentially different conditions. However, when a cause comes to act on the system, two things can happen: it will either return to its initial position and the balance will be restored—stable equilibrium, or the system will be removed from its initial position, and it will return to a calm state 'only after having passed through an entirely different situation'—unstable equilibrium. (146) It is clear how these two states can be transposed into social and political systems: there are sometimes agitations in the socio-political system producing slight movements that stop on their own. But other times we see 'complete revolutions, which will allow the state of interior peace to be reborn only after great changes in the social order' (146).

As I will further discuss in the next section of the paper, Germain's attempt to transpose the states of the stable and unstable equilibrium to social and political phenomena —what I configure as her *mechanics of the social*—brings in mind Gabriel Tarde's philosophy of society and his controversial argument that 'all things are societies' (58), or 'associations' in Bruno Latour's exposition of Tardean sociology (2002, 120). As Latour further comments, 'this does not mean, as with Auguste Comte, that sociology must occupy the throne and rule over the sciences, but simply that every science has to deal with assemblages of many interlocking monads. (120)

In drawing relations between mechanical and social systems, Germain is precisely interested in such interlocking monads, in the sense of individual, social and political attitudes: 'states governed without regard to social tendencies retain inner tranquillity, as long as no event comes to agitate the spirits; but the slightest circumstance is enough to shake society to its foundations', she observes (147). When trouble comes, 'it is necessary, either to oppose powerful obstacles to it, or to know how to conform to their requirements', she writes, thinking scientifically about the events that shook France throughout the nineteenth century, by pointing to the critical difference between 'precarious and sustainable tranquillity' (148). And it is not only social systems that she considers in this development of the *mechanics of the social*: in the same way that all points in a system endowed with gravity tend to be placed as near as possible to the centre of the earth, all individuals in a social system tend towards well-being in a relation within which 'the well-being of each harms as little as possible that of the others'. (148) Motion and gravity are further used as analogies to illustrate balance and the effects of impulses:

> If the direction of motion imparted to a system of bodies passes through the centre of gravity of that system, it will be moved as if all the points of which it is composed were united into one, and the whole force will be employed to produce the effect that we expected. In the same way also, when the action of the government is directed in the direction of public opinion, society seems to move like a single individual who would act in accordance with [his] interests, and all the forces of the state contribute to the general prosperity. (149)

Things become more complicated when the direction of the movement is different, both in physics, as well as in social and political systems. In such cases the driving force would break down in two parts: the first would again pass through the centre of gravity, while the second would destabilize the system and make it rotate around its centre of gravity having totally lost its goal and eventually leading to the system's dissolution. (149) The same can happen with government actions and policies: if some of them are favourable to the public, while others are against it, 'the state would experience an internal agitation that would tend to dissolve it. (150)

In further thinking about the dynamics of the social Germain notes that 'societies are made up of three main elements: interests, passions, inertia', (150) which individuals bring together in their way of being, as well as in their social attitudes, thus forming many different characters. Individual behaviours thus correspond to the physical attitudes of hard, elastic and soft bodies respectively: there are hard individuals who 'stubbornly cling' to the path leading to the attainment of their interests and resist any opposing force even if this means that they will be utterly destroyed. In the modality of elasticity individuals driven by passions will change route at the slightest shock following unexpected paths and finally there are those who enjoy rest and will suffer real damage rather than thinking of reacting to events that destabilize their calm state. (151) Of course individual attitudes depend on social and political conditions Germain argues: 'in times of tranquillity, interests dominate', (151) but the passions which were contained within periods of peace wake up and increase the disturbance during periods of internal turmoil: 'they act in a thousand directions at once; we do not know where they tend, and it is very difficult to foresee what will be the result of their shock'. (152)

By creating a typology of characters and attitudes in analogical correspondence with physical bodies, Germain, the mathematician, observes that although 'we have not yet imagined making a statistic of characters' (153), we know by experience that more half of the population act according to their interests, while the other half are either taken by their passions or they are just inert. Moreover, we also know that hard, elastic and soft states are never pure or absolute. In the same way that there are no bodies perfectly hard, or elastic bodies that cannot retain something of the direction in which they are pushed, or finally soft bodies absorbing everything, individual characters and behaviours are multi-faceted:

> Similarly, we do not see people so attached to self-interest that, at certain moments in their lives, they do not act from other motives. Passionate men sometimes yield to their interests, and people who are naturally lovers of rest can find, in the things and in the people around them, material to excite in them the desire for wealth, fame or affection. (153)

While however the balance between different attitudes and characters can be maintained in periods of peace, when systems are disturbed, 'all individuals receive an impulse that transforms them into passionate people'. (153) In such cases moving forces are difficult to be foreseen and calculated, directions are uncertain and variable and given that actions are often spontaneous, 'society runs a thousand dangers, which is as difficult to avoid as to foresee'. (154) The days of *The Reign of Terror* must therefore have been in Germain's mind when writing that in times of trouble 'individuals arise from all sides 'with an energy hitherto unknown', (154) and often uncritically immerse themselves in the vicious circle of violence. (155) This is why revolutions are dangerous and risky, according to Germain: by suddenly changing the relations between the vital forces of the different classes of society, they can create uncertain effects. Otherwise, violence and disorder soon disappear in revolutions, she notes, 'by virtue of this general theorem which shows that, in all things, the disturbing forces are functions of the times, and that regularity tends to be established in any system of whatever nature it is' (155-56). Here again we can sense the historical uncertainties, as well as the post-revolutionary regimes that she has in mind in drawing theses analogies between the laws of nature and the laws of society.

Germain's historical account inevitably brings in mind Comte's law of the three different theoretical states [états]: 'the theological, or fictitious; the metaphysical, or abstract; and the scientific, or positive' that all branches of knowledge and principal conceptions pass through on the plane of his *Philosophie Positive*. (1830, 3) Germain, however, does not align with Comte's paradigm. It is even unlikely that she ever had the chance to read Comte's work, as the first volume of *Philosophie Positive* was published at the end of 1829, by which time she was already suffering from cancer. Even considering the time earlier in the 1820s, we should bear in mind that Germain was moving in the mathematical circles of the Academy of Sciences in Paris and although she worked with many renowned mathematicians of her time, there is no evidence that she ever collaborated with Comte.

As I have discussed in other works, Germain's contributions can be situated within the broader context of process philosophies (see Tamboukou 2024). However, this paper specifically examines how her often-overlooked *Considérations* represents an earlier and distinct genealogical emergence of mathematical concepts that influence social theories, predating and diverging from Comte's approach to the social. Here it is important to note that in Foucault's genealogies (1986), 'emergence' refers to the process by which certain discourses, practices, or social phenomena arise—not through a linear or inevitable progression, but through contingent historical struggles, power relations, and chance events. As the 'entry of forces' (ibid., 84) into history, emergence emphasizes discontinuities and ruptures, marking 'moments of arising' (ibid., 83) as the effect of unpredictable forces rather than a unified or teleological development.[5]

Between Germain and Tarde: retracing marginalised connections

As noted in the previous section, in reading Germain's *Considérations*, Comte's image of sociology as 'social physics' [physique sociale], looms large. Comte defined social physics as the science that studies social phenomena in the same way as astronomical, physical, chemical, and physiological phenomena—that is, as subject to natural and invariable laws,

the discovery of which is its primary objective (in Iggers 1959, 434). He expressed this view in a series of three articles published between 1825 and 1826 in the Saint-Simonian journal *The Producteur*. His notion of 'social physics would then be elaborated in the six volumes of his *Philosophie Positive*, as already discussed above. Parallels between Germain's work and Comte's positive philosophy were noted by Stupuy in his introduction to her philosophical writings (1896), as well as in several subsequent reviews.[6] But although Stupuy had commented that 'she had the power and the correctness of the founder of sociology' (1896, 54), he had also remarked that she does not distinguish the specific logical methods relevant to each field of knowledge, nor does she clearly define the separate aims of art and science, and her work still contains traces of metaphysical ideas. (ibid.) Stupuy's critical commentary of Germain's ideas as mingled with metaphysics, inevitably bring in mind Latour's appreciation of Tarde's work on precisely the grounds of bringing together philosophy, ontology and metaphysics in theorising the social:

> Instead of establishing sociology by means of a complete rupture with philosophy, ontology and metaphysics, as Durkheim will be so proud of doing, Tarde goes straight to these disciplines and reclaims them in his project to connect social theory with bold assumptions about the furniture of the world itself. (2002, 118)

In his study on Tarde's sociology, Sergio Tonkonoff (2018) examines the influence of metaphors and analogies from the natural and 'exact sciences' on modern social theories. He particularly emphasizes Comte's foundational concept of 'social physics,' which is described as 'macrophysical totalism,' marked by a holistic positivism where society is seen as large, teleological systems tending toward equilibrium. In contrast, Tarde's social theory is referred to as 'microphysics,' shaped by the dynamic scientific advancements of the late 19th century, which eventually gave rise to 20th-century physics, including quantum mechanics and relativity.

Germain died before the scientific advancements that undoubtedly influenced Tarde's theorization of the social. Nevertheless, her significant contributions to elasticity theory and the physics of acoustics remain among her most notable achievements as a mathematician, earning her the *Grand Prix des Mathématiques* in 1816, as discussed earlier. It was her research in applied mathematics that informed her theoretical work on social and political systems, as outlined in the previous section. There are, therefore, parallels between Germain's and Tarde's theorisation of the social that I want to chart below. Although their approaches differ, they trace a distinct genealogical line in social theory—one that adopts a holistic view of the natural, human and 'exact' sciences, revisits the conceptualization of the social, rejects the individual/society divide and emphasizes the micro-level of analysis.

In his magnum opus *Monadology and Sociology*, (2012 [1895]) Tarde argues that sociology must not overlook the trend of examining 'the imperceptibly small', echoing Leibniz's hypothesis that the true agents and forces shaping the world operate on an infinitesimal scale: 'The monads, children of Leibniz, have come a long way since their birth. By several independent paths, unremarked by scientists themselves, they slip into the heart of contemporary science', he has written (2012, 5) As Tonkonoff (2018, 3) observes, Leibniz's mathematical concepts of the monad and infinitesimal calculus are central to Tarde's social theory. In his approach, the smallest entities, be they individuals or social units possess

greater richness in difference and complexity than their aggregates or the superficial appearances we observe from a distance. His approach emphasizes the microscopic, often imperceptible details of social reality, which is composed of innumerable small, distinct elements, including the flows of beliefs and desires. This perception of reality has an impact on the process of the sociological analysis. As Tarde puts it:

> For since everything in the world of facts proceeds from small to great, everything in the world of ideas, which reflects it as though reversed in the mirror, naturally proceeds from great to small and in the course of its analysis comes upon the elementary facts and real explanations only at the end of its journey. (Tarde 2000 [1899, 55).

Long before Tarde, however, Germain had already asserted that mathematics in general, and calculus in particular, play a crucial role in understanding the social. She observed that 'by lending itself to new uses, the language of calculus has been enriched with several new methods' (1896, 125), adding that the numerous applications derived from calculus 'have turned all minds towards the mathematical sciences' (ibid), which were previously limited to a small number of abstract truths. She had further argued that if the language of calculus became applicable to social, political, metaphysical and even aesthetic questions and issues, it would reveal that these diverse subjects share underlying similarities. (ibid., 143)

As mentioned in the previous section, Germain had emphasized the need to use statistics to develop a typology of characters and attitudes, drawing an analogy with physical bodies, to better understand social equilibrium and social change. The use of statistics was the mathematician's way of making sense of multiple minor trends and tendencies. Here it is important to note that at the time that Tarde wrote *Monadology and Sociology,* as well as the *Social Laws,* he was director of the Criminal Statistics Bureau of the French Ministry of Justice. He had actually highlighted the importance of 'a science of statistics' (2000 [1899], 21), with the goal 'to discover and separate real quantities from the confused general mass of social facts' (ibid.), a real critique of Durkheim's famous notion. In his view, the success of a science of statistics 'is greater the more it strives to reach beyond the particular human acts which it collects, and to measure the total mass of beliefs and desires.' (ibid., 22)

Beyond the level of application and in the philosophical context of thinking small, Latour has observed that Tarde did not seek to explain 'the lower levels,' meaning the individual, by referring to 'the higher levels,' which pertain to the social (2002, 119). Tarde, in rethinking the social, argued that the division between the individual and society is irrelevant for understanding human interactions. Instead, he argued that the social does not explain anything but is itself what requires explanation. In referring explicitly to the sociologies of Durkheim and Spencer that were prevalent in France after Comte, he wrote:

> These writers imagine they are stating a weighty truth when they assert, for instance that languages and religions are collective productions […] and that the formations and transformations of societies are always to be explained by the coercive action of the group upon its individual members (so that the latter, great and small alike, are always moulded and made subordinate to the former), rather than by the suggestive

> and contagious influence of certain select individuals upon the group as a whole.' (2000 [1899], 25).

For Tarde, the main issue with such assertions lies in explaining 'how such a general assimilation could ever have taken place' (ibid). He thus viewed the social not as a cause, but as the effect of individual interactions occurring in the details of everyday practices and relationships, shaped by the laws of imitation, opposition, and adaptation, a universal system that he developed in detail (2000 [1899]. Referring to Tarde's concept of the 'contagious influence' of individuals on groups, and expanding on his *Social Laws,* Tonkonoff has commented that, for Tarde, the social emerges through 'contagion, creation, and conflict' (2024, 48).

Tarde's critique of the idea that 'languages and religions are collective productions' parallels Germain's claim that the creation of the language of reason was the result of concentrated efforts among 'a very small number of men' (1896, 129, emphasis mine). Just as Tarde questioned how the 'conformity of millions of men acting together under certain relations' (2000 [1899], 25) could be explained by the notion of a 'collective force,' Germain similarly challenged the sustainability of any social or political system through coercion alone. As discussed earlier, rather than relying on the idea of collective forces, Germain focused on the *mechanics of the social*, emphasizing the influence of 'social tendencies' in relation to events and unforeseen circumstances that affect individual minds and bodies. Recall her argument that '*the slightest circumstance* is enough to shake society to its foundations' and that '*each individual* will receive a new impulse' (1896, 147, emphases mine).

For both theorists, the small—whether it refers to the individual, a social unit, or a minor practice—exhibits greater complexity and richness than the large. Moreover, Tarde's theorization of difference as an ontological condition and his rejection of the very concept of identity have greatly influenced Deleuze's philosophy in *Difference and Repetition* (2004 [1968]) and have shaped his engagement with the unique aspects of microphysics, micropolitics and eventually microsociology. Indeed, the following excerpt from Tarde on difference has likely been particularly impactful for Deleuze and beyond:

> To exist is to differ; difference is, in a sense, the truly substantial side of things; it is at once their own most possession and that which they hold most in common. This must be our starting point, and we must refrain from further explaining this principle, since all things come back to it—including identity, which is more usually, but mistakenly, taken as the point of departure. For identity is only the minimal degree of difference and hence a kind of difference, and an infinitely rare kind, as rest is only a special case of movement, and the circle only a particular variety of ellipse. (2012 [1894], 40)

In the same vein, Germain's approach to the social is very much focused on the study of the micro, the infinitesimal, the yet unseen: 'indeed, a stroke of genius, a stroke of eloquence, whether in the sciences, the fine arts, or literature, pleases us for the same reason: they reveal to our eyes a multitude of connections that we had not yet perceived', she wrote (1896, 81-2). She particularly criticized approaches that focus on identities rather than analogies:

> Thus, by assembling a certain number of particular beings, one attributed dominion over the others to one of them; in this way, the latter, stripped of their individual realities, were clothed in the reality that solely corresponded to the dominant truth that had been chosen. Instead of seeking analogies, the aim was to find identities, as identities would indeed be simpler and, consequently, more satisfying than analogies. (ibid., 139-40)

Paul Patton has commented that the difference between macropolitical and micropolitical levels of social analytics 'is not simply a difference in scale but a difference in kind' (2006, p.30). It is an analytical path oriented towards complex and multifarious modalities of living in the interstices and ruptures of dominant social entities and amongst the minutiae of sociocultural and affective relations, the micro-spaces where power and desire meet in producing realities and indeed the subject.

In this context, Tonkonoff suggests that Tarde's ideas significantly influenced Foucault's microphysics of power and Deleuze's micropolitics, both of which explore the small-scale, dynamic forces that shape social structures. (2018, 4) Although Foucault did not explicitly reference Tarde's ideas, Deleuze and Guattari, in their collaborative work *A Thousand Plateaus*, emphasized Tarde's focus on the 'infinitesimal.' They highlighted his interest in the world of small details, writing: 'Tarde was concerned with the infinitesimal—the minor imitations, oppositions, and inventions that form an entire realm of subrepresentative matter'. (1988, 218-219). Neither of them however has considered or referred to Germain's work.

In tracing a genealogical line in social theory from Tarde to Foucault and Deleuze, Tonkonoff (2018) goes back to Comte, as his point of departure, juxtaposing his 'macrophysical totalism' with Tarde's 'microphysics', as we have already seen. What I contend however, is that 'the micro' in social theory emerges in Germain's *mechanics of the social* and runs in parallel with Tarde's important statement that 'to exist is to differ' and that 'difference, is in a sense, the truly substantial side of things' (2012, 40). Moreover, both approaches constitute the historical context of 'processual sociologies', wherein 'individual and social entities are not the elements of social life, but are patterns and regularities defined on lineages of successive events […] moments in a lineage, moments that will themselves shape the next iteration of events, even as they recede into the past' (Abbot 2016, ix-x). Despite its brevity, as well as its fragmented and unfinished state Germain's treatise is an unrecognized trace of processual approaches to philosophy and social theory in the nineteenth century, but also a rare exemplar of transdisciplinary though, as I will discuss by way of conclusion.

Transdisciplinary approaches to processual sociologies

Alfred North Whitehead famously wrote, that 'the actual world is a process, and process is the becoming of actual entities' (1985, 22). As Steven Saviro insightfully noted, Whitehead's conception of reality as a process shifts the analytical focus from the philosophical question of 'why is there something rather than nothing' to the more sociologically driven question, 'how is it that there is always something new?' (2012, x). This shift from the 'why' to the 'how'

also resonates in Germain's unfinished treatise and runs in parallel with Tarde's microsociology as we have seen in the previous section.

Whitehead's process philosophy serves as the epistemological foundation for processual sociologies, which view social phenomena as dynamic, evolving processes rather than fixed structures. These sociologies prioritize change, movement, and transformation in their understanding of society, emphasizing how new social forms, institutions, relationships, and patterns emerge through continuous interactions over time.[7] Throughout this paper, we have seen how both Germain's and Tarde's approaches challenge the traditional division between micro and macro levels of society, positing that large-scale social changes emerge from micro-level interactions. They also critique top-down models of social forces, each in their own way arguing that power is not centralized but rather distributed and fluid, arising through processes of negotiation, competition, and cooperation. In this context, individuals, social relations, institutions, and even political systems are seen as assemblages—or 'aggregates', as Tarde termed them (2000 [1899], 71)—of interacting processes, which are continually reconfigured through what I have configured in this paper, as Germain's 'mechanics of the social'.

As discussed in the previous section, both Germain and Tarde adopted a holistic approach to studying society, rejecting the nature/society divide and striving to develop, each in their own way, a universal framework for understanding individuals, society, and the broader world. In doing so, they emerged as transdisciplinary thinkers *avant la lettre*.

Stella Sandford has argued that, 'transdisciplinary theory and its concepts are not necessarily identifiable with any specific disciplinary fields, either in their origin or application' (2015, 160). While we know that distinctions between disciplines existed in the history of philosophy and science, these fields were deeply interconnected. In the early modern period, savants were engaged in a wide range of disciplines, including mathematics, physics, natural sciences, philosophy, and literature (see Smith 2009). By Germain's time, however, disciplines had become more specialized and bounded. As explored in the second section, Germain notably paid tribute to mathematics as the science of truth par excellence.

In this context, Germain's adventures into philosophy and social theory represent a bold transdisciplinary move. Not only did she engage with the key philosophical debates of her time, but she also sought to transpose concepts from physics and mechanics into the social, cultural, and political realms. This approach extended to individual characters, attitudes, and trends, intricately intertwined with broader systems. In doing so, Germain surpassed the individual-society divide—a division later critiqued by both Tarde and Latour in their interpretations of the social, as already discussed.

Latour has famously declared that his Actor Network Theory had a forefather: 'I have decided to share with the readers the good news that ANT actually has a forefather, namely Gabriel Tarde, and that, far from being marginalised orphans in social theory, our pet theory benefits from a respectable pedigree' (2002, 117). But it seems that the famous professor of philosophy at the Collège de France, who worked to establish his system of social laws at the turn of the nineteenth century, already had at least an important foremother in the

philosophical work of Sophie Germain, although this matrilinear intellectual heritage has not been recognized or acknowledged yet.

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[1] For a comprehensive overview of the literature around Germain, see Musielak 2020.

[2] See Musielak 2020, particularly Chapter 10 for a discussion of Germain's philosophical work. All translations of Germain's philosophical work in this paper are mine.

[3] For a detailed discussion of Germain's work on Fermat's last theorem, see Musielak 2020, particularly Chapter 9

[4] See Del Centina and Fiocca 2018.

[5] See Tamboukou 2023b for further elaboration of this concept in relation to writing a feminist genealogy of automathographies.

[6] See the annexes of Germain's *Œuvres Philosophiques* (1896, 358-393).

[7] There is a rich body of literature around processual sociologies, from different perspectives and with different approaches. See amongst others, Joyce 2002, Latour 2007, Abbot 2016, Candea 2019, Tonkonoff 2024.