COSMOLOGY, ASTRONOMY, AND PHILOSOPHY AROUND 1800: SCHELLING, HEGEL, HERDER

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This article focuses on debates on philosophical knowledge, mathematics, and the empirical sciences by analyzing the positions on cosmological and astronomical knowledge, around 1800, of three German authors: Herder, Schelling, and Hegel. I show the mutual interdependence of Schelling's and Hegel's *Naturphilosophie* and Herder's *Ideen*, and I then demonstrate that the latter's position during the last years of his life was a reaction to Schelling's and Hegel's speculative philosophy. While Herder seems to ignore the works of the *Naturphilosophen* in his journal *Adrastea*, in fact he participated in a very lively debate that included Schelling's *Weltseele* and Hegel's *Dissertatio de Orbitis Planetarum*.

1. The Origins of the Universe

The problem of the relationship between the speculative philosophy of nature and the empirical sciences is central to German *Naturphilosophie*. The reciprocal exchanges between idealistic philosophy and the Romantic sciences have been the subject of perennial scholarly investigation because of their complexity and the decisive importance these interrelationships have assumed in relation to the developments in science in various fields. The birth of the life sciences and advances in medicine; the development of chemistry; the study of electric and magnetic phenomena; investigations of light, optics, and heat; and surveys and discoveries in astronomy were all nurtured by the cultural climate that developed in the

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post-Kantian era around 1800 (Cunningham 1990; Poggi 2000; Breidbach 2001; Richards 2002).

The *Naturphilosophen* not only drew heavily on scientific investigations and on the different approaches to natural phenomena from complementary perspectives; they above all questioned the status of these special sciences by deepening their relationship to philosophical knowledge. It was undoubtedly Kant's work that provided a decisive impetus for the definition of these intersections. Kant's appeal to the exact sciences is already present in his precritical studies, in which he tried to find a new definition of metaphysics that, while not emulating the mathematical model, would be capable of guaranteeing the same objectivity and shareability (Palumbo 1984; Micheli 1998; Schönfeld 2000; Massimi 2017). Moreover, during the final years of the eighteenth century, a rapid transformation affected many scientific disciplines, in particular the field of astronomy and the study of the origin and structure of the universe. An increasing number of new theories and discoveries was emerging, and this prompted a response by philosophers.

A recurrent topic connecting Kant's earlier reflections with his most mature writings concerning the investigation of the universe is undoubtedly his astonishment before the spectacle of the cosmos and the mysteries of its origin, a wonder, as Kant (1755) states in the *Allgemeine Naturgeschichte*, in the sight of which we find ourselves almost dazzled. Just as ancient philosophers observed the heavens and wondered at the marvel of the universe, so the moderns, during the Enlightenment period, still admit the impossibility of fully grasping all the magic of nature. In Plato's *Timaeus*, a text that was to become an essential reference point in the second half of the eighteenth century in Germany in relation to the investigations into the origin of the solar system and the universe, an almost insurmountable limit to such investigations is expressed (Franz 2012). According to Plato, few human beings can succeed in penetrating the profound reasons of the universe, and, once discovered, they can barely transmit this knowledge to other people except through recourse to figurative and metaphorical speech, to a kind of analogical reasoning and to images.[1] At the same time, according to the *Timaeus* (29c4–d3), we must content ourselves with plausible accounts about the origin of the universe, because of our limited capacity to deepen such a complex and mysterious event.

It is no coincidence that Herder, in his discussion of the origin of the universe and the earth in the first book of the *Ideen zur Philosophie der Geschichte der Menschheit*,[2] associated Kant's name with a series of authors who straddled

1. Plato, *Timaeus* 28c3–5.

2. This work was originally published in four volumes: vol. 1 in 1784, vol. 2 in 1785, vol. 3 in 1787, and vol. 4 in 1791.

naturalistic investigations, literature, and philosophy but also theology and mysticism (Herder 1784–91/1800, 1:25–26). Herder emphasizes precisely the inevitability of having recourse not only to exact, mathematical, or conceptual reason but also to imagination and analogical thought, to probe those spaces that the intellect alone would not be able to embrace (cf. Follesa 2021). Herder's caution regarding the limits of human knowledge concerns the origins of the universe and that of the future destination of humanity. With respect to the past and the future of the universe, there are unsurmountable limits that human beings are not allowed to cross, and if someone has the presumption or the ambition to be able to go beyond them, he or she would risk being overwhelmed by the infinite. Being aware of the limits of human (and scientific) knowledge, Herder outlines in his *Ideen* a 'natural history' made of images, examples, and visual comparisons. Analogical thought is the only way to provide an explanation of the origins of the world, the structure of the universe, the development of the solar system, and life on earth from the point of view of a "terrestrial understanding, gradually fashioned by the things around us" (Herder 1784–91/1800, 1:6). The universe is conceived as a 'chorus' of worlds, originated and nourished by the sun, and obeys "simple, eternal, and perfect laws of formation and motion" (1:2). We, as human beings, "content ourselves with viewing the Earth as a grain of sand moving in that great abyss . . . till at length both the understanding and the imagination are lost in this sea of immensity and eternal magnitude" (1:2).

Herder's images and analogies are grounded on a defined metaphysical structure and philosophical concepts—that is, they are an integral part of his philosophical worldview, in which a "grain of sand is not of less value than an immeasurable whole" (1784–91/1800, 1:2). In the universal order of the world, each single being is connected to the All and, at the same time, is preserved as an individual. An internal power, which is always one and the same and is eternal, acts from within by means of its instruments and organs and "holds together the Sun and the stars" (1:3). We observe the different forms in the natural world and consider them as expressions of the same law and the same power. We "compare," according to Herder, "the general constitutions of the several planets" with "the various colors of a ray of light" (1:6). The insistence on the limitedness of human knowledge and the focus on the analogical-morphological method do not prevent Herder from recognizing the importance of the scientific progress: "The new discoveries, that have been made respecting heat, light, and their various effects on the composition, resolution, and constituent parts of terrestrial substances; the simple principles, to which the electric matter, and in some measure the magnetic, are reduced; appear to me, if not near approximations, at least considerable advances, which will in time enable some happy genius, by the aid of some connecting idea, to explain our geogony on principles as simple as those, to which Kepler and Newton have reduced the solar system" (1:8).

Herder's ideas had a deep impact on his contemporaries, not only for conceptual reasons but especially because of their allusive and visual power that had a more effective and deep impact than the cold and abstract language of philosophers—as Kant (1785), even in his critique of Herder's use of analogies, did not fail to recognize. Questions concerning the relationship between scientific knowledge and philosophy aroused a reaction in the *Naturphilosophen* and Romantic scientists who engaged with Kant's and Herder's writings beginning in the 1780s.

2. Schelling's *Weltseele* and the Theory of Light

The acquaintance of the *Naturphilosophen* with ancient thought, especially Plato's, as well as with the thought of Kant and Herder, was accompanied by the study of the recent discoveries in physics, chemistry, and the life sciences, which represents the composite basis for the flourishing of German philosophy in the final years of the eighteenth century. Schelling's work represents a radical change of paradigm compared to previous accounts of the relationship between the philosophy of nature and the sciences of the universe, and thus that change is among the most significant moments of *Naturphilosophie*. In 1798 Schelling published a treatise, *Von der Weltseele* (On the world soul), in which he establishes a connection between the work of the ancient Greeks (and, of course, late antiquity and Renaissance traditions as well), in which the concept of world soul is to be found, and the novel empirical sciences of the late eighteenth century (Vassányi 2011; Helmig 2020).

Beyond the immediate reference to the concept of world soul in the title and the introduction, however, the treatise in fact has little to do with Platonic philosophy in a strict sense. Rather, Schelling's intention was to establish a bridge connecting the ancient and the modern worldview, to understand the new scientific ferments within a philosophical-metaphysical frame, but without reducing the specific scientific knowledge to philosophical-metaphysical knowledge. Schelling's aim is to address the world of nature in a more authentic way, avoiding fictitious constructions and focusing on unity. A 'real' philosophy of nature must be able to deal with nature as a whole and provide within it a common metaphysical structure to which the individual scientific disciplines can refer. The meaning behind this work's title, with its reference to a 'soul of the world', is also an acknowledgment of the limits of human language—in other words, to the changing of human knowledge and language through history. Ancient philosophers chose a name, the world soul, to indicate something for which the modern sciences provide detailed explanations through a more specific language thanks to theoretical and empirical advancements. The obscure, symbolic, and poetic representations of ancient philosophers and writers are not necessary any longer in the light of new scientific achievements (Schelling 1798, 4).

If the task of Schelling's philosophy of nature is to focus on unity, it should proceed from a unitary model, and the most adequate model for unity is the organism—in line with Plato's *Timaeus*, as well as with Herder's *Ideen* and Kant's *Critique of Judgement*. The idea of a whole made up of parts organized in view of a single end supports a unitary model, while the notion of mechanism as a mere juxtaposition of parts or a mere opposition of forces cannot be an authentic start for philosophy. Within the organic paradigm, Schelling developed his polar model, that is, a coincidence of opposites that permits the existence of a plurality of forms in the whole of nature. Only if opposing principles are not absolutely opposed, but intimately connected with each other, can we have an organic development. This development is guided by a type, a scheme, a speculative framework: namely, the polar model, which is applied to different natural phenomena at different levels and serves as a paradigm for several scientific disciplines.

According to Schelling, every philosophy of nature (and every discourse on the origins of the All) must start from a positive and all-encompassing principle to which all beings can be traced back. This first principle does not separate; instead, it unites, organizes, encloses. Schelling (1798, 5) considers this first principle as the Proteus who eternally returns to himself. This first principle is the opposite of the real interest of every discipline that is called "science of nature." We do not find a totalizing tendency in the science of nature but instead its opposite: a negative principle capable of discerning, separating, distinguishing differences, which is the only way to acquire new empirical knowledge (6–9). The gap between the philosophy of nature and the science of nature could not be clearer. On the one hand, we have a speculative physics, with its concepts of original and fundamental forces, defined by Schelling as "limit concepts"; on the other hand, there are individual natural sciences, with their empirical explanations of nature that rely on these limit concepts without having their scientific validity being limited. This latter would, on the contrary, "guarantee" the limit concepts of speculative physics (11). At this point it clearly emerges that this would be the only possible way for Schelling to reconcile philosophy and the science of nature, guaranteeing the legitimacy of each discipline and, with it, the conditions of possibility for the existence of new research developments. From such a relationship between speculative physics (namely, Schelling's *Naturphilosophie*) and the special sciences, the discovery of new theories and concepts is made possible; these latter, indeed, are grounded on the limit concepts provided by philosophy of nature, namely, the fundamental discipline par excellence that includes them.

Schelling (1798, 11) also refers to the birth of a new subject of investigation hitherto "unknown, which however cannot be considered invented." His philosophy of nature allows him to formulate a new physical hypothesis, which will be of great impact in the field of *Naturphilosophie* and Romantic science: the idea of a unification of the corpuscular theory of light with the wave theory of light. Schelling referred to it in a previous text, the *Ideen zu einer Philosophie der Natur als Einleitung in das Studium dieser Wissenschaft* (1797); but this hypothesis finds its full formulation exactly in *Weltseele*: "I wondered"—Schelling (1798, 12) writes—"if it is not possible to combine Newton's and Euler's theory of light" by examining the starting thesis of each and putting them together. In this way we could obtain "what Newton wants, that is a particular luminous material, also capable of chemical relationships, as well as what Euler wants, that is, a propagation of light through the simple shaking of a decomposable medium" (12–13). This would be possible, therefore, by exploiting the strong points of each of the two theories and setting aside the difficulties of each. Do not think, however, that Schelling came to this formulation out of thin air, because it was his constant attention to the empirical sciences, and in particular to the astronomical ones, that suggested it. The works of astronomers, including J. E. Bode and above all William Herschel, were essential points of reference for the young Schelling in his investigation of the conditions of possibility of an authentic *Naturphilosophie* (14; cf. Nisbet 1970).

The unifying theory of light starts from the consideration that, according to Schelling (1798, 14), "what we call light is itself a manifestation of a higher matter, which is capable of various other bonds and which, with each new bond, also assumes a different way of acting." Light, which to the human eye appears to be such a simple phenomenon, has in itself the character of an "original opposition" (the polar model), that is, the origin and cause of all opposition in the physical world (e.g., the light of the sun is the origin and cause of every opposition on earth: light and dark, heat and cold, liquid and solid).

Original opposition or heterogeneity must not be admitted without postulating an original substratum in which such opposition exists and is possible. This substratum or original matter is none other than the ether, the vital air (*aer vitalis*) "scattered inside the cosmic bodies" (Schelling 1798, 15). It corresponds to a widespread concept in ancient philosophies that found supporters among philosophers and scientists of the time (Descartes, Huygens, Euler, Newton). In this way the ether ceases to be a mere hypothesis for Schelling, acquiring new strength and credibility thanks to new scientific knowledge (the new speculative physics above all), becoming suitable for explaining both the material and the spiritual

(16). Far from being an irresolvable opposition, the relationship between philosophy of nature and the natural sciences is, to Schelling, a synergy, drawing sustenance from intersection and mutual exchange.

The program of elaboration of a *Naturphilosophie* or speculative physics, which looks at the original principles of nature and not at its particular driving forces (these latter as objects of a mechanical philosophy based on the Newtonian framework), was already present in Kant's philosophy of nature (cf. Ferrini 1995, 38). However, it acquires new light in Schelling: he connects it with the problem of the definition of a substratum to which the opposite forces or principles must be necessarily traced back. It is intriguing here to remember the importance of the notion of substratum in Plato's *Timaeus* and in the *Philebus* as well, two works Schelling studied thoroughly during his time at the Tübingen *Stift* (Beierwaltes 1972; Franz 2012; Follesa 2020). In his commentary on the *Timaeus*, Schelling identifies Plato's notion of "original matter," namely, of a preexisting matter before the creation of the world, with something formless and highly perturbed that precedes the existence of the natural forms. Schelling also mentions Plato's definition of απειρον in *Philebus* (24a–25b) to explain original matter as indefinite and continuous. The crucial point is Schelling's attention to the indissoluble connection between original matter and its principle of movement, the original world soul. By referring to an original principle of movement inseparable from original matter, Schelling—with Plato—can easily avoid the idea of an inert matter and establish a connection between animated matter (before creation) and life in the cosmos (after the creation, namely, after the union of matter with intelligible forms; Schelling 1794/2008, 210). Schelling's commentary on Platonic cosmology testifies to his early effort to dissolve the dichotomy between matter and spirit and provides the ground for a new description of the universe in which matter already includes in itself the (pre)conditions of life.

Exactly for this reason (the need to include the explanation of life phenomena) is Schelling's conceptualization of matter anything but simple, requiring significant commitment on his part to elaborate during his early and even later intellectual career (Cesa 2011; Marchetto 2011). Schelling's philosophy of nature was innovative and visionary, and it influenced philosophers and scientists of his time. Even those authors who did not recognize officially the relevance of Schelling's contributions and his creation of a 'speculative physics', such as Herder, were profoundly impressed by his work—although we should not forget that Herder himself was one of the most important references for Schelling's definition of matter as the "expression of an internal activity."[3] Schelling's *Naturphilosophie* deeply

3. From Steffens's (1800, 14) review of Schelling's *Weltseele*.

influenced the work of other philosophers like Henrik Steffens and especially Hegel, who was interested as well, at the time, in defining a dynamic philosophy of nature in its relationship with the empirical sciences.

About a decade after his studies on Plato's cosmology and a few years after the founding of the new *Naturphilosophie*, Schelling returns to the problem of the "construction of matter," as well as to astronomical and cosmological issues, in writings including the dialogue *Bruno, oder über das göttliche und natürliche Prinzip der Dinge* and *Fernere Darstellungen aus dem System der Philosophie*, both published in 1802.[4] These writings prove Schelling's uninterrupted commitment to physical and astronomical topics, along with the study of Platonic and Neoplatonic sources and with his interest in the work of Kepler. In *Fernere Darstellungen*, Schelling (1802, §VI, 53) defines the "original unity" as "eternal nature" or "eternal matter," in which "all the forms are included," exactly like the notion of substratum in his early *Timaeus* commentary. He characterizes "gravity" as a "direct imitation of the eternal nature" (58)—namely, a phenomenon or manifestation of the original matter. What is relevant here is the preservation of the unitary character of the eternal nature in each "cosmic body," as an organic whole and as the "absolute connection of the infinite and the finite" since "a timeless eternity" (§VII, 84). The reference here is again to Plato, who, in his *Timaeus* (33b–33d), "affirms of the universe what we can affirm of the cosmic body too: it doesn't need anything from outside, since it has everything in itself" (Schelling 1802, §VII, 66).

Schelling's *Fernere Darstellungen* is clearly a testament to the mutual exchanges between Schelling and Hegel. So much is clear from Schelling's (1802, §VII, 63) words about the "speculative meaning" of Kepler's laws:

> If others have admired the laws of the cosmic system discovered by Johannes Kepler more for their effects and for the consequences that have been deduced from them, we must instead consider them in themselves and recognize their high value since they express in themselves, as in the purest reflection, the entire type (*Typus*) of reason and the life of ideas. The deformation that these laws have undergone with the Newtonian doctrine of attraction and with the attempt to derive them in a mechanical-mathematic way from accidental and empirical conditions, assumed *ad arbitrio*, has been highlighted in a sufficiently clear and rigorous way in Hegel's treatise *De orbitis Planetarum*.

4. *Fernere Darstellungen* was published in two parts in Schelling's journal *Neue Zeitschrift für spekulative Phyisk*.

3. Hegel's *Dissertatio Philosophica de Orbitis Planetarum* (1801)

In the very first years of the nineteenth century, Hegel took an active part in the debates relating to the intertwining of the natural sciences and the philosophy of nature, focusing, with particular interest, on astronomical issues. As is well known, he presented his dissertation for qualification for university teaching (*Dissertatio Philosophica de Orbitis Planetarum*) to the University of Jena at the beginning of 1801. It is a piece of writing that is controversial in some respects and much discussed by the critics and one to which scholars have assumed different attitudes. Some scholars have focused attention on the "errors" made by Hegel, in relation to the calculations of the position of the planets; others have emphasized the strengths of Hegel's dissertation, focusing in particular on the *pars destruens* taken by the text and on the reasons behind Hegel's rejection of the Newtonian philosophy of nature (Ferrini 1995); still others have highlighted the Platonic-Pythagorean origins of the discourse carried out by Hegel, ignoring the importance of other traditions of thought, for instance, Aristotle (Hösle 1984; Neuser 1986; Ferrini 1995).

The *Dissertatio* is a fundamental moment in the history of the intersections between science and philosophy in the context of German *Naturphilosophie*. Hegel was acquainted with some of the most relevant debates of his time concerning astronomy, and he did not hesitate to take a position, without necessarily adhering fully to the positions of others. His dissertation is therefore not an isolated case but fully in the spirit of his time and, at the same time, presents some original elements that are worthy of further investigation. Moreover, it is an example of the efforts that German philosophy of nature was making in the direction of continuous updating with regard to results in the emerging empirical sciences (Ziche 1996, 1997). What is most important, in this regard, is the fact that both Schelling and Hegel do not reduce philosophy to the novel scientific knowledge and empirical discoveries of their time; they strive—and here lies the main difference with Herder—to provide a philosophical system to include and explain at the same time all the specific sciences.

The comparison carried out by Hegel between the Newtonian approach and that of Kepler is fully engaged with the discourse of his time: it was a topic discussed at the time by other philosophers and intellectuals (Ziche 2013) and shortly thereafter by Herder in 1802 in the sixth issue of his *Adrastea*. This comparison was developed also in the wake of another famous debate that lasted more than a century and that runs in parallel, in the German sphere, to that between Leibniz and Newton (or between Leibnizians and Newtonians), about the first discovery of the infinitesimal (or fluxion) calculus. For instance, a very important source for both Hegel and Herder was Abraham Kästner, author of the *Geschichte der*

Mathematik (1796–1800), who analyzed the juxtaposition between Kepler and Newton in the fourth volume of his work, in which he affirms the Newtonian law of gravity: "When a body goes in an ellipse, the ellipse focal point attracts it, inversely as the square of the distance.[5] This would be merely a theoretical truth. It becomes the ground of physical astronomy, since Kepler had shown that the planets go in ellipses in whose focal point is the sun" (Kästner 1796–1800, 4:373). In fact, the juxtaposition between Newton and Kepler emerges, at the end of the century, precisely from the investigations concerning the task of the physical and empirical sciences, on the one hand, and the role of mathematics and speculative physics, or natural philosophy, on the other (Ferrini 1995; Nasti 1996). The context in which the Hegelian arguments are situated, therefore, as Ferrini has explained extensively, is "much more sophisticated and structured than what has been believed up to now." It cannot be merely traced back, as appears in a good part of the critical literature on the subject, to a mere adherence of Hegel to the Pythagorean-Platonic tradition—to which Kepler can certainly also be traced (Baum 1989, 140; Ferrini 1995, 117).

Reconnecting with the Schellingian project of an authentic *Naturphilosophie*, Hegel also affirms the need to look at totality as a fundamental prerequisite for knowing something real about nature, fully grasping the "structural whole of the solar system" (Hegel 1801/1986, 4),[6] rather than merely representing empty formal and abstract mechanical relationships. Newtonian science, also called 'experimental philosophy', is the result, according to Hegel, of a mixture of physics and mathematics that adds nothing, in fact, to the contribution previously provided by Kepler. That gravity was a real, physical force is not deduced from the law of universal gravitation but was already implicit in what previous physicists knew before its formulation: "Our great countryman Kepler, blessed with the gift of genius as he was, discovered the laws according to which the planets circulate in their orbits. Later, Newton was celebrated for proving these laws not from physical, but from geometrical grounds, and also, despite that, for integrating astronomy into physics. Now Newton certainly did not introduce the force of gravity, which he wants to identify with centripetal or attractive force, into this part of physics" (Hegel 1801/1986, 4; cf. Neuser 1986, 82). Kepler "took gravity to be a common quality of bodies" and "discovered the attraction of the moon as the cause of the ocean tides and that the irregularities in moon motion were due to the combination of forces of the sun and the earth." The core of the problem, concerning Kepler, is that "it would certainly have been very easy for him to give pure and mathematical expression to the physical form of the unchangeable laws

5. Newton, *Principia* L. I. Pr. XI. [Kästner's note.]
6. In the original, "compage systematis solaris." Cf. Neuser (1986, 82).

he discovered," but this would have required us "to tolerate the kind of confusion which arises"—or so Hegel says—"from combining gravity, centripetal force and centrifugal force" (Hegel 1801/1986, 6–7; cf. Neuser 1986, 86–88). Thus Kepler, who moved exclusively on the field of physical phenomena, had elaborated his laws exclusively on the ground of the movement of the planets, refraining from making a mixture between these laws and the force of gravity—that is, from starting from an 'external' perspective (Hegel 1801/1986, 4, 6–7; cf. Neuser 1986, 82, 86–88).

Newton's plan would have been, according to Hegel, to apply mathematical language to the description of physical phenomena, with the consequences that this application entails, for example, in the definition of concepts and in the real explanation of phenomena (Hegel 1801/1986, 6; cf. Neuser 1986, 86). Such an operation is destined to fail, at least partially, since mathematics and physics inevitably remain distinct disciplines, as their way of operating is fundamentally distinct. Whereas mathematics defines its objects as data and deals with quantitative relationships that have nothing to do with the notion of 'force', physics, on the contrary, aims at the explanation of movement. Therefore, it tries to reconstruct the origin of its objects, focusing exactly on the concept of 'force', which is alien to pure mathematics (Hegel 1801/1986, 5–6; cf. Neuser 1986, 84–86). Deprived of such a mathematical apparatus, the Newtonians would be left with only a series of poor examples, incapable of constituting a real science of nature:

> Now turning to the physical reality of centrifugal force leaving geometrical justification aside, shall we not consider the philosophical construction of this force in that experimental philosophy which Newton regards, or rather all Englishmen have always regarded, as far and away the best, indeed as the one and only? They are only able and only want to confirm the hypothesis of this force through experience. Nothing, however, could be sadder than the examples they adduce to that end. Popular with Newton and his followers is the stone in the sling that tends away from the thrower's hand as he swings it, flying off the moment he unleashes it. Then they illustrate centrifugal force with that other example of the lead cannon ball, shot with the explosive force of a cannon at a given velocity on a horizontal line from the summit of some mountain, flying on a curved trajectory before hitting the ground two miles away. (Hegel 1801/1986, 9–10; cf. Neuser 1986, 94, 96)

If the aim of experimental philosophy is to start from concrete examples, that is, from the observation of how the physical forces, divided into opposing attractive and repulsive forces, give rise to physical phenomena, and to arrive in this way at an adequate description of nature, such efforts would only lead to unsuccessful results, since it is impossible to achieve a unitary vision of nature from a composition, external, of these forces (Hegel 1801/1986, 10–11; cf. Neuser 1986, 96, 98). Hegel will develop a new kind of philosophy that is not experimental but truly capable of drawing from itself only, by deducing a priori that unitary vision that is lacking in an exclusively experimental approach. This unitary vision can be provided only in a formal abstract way by the direct application of the mathematical method to physics:

> However much the experimental philosophy draws upon geometrical-physical reasoning for its concepts of a force tending towards a center and a tangential force, the way it constructs the phenomena out of absolute opposites certainly can't be identified with the geometrical method. For geometry does not try to construct a circle or any other kind of curve from lines coming together at right angles or any other angle, but rather assumes a circle or other curve, the object of study, as given and then shows how the relationships between the remaining lines are determined from this. Physical science must imitate this true method exactly, positing the whole and deriving the relations between the parts from that. It may not under any circumstances compound the whole from opposed forces, which are but parts. How then could astronomical physics arrive at its laws with the help of mathematics without following mathematics faithfully? Thus, even when it believes itself to be talking about centrifugal force, centripetal force or gravity, it is in fact always making assertions about the whole phenomenon. (Hegel 1801/1986, 11; cf. Neuser 1986, 98; see also Hegel 1801/1986, 12; Neuser 1986, 100)

Hegel's recourse here to a terminology that makes no secret of its Platonic roots is significant when he defines as shadows (*simulacrum*) knowledge deriving from the senses as opposed to the "true philosophical concepts" (Hegel 1801/1986, 11; cf. Neuser 1986, 98).[7] Again, along the same lines, Hegel speaks of "imitations" of nature when referring to the knowledge provided by mechanical and experimental philosophy, which is imperfect and subject to chance and arbitrariness, as opposed to that of "true philosophy," which does not imitate (and above all it does not imitate a "dead" nature that is regulated exclusively by blind mechanical forces) but rather effects a synthesis, starting from itself, that captures the dynamic and real character of nature as a totality (Hegel 1801/1986, 11; cf. Neuser 1986, 98).

7. In the original, "verarum philosophiae notionum."

4. The Force and Its Instrument

Herder did not accept the work of the *Naturphilosophen* because he refused the foundations of their philosophical method, that is, a 'speculative' philosophy that originates from itself, independently from any reference to knowledge from the senses. According to Herder, philosophy should not be pure (and systematic) knowledge, cannot express its content independently from perceptual experiences, and as with authors like Kant, a decade before, or Schelling, at the time, cannot consider itself as an abstract object. All our knowledge strongly relies on interactions between the inner activity of our soul and the instrument of this activity, which is the body with its perceptions, feelings, and images. That is why human knowledge can only be analogical and historically determined. Philosophical and scientific theories are, according to him, deeply rooted in experience, which is not merely intellectual but a complex ensemble of forces and impulses; they are historically determined organs and instruments, part of the unique and eternal spiritual power that animates the world from within. A 'pure' spiritual activity does not exist, according to Herder, just as pure and a priori concepts and knowledge are considered by him to be merely dreams. Natural forms and historical expressions are required to be real and act in the world.

In his last work, the six volumes of the journal *Adrastea*, published between 1801 and 1803, Herder gives expression to his reflections on the relationship between scientific and philosophical knowledge, with specific references to the newest discoveries in the field of cosmology, astronomy, and optics. In the sixth issue of the journal, the so called 'Licht-Adrastea' (or Adrastea of light), Herder focuses on the underpinnings that, during the eighteenth century, characterize the history of astronomical discoveries (Follesa 2019). The way in which he addresses this astronomical history is fascinating, since Herder does not deny himself his inclination toward analogies, insisting on powerful metaphors involving light and the sense of sight. In this way, he creates a mixture of scientific knowledge, moral values, literature, and aesthetics, and he discusses, in a rather literary style, the most recent discoveries in astronomy and optics, resulting in a very peculiar and fascinating but also controversial work.

The journal *Adrastea* has been neglected by many scholars because of its ambiguity, vagueness, and absence of a rigorous method (Arnold 2001). The recurrence of metaphors and images is not by chance: they are used to make concepts and theories clearer and more accessible to a wide public of nonspecialist readers; they are the result, as well, of Herder's refusal to remain within the exclusive circle of specialist literature and abstract philosophy. Finally, the style is coherent with Herder's gnoseological view, according to which we know only by a mixture of concepts and images. Although only implicitly, Herder clearly refers in a negative way to the philosophical trends of the previous 2 decades, from Kant's transcendental philosophy to German idealism and *Naturphilosophie*, criticizing their aim of handling philosophy from a speculative viewpoint independent of experience.

Herder considers each philosophical theory, scientific discovery, term, or law within a specific historical context, and he is skeptical of the idea of immutable human knowledge. Scientific knowledge belongs to a continually changing process, in which several elements take part in different ways. Individual acuity and geniality may be effective only in a fruitful context, that is, within advantageous cultural, political, economic, and social conditions that promote and do not impede scientific advancements. These considerations are expressed by Herder in a chapter in the sixth issue of *Adrastea*, aiming to recognize the complexity of scientific development and its close dependence on historical circumstances and to eliminate some prejudices and anecdotes that present new discoveries and theories as merely coming from an illuminated genius or a single exceptional mind (Herder 1802). A genius, a bright brain, a brilliant scholar can scarcely achieve great results if not supported by financial assets, by political encouragement, and by the approval of a community. Herder applies these thoughts to both theoretical and empirical sciences, since both these aspects of scientific development are firmly connected to each other.

The metaphors used by Herder to explain the development of scientific knowledge are deeply rooted in his metaphysics, on which his philosophy of nature and philosophy of knowledge are grounded as well. The main idea is the close relationship between a spiritual element (e.g., a noncorporeal and nonmaterial element), which he usually calls 'force', and its counterpart, the concrete, material, corporeal side that acts as an instrument or an organ (Herder 1802). He distinguishes these two parts of reality without clearly defining 'force' and without ontologically separating force from the organ that brings it about. They both belong to the same unity and represent, respectively, the interior active part and the external manifestation of one and the same reality. This scheme is applied by Herder to describe all natural phenomena: the universe as a whole as well as its single parts, human history, and the human mind. Herder applies the same model of explanation to scientific knowledge, affirming the importance of optical instruments, for instance, for the development of theoretical knowledge and astronomical sciences. Theory and empirical observations can only proceed hand in hand (254). Even more fascinating, Herder defines optical instruments, for instance, and the empirical observations that depend on them as the continuation of limited human perception (e.g., the eye). But the eye itself is an instrument, if considered with respect to that most interior activity: that of the mind, of reason. Everything belongs to a great organism, of which the inmost and most inaccessible part is an eternal and *in sich* concealed power (255).

The sixth issue of *Adrastea* is not simply a repetition of what Herder already expressed in his *Ideen* (1784–91/1800). This is evident if we consider it through a close comparison to what Schelling and Hegel affirm, respectively, in the *Weltseele* and *De Orbitis* referred to above. Although we have no particular evidence of it, Herder must have been aware of the debates between philosophers and scientists at the turn of the nineteenth century. He mentions the hypothesis of a unifying theory of light, of which he undoubtedly learned from Schelling's *Weltseele* as well,[8] but he does not mention Schelling in the sixth issue, and even Goethe's name is, inexplicably, completely absent (Herder 1802, 263–64, 277ff.). The relevance of the sun, as the center of the solar system and as the origin of all life, with its sources in the Keplerian view of the universe, is found in Hegel as well as in Herder (277ff.). The critique of Newton mechanical philosophy found in both Schelling and Hegel is also found in Herder, who argues that two opposing forces cannot be the ultimate principle of reality, as both must be able to affirm some principle that unites them (235–36). Yet, contrary to Hegel, for example, Herder does not exploit this argument to deny the legitimacy of Newton's own conceptions. Instead, Herder argues that it was Newton's successors and supporters who distorted the message contained in his view of nature.

The juxtaposition between Newton and Kepler that occupies several pages in Herder's *Adrastea* is not that sharp as in Hegel's dissertation. It examines in detail the different historical conditions in which both authors, one in Germany, the other in England, lived and worked. Kepler "already knew and comprehended the law of gravity," according to Herder—a law that, many years later, Newton "derived, if you like, from Kepler's principles" (Herder 1802, 229). As a "martyr of the purest truth" (229), Kepler had to fight against the "enemies of sciences" (252) for pursuing his research and even for his survival. Kepler used the language of his epoch, as well as the images that were necessary to communicate his mathematical truths to his contemporaries (e.g., "animal force" instead of the law of gravity). But Kepler was, no less than Newton, a great mathematical mind and a genius (Herder 1802, 252; cf. also Kästner 1796–1800, 4:363–64, 379). Herder focuses on these historical conditions more than on the critique of their scientific approaches, since his aim is not to promote a new form of philosophy (a dynamic philosophy or a speculative physics) as a substitute for the mechanical-Newtonian experimental philosophy but to show, from a historical perspective, the intercourse between intellectual development and practical conditions (in which financial, political, and technical features are involved).

8. If not directly, through the mediation of associates such as Goethe or his friend L. von Knebel.

Newton was a genius, a great man, as was Kepler—this is to Herder an indisputable truth. However, the fact that they lived different lives was relevant to the success of their ideas and scientific theories.

Attributing the constitutive role of the real to blind mechanical forces does not belong to Newton's worldview, since Newton had never expressed, with respect to the ultimate ontological status of reality and causes, any similar idea in this regard. On the contrary, his faith in the existence of a "substratum" had never failed (Herder 1802, 235–36). In any case, in Herder's perspective, the substratum, as such, is unavoidably inaccessible. Yet, it can be known in some way, since human beings are fully immersed in nature, in an ocean of perceptions that is a variegated manifestation of that substratum and an inextricable network that ultimately refers to the substratum. Whatever the name that is attributed to it from antiquity until the early nineteenth century (most of all, *ether*), it nourishes human knowledge in line with what Plato affirmed in the pages of his *Philebus* (29c2) about the fire of the universe. From Herder's point of view, reflections on the concept of substratum cannot set aside the relationship between force and instrument, and they must come back to the idea of a fundamental unity of nature, consisting of activities that proceed from within and manifest themselves externally in corporeality. If the Kantian distinction between force and instrument is very clear and precise, Herder's is not rigorous and defined once and for all. There is a nuance, an imprecision (but deliberate) between the definition of 'force' (a very 'vague' concept of it) and the definition of an instrument, an organ, a tool: our knowledge and our definition of it continually change. As Kant (1785) already pointed out in his review of Herder's *Ideen*, Herder's definition of force is not univocal and, indeed, easily leads one to think of the concept of force as a kind of "obscure" concept, not scientifically determined. However, the force-instrument model represents for Herder a dynamic explanatory model, a (functional) paradigm that he can apply, in different ways, to the knowledge both of nature and of the human world, giving his system a particularly organic structure beyond any apparent "confusion."

The aim of this article was to focus on the discussions concerning the relationship between philosophy and science, and in particular the interactions among speculative philosophy and empirical observation, between the end of the eighteenth and the very beginning of the nineteenth century in Germany. The sharp juxtaposition between Herder's view concerning the limits of human knowledge and Schelling's formulation of a speculative physics that goes beyond the limits of empirical sciences does not prevent the convergence of their ideas in conceiving a similar unitary theory of light, based on a common notion of 'substratum'. This latter, which has been often equated to ether, to an original matter animated by an original 'world soul', or to an internal and creative power, is the common basis for the explanation of the universe as a unitary and organic system. The common reference to ancient (Plato) and modern (Kepler, Newton) sources, as well as to the most recent discoveries in astronomical empirical sciences (Herschel), provides a common ground to Herder and the *Naturphilosophen* like Schelling and Hegel, although it led to divergent conceptual and methodological results. The nonlinear development of the engagement between philosophical ideas, mutual suggestions, references to common sources and their different interpretations, and continual exchanges between metaphysics and scientific investigations were among the characteristic aspects of those decades at the turn of the century in Germany, when cosmology and astronomical sciences were influenced by philosophical views that were deeply concerned with the explanation of life and the organic world.

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