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PHILOSOPHY OF NATURE*

Dieter Wandschneider

It is one of the oddities of intellectual history that our present age – an epoch determined by natural science and technology – has developed an elaborate philosophy of science but no full-fledged philosophy of nature. Popular accounts of the results of scientific research, which have appeared in great numbers for decades now, have made important contributions to the promotion of science. But they cannot replace the philosophical penetration of natural scientific knowledge. Consider, for example, the problem of what constitutes a law of nature. This problem is central to our understanding of nature. Yet philosophy of science has not provided a definitive response to it up to now. Nor can we expect to have such an answer from that quarter in future. Since its interest lies above all in the question of whether and how assertions concerning universal laws of nature are empirically justified, contemporary philosophy of science loses sight of the *ontological* issue at stake, namely, the question of an *intrinsically lawful nature*. What is needed in this regard would be a philosophical ontology of nature that takes account of the modern development of science. Of course, the articulation of such an ontology would have to integrate and render useful the immense theoretical labour already purveyed by the philosophical tradition. And this would undoubtedly

mean thinking primarily of Hegel. But why Hegel?

The orientation of Descartes's thought is epistemological and methodological rather than ontological. While Spinoza and Leibniz have their general ontologies, neither of them developed a special ontology of nature. Moreover, the empiricism of Hobbes, Locke, Berkeley and Hume is again primarily of epistemological orientation. Finally, while Kant's transcendental turn in the theory of knowledge has direct implications for the problem of natural law,¹ from a justificational point of view it sticks to a construction that leaves open the essential ontological questions. According to Kant's own testimony, the *Metaphysical Foundations of Natural Science* (MAN) of 1786 does not satisfy the philosophical need for a fully realized metaphysics of nature. That this need ultimately remains unsatisfied is evidenced by the repeated attempts at clarification that we find in Kant's *Opus postumum* (Mathieu, 1989; Edwards, 2000, pp. 132–92). The account of organisms' 'inner' purposiveness that Kant gives in the 1790 *Critique of Judgement* (KU) also lacks a foundation in natural ontology (Dahlstrom, 1998). Kant was well aware of this latter deficiency, and he responded to it by means of his hypothesis of a 'supersensible', that is, rational, 'substrate' of nature.

But in immediately revoking this hypothesis by interpreting it as a merely subjective reflection on nature, he ontologically devalued his response (see *KU AA* 5:414; cf. *KU AA* 5:176, 196, 381, 388–9, 409–15, 422).

At the same time, though, an entirely new perspective becomes evident through *KU*'s conception of nature's supersensible substrate. This substrate, which Kant thinks of as a rational ground of being, is in a fundamental sense already the idea of an absolute *logos* that encompasses subject and object in equal measure. In Kant's formulation, it is the idea of a 'supersensible real ground for nature . . . to which we ourselves also belong' (*KU AA* 5:409) – a genuinely ontological conception that was of central significance to the emergence of German Idealism. Indeed, one can understand the developmental history of German Idealism from Fichte through Schelling and towards Hegel as precisely the emergence and further shaping of that Kantian conception.

Of fundamental importance to German Idealism, then, is the concept of an absolute that lies at the basis of reality. This is a concept interpreted differently by Fichte, by Schelling and by Hegel. For Fichte, the 'I' has absolute standing while the world, including nature, is first and foremost determined as non-'I'. This devaluation of nature, which goes hand in hand with Fichte's subjective idealism, was remedied by Schelling. Thus, Schelling's historical merit should be seen not least of all in the fact that he made clear the relevance of the *concept of nature* for the project of a viable idealistic system. Nevertheless, Schelling's brilliant philosophical conjectures did not coalesce into a complete and convincing picture. A basic difficulty in this regard lies especially in the unclarified relation of the absolute – Schelling spoke of 'absolute identity' or 'absolute indifference' – to natural

reality and the reality of spirit. Just what is it that necessitates the realization of the absolute in the forms of nature and finite spirit? This is a question that Schelling ultimately left open and that Hegel is the first to have made progress in answering. From a systematic point of view, Hegel's philosophical interpretation of nature is until now perhaps the most well thought out account of a philosophical concept of nature.

AN INTERPRETATIVE PREJUDICE

Opposed to this evaluation is a prejudice of long standing, namely, the view that Hegel's philosophy of nature is not only the weak spot in his system, but is also downright absurd on account of its purely speculative character and its lack of any real relation to empirical data and the positive sciences. As an example of the devastating judgements passed on Hegel's philosophy of nature, consider what Henrich Scholz had to say during the period of Hegel's rediscovery in the last century:

Hegel's philosophy of nature is an experiment that, instead of promoting natural philosophy, throws it back several centuries to about the level of Paracelsus . . . Hegel's natural philosophy is a play with concepts – a game that will never again be taken seriously and that can serve merely to prove that a great thinker, when he goes astray, does not stop at minor aberrations. (Scholz, 1921, p. 38)

Given this sort of assessment, Michael Petry states that '[u]ntil 1970 there was hardly anyone among the Hegelians – let alone any philosopher of science – who was prepared to

recognize Hegel's philosophy of nature as a serious area of research' (Petry, 1981, p. 618).

Undoubtedly, the interpretative attitude just characterized will not appear to be entirely groundless in view of some of the outdated, historically conditioned points in Hegel's work on natural philosophy. This can be seen especially in the second part of Hegel's mature system of the philosophy of nature, that is, in the part titled 'Physics'. (We bear in mind here, however, that Hegel's explanations regarding light and chemical processes are undoubtedly of fundamental interest. More on this below.) It is certainly true that Hegel did not always resist the temptation of co-opting insufficiently researched empirical materials and then rashly declaring them to be derivable from 'the concept'. But the pioneering works of Petry (1970) and D. von Engelhardt (1972), which have given rise to many further investigations, have effectively shown Hegel's purported disdain for empirical data to be an interpretational prejudice that can no longer be supported (Neuser, 1987a; Petry, 1988). The scientific and mathematical works used by Hegel and available in his library bear testimony to his intensive preoccupation with the empirical sciences of nature of his time as well as with mathematics (Neuser, 1987b; 2000b, pp. 199–205; Bronger, 1993; Mense, 1993; Petry, 1993a).

In any case, the long neglect of Hegel's natural philosophy must appear as absurd when regarded from the general perspective of the interpretation of his thought. Hegel consistently emphasized the character of philosophy as system, and for a thinker of Hegel's stature it is extremely improbable that parts of his total system can simply be eradicated without losing something essential for understanding the remaining parts. This is already reason enough not to disregard the role of natural

philosophy in Hegel's overall philosophical project. To mention just one example: the very concept of spirit, according to Hegel, simply cannot be determined independently of the concept of nature.

The following considerations are based on the final version of Hegel's comprehensive account of his system that is found in the 1830 edition of the *Encyclopaedia of the Philosophical Sciences (Enc)*, which is divided into the Science of Logic, the Philosophy of Nature and the Philosophy of Spirit.

THE LOGICAL BASIS

According to Hegel, only logic comes into question as the foundation for every philosophical undertaking. Every philosophy that lays claim to rational demonstrability must be in a position to ground its own point of departure. While this demand appears to be taken for granted, it has hardly ever been satisfied in more than two millennia of rational Western philosophy. Even the great systems – Kant's or Schopenhauer's, for example, which rest on the merely assumed basis of 'transcendental subjectivity' or, respectively, 'primitive will' – come up short in this respect. They are significant because they are astutely and elaborately worked out. Yet they lack any rationally demonstrable justificational basis. Hegel avoids precisely this deficiency by setting out from logic.

Hegel's procedure in this regard is based on the insight that fundamentally *everything* can be called into question except for logic. For logic always furnishes the *presupposition* of every line of questioning – of every possible epistemic challenge to any given claim. According to Hegel, only a *fundamental logic* can furnish the basis of philosophy. It is clear,

then, that this logic cannot be one of the many 'logics' that, as formal systems, rest on axioms, and thus on arbitrary assumptions that could have been selected differently and that therefore cannot be taken as genuinely fundamental.

But how are we to understand fundamental logic in Hegel's sense? Consider, for example, the principle of contradiction – hence the principle that contradiction is to be avoided. This principle is held to be unconditionally valid since any arbitrarily given proposition would be formally derivable if contradiction were permissible. If the principle of contradiction did not obtain, then all argumentation would be an idle and pointless exercise. Furthermore, there could not even be meaningful concepts: If 'A' and 'non-A' did not differ, there could be no negation; but without negation (as the contrary of affirmation) there is no demarcation, and thus no possibility of conceptual determination (*Begriffsbestimmung*). That is to say, by reverse inference, that whenever meaningful concepts are applied, the principle of contradiction does hold true. This principle is thus indispensable for meaningful argument and is, in this sense, fundamental.

Analogously, the entire system of fundamental logic – which in the following I will abbreviate as 'logic' – must be understood as the un-annullable basis of meaningful argumentation. To use a key term from contemporary philosophic discussion, logic is *ultimately groundable*. Of course, if logic itself is to be grounded, then it is already presupposed (since grounding is itself a logical operation). In other words, fundamental logic can be grounded, or proved, only in the form of its self-grounding. This should not, however, be taken literally as a grounding of logic upon itself – which would be absurd – but rather as logic's own logical exposition

and clarification. In short, it must be understood as the *self-explication* of logic by logical means (for details, see Wandschneider, 2005b).

This self-referential and *cyclical* structure of fundamental logic (Rockmore, 1993) involves the idea that the system of logic 'coils in a circle' (*Science of Logic* [WL] GW 12:251). As Hegel had already expressed this idea during his Jena period, logic presents a self-grounded totality (*Begründungstotalität*) to the extent that it is 'a whole that is internally supported and completed, that has no ground apart from itself but is instead grounded by itself in its beginning, its middle, and its end' (*The Difference between Fichte's and Schelling's System of Philosophy* [*Differenzschrift*] GW 4:30–1). Taken in this sense, logic is a self-supporting, internally autonomous and *un-conditioned* (*un-bedingt*) holistic structure. As such, it is *absolute*.²

HEGEL'S CONCEPT OF NATURE

The absoluteness of fundamental logic as a whole, which Hegel characterizes as *absolute idea*, is also what furnishes the basis for the existence of nature (Wandschneider, 1985) – which is tantamount to saying that that logic also has ontological relevance. That is because what simply cannot be gainsaid cannot *not be*. Rather, it *must be*; and this applies in particular to the being of nature.

Hegel's own considerations on the relation between logic and nature, which are exceedingly terse, have been the subject matter of numerous and controversial investigations (see, e.g. Volkman-Schluck, 1964; Burbidge, 1973; Brinkmann, 1976; Wandschneider, 1985; Falkenburg, 1987, ch. 1.2; Drees, 1993). This is not the place

to go into this discussion, and it will have to suffice for me to provide a plausibility argument. The notion that fundamental logic – Hegel's absolute idea – is absolute or unconditioned (*un-bedingt*) signifies that it cannot be grounded 'from the outside', that is, from a *non*-logical standpoint; for the activity of grounding is itself already a logical operation. What is logically ideal points beyond itself precisely because it is determined as unconditioned; and it does this precisely as that which is not conditioned by the *non-ideal*, whatever that might be. Thus, the *non-ideal* is always co-implicit by the logically ideal – a point which, incidentally, expresses the essentially *dialectical* character of fundamental logic. From the standpoint of dialectical logic, the absolute idea and the *non-ideal* belong together inseparably (Wandschneider, 1995).

But what *is* the *non-ideal*? If the ideal is characterized by logical and conceptual connectedness, the *non-ideal* is characterized by separateness, that is, by 'externality [*Außereinander*]' or simply 'juxtaposition [*Auseinanderseyen*]' (*Enc* §253) as this is encountered in the spatio-temporal being of nature (Halper, 1998). Nature, then, is understood as the complement of the absolute idea. From the viewpoint of dialectical logic, nature belongs to the absolute idea as the positive belongs to the negative. According to Hegel, nature is also 'the idea', but it is the idea in the negative form of 'otherness [*Andersseyen*]'. It is, as it were, the eternal accompanying phenomenon of the ideal that determines itself as absolute. Together with the logically ideal (the existence of which cannot meaningfully be denied on account of the very character of its absoluteness), there must also always be nature.

But is the character of absoluteness likewise to be ascribed to nature? Not at all,

for nature is what is *conditioned*. It is what is conditioned by the logically ideal as that which is *un-conditioned*. The logically ideal, in Hegel's sense, is the underlying principle of nature, and nature is that which is principiated. Given this relation, a remarkable ambivalence accrues to the concept of nature: as the other of the idea – as the *non-ideal* – nature is characterized by separateness even though the ideal is what furnishes its underlying principle. Put differently: natural being *appears* as something separate, but its underlying *essence* is of an ideal nature (Wahsner, 1996, ch. 1.1). Although this may sound mysterious, it is in fact something quite familiar. For natural reality is not absorbed into its spatio-temporal separateness, but is rather determined by natural laws, that is, by a logic that lies at the very basis of nature. A law of nature, of course, is not a natural object. The law of falling, for example, is not itself something that can fall; and the laws of electricity are not themselves electrical. The laws of nature, then, constitute the logic of nature, in the sense that they are the ideal entities that lie at the basis of nature as its underlying ideal essence.

THE OBJECTIVE-IDEALISTIC PERSPECTIVE

The sort of philosophy which takes logic as its basis, even in its account of nature, is designated as *objective idealism* (cf. Höhle, 1987c). It must not be confused with the subjective idealism of Descartes or Fichte, which seeks to ground everything by starting from the 'I'. Much less may it be confused with Berkeley's psychologistic version of idealism (cf. Solomon, 1974; Maker, 1998). Hegel's idealism is called 'objective' because

Hegel sets out from the objectively binding character of logic. As was explained above, logic can be called into question only at the cost of self-contradiction, and it is for this reason that logic alone comes into question as a firm rational foundation. The being of nature – which is necessarily entailed by dialectical logic – thereby qualifies as something that in its essence is ideal. This means that it must be grasped as something determined by an underlying logic, and hence by laws of nature. This relation between the logically ideal and natural reality grounds a unique characteristic (*Alleinstellungsmerkmal*) of Hegel's philosophy of nature, namely, the fact that *reasons* are given for both the *existence* of nature and nature's *lawfulness*.

When understood from the standpoint of objective idealism, 'all reality is in itself lawful' (*Phenomenology of Spirit* [PhG] GW 9:92) in the sense that it is determined by an underlying logic that for its part is accessible to thinking. This logic, however, must not be understood as a merely subjective faculty, but rather as 'the reason of that which is' or as a universal *logos* that inhabits all being (WL GW 21:17). At issue here is Hegel's conception of the 'idea' which underlies both thought and reality in equal measure: 'Everything actual is the idea inasmuch as it is something true and has its truth only through the idea and in virtue of it' (*Enc* §213R; cf. *Berliner Antrittsrede* 1818, GW 18:19–20). This ideal ground of nature explains why nature is *cognizable* – why determinations of thought can grasp and penetrate reality.

That the natural sciences actually presuppose the objective-idealistic conception of nature – while not explicitly reflecting this on their part, of course – is something that can be seen in their attitude towards scientific research (Borzeszkowski and Wahsner,

2004; for criticism, see Wetzel, 2004, p. 18). Hegel speaks of the *theoretical approach* in this regard.

To take up things directly, to deal with them and apply them is what he calls the *practical approach* – which is what occurs when even an animal simply tucks into things and devours them. Opposed to this, then, is the theoretical approach, that is, the purely cognitive attitude that does not involve changing or destroying things, but rather 'leaving them as they are, and adjusting to them' (*Enc* §246A). Following Hegel, however, we must take into consideration the fact that in cognition we also 'transform [things] into something universal' (*ibid.*). Thus, the theoretical approach seems to be 'inwardly contradictory since it appears to bring about the precise opposite of what it intends' (*ibid.*). For theory is what makes things into something ideal: 'We make them into something subjective, produced by us . . . for the things of nature do not think, and are neither representations nor thought' (*ibid.*). Consequently, the question arises: 'How are we as subjects to get over into the object?' (*ibid.*).

An answer to this question is possible only in the framework of an objectively idealistic conception of nature: The universality that belongs to the conceptual determinations of theory 'is not something subjective and belonging to us; it is rather . . . the truth, objectivity, and actual being of the things themselves. It resembles the platonic ideas, which do not have their being somewhere in the beyond, but which exist in individual things' (*Enc* §246A). Being the 'true nature' of factual reality, the universality of conceptual theoretical determinations belongs as well to laws to which 'is ascribed objective reality' (*ibid.*). Cognition, then, ought to leave things as they are. Yet it must apprehend not their sensible surface but rather their essence. That

is to say, it must grasp the immanent *lawfulness* that completely determines all things. Scientific research is directed to this alone; and to that extent it presupposes the objectively idealistic conception of nature even if it does not know that it does so.

‘COMPREHENDING’ COGNITION

It is only on the basis of logic that nature is cognizable at all. Otherwise, it would be as inaccessible to thinking as Kant’s thing in itself is supposed to be. If nature is cognizable, however, then it must be more completely open to conceptual *comprehension* than it is to merely empirical acquaintance. According to Hegel, ‘comprehending consideration [*begreifende Betrachtung*]’ is the special goal of natural philosophy the task of which is to make evident the conceptual infrastructure concealed in nature’s basic features (*Enc* §246). This is what distinguishes philosophy of nature from empirical natural science. The latter erects complex theories, but it does this in the form of abstract and hypothetical positions that lose sight of any holistically integrated perspective. Hegel refers to this as a ‘deficiency in physics’ (*ibid.*), but it is a deficiency that is representative of the natural sciences in general. To be sure, physics already demonstrates the tendency to fathom conceptual connections and base them on principles – which is, as it were, an intrinsically philosophical tendency at work within the science. One thinks here of natural scientists like Einstein or Heisenberg as well as the contemporary project of a Grand Unified Theory (in which the role played by a priori arguments has become increasingly pronounced) (Posch, 2009).

Is it conceivable that natural *science*, by ultimately substituting pure a priori cognition

for what is empirically yielded by observation and experimentation, could in the end be absorbed into a comprehensive *philosophy* of nature (Webb, 1980; Höhle, 1987b, ch. 3.2.2)? Such a ‘philosophical’ tendency is indeed grounded in the desire to understand nature, and it is comprehensible insofar as it is so grounded. In what follows, we will repeatedly encounter examples of this tendency while concretely expounding on Hegel’s philosophical arguments. Nevertheless, philosophy of nature is not pure logic, and it always remains reliant upon *nature*. As Hegel himself emphasizes, beyond conceptual argumentation the point holds that ‘the *empirical* appearance . . . also has to be specified, and it has to be shown that the appearance does in fact correspond to its conceptual determination’ (*Enc* §246). With respect to the ‘necessity of the content’ (*ibid.*), then, this is not an ‘appeal to experience’ (*ibid.*). Yet as Höhle rightly remarks: ‘in designating what corresponds to reality in this [conceptual] structure, philosophy . . . inevitably surrenders itself to experience – which always means: to the contemporaneous state of empirical knowledge’ (Höhle, 1987b, p. 82). If, for example, philosophical arguments for the three-dimensional character of physical space are put forward, there is always the question whether space’s tri-dimensionality, which seems empirically obvious, will not at some point be shown to be outdated (as will in fact happen should contemporary ‘super string theory’ be confirmed along with its supposition that there are at least seven additional spatial dimensions).

One essential thing to bear in mind in this connection is the fact that Hegel determines real nature (as distinguished from natural law) as the non-ideal, that is, as something that is in principle non-conceptual. As a matter of principle, then, this determination sets

cardinal limits upon our conceptual grasp of nature. There is in this sense a moment of contingency contained in Hegel's conception of nature (see Henrich, 1967, pp. 157–86; Höhle, 1987b, pp. 88 ff.). Hegel speaks of the 'impotence of nature' in this regard, and he holds that it is the height of pointlessness 'to demand of the concept that it should comprehend such contingencies of nature' (*Enc* §250R). To a certain Mr. Krug's naïvely polemical demand that natural philosophy ought to prove itself capable of 'deducing *only* his pen', Hegel replies that this task can wait until 'there is nothing more important to comprehend' (*Enc* §250R note).³

THE IDEALIZING TENDENCY IN NATURE

Hegel's position is that the conceptual-ideal (*das Begrifflich-Ideelle*) is only the inner ground of nature while the real being of nature appears above all as non-ideal separateness. This supports the further claim that there is in nature an effective 'drive' which can be characterized as a *tendency towards idealization*. According to its original and most general description, nature is first of all nothing more than the non-ideal. Taken simply as such, nature is incomprehensible; and it must therefore be grasped as *pure separateness*. Yet the very point of Hegel's philosophy of nature lies in the insight that the comprehending account of nature cannot remain caught at the level of this abstract extrinsicality. Instead, such an account places upon itself the demand to advance towards ever more concrete specifications of nature's real being. It must advance to the structures of space and time, to the structures of the material world and of living nature and finally to

the structures of spirit. As 'determinations', these specifications are essentially conceptual, and therefore *ideal*. Thus, Hegel's philosophy of nature, which takes the *non-ideal* as its starting point, progresses to determinations that make evident nature's increasingly ideal structures.

For this purpose, Hegel brings to bear the discrepancy that is characteristic of natural being, namely, the discrepancy between nature's *real* forms of appearance and its underlying *ideal* essence. This fundamental discrepancy between nature's appearance and essence means that 'the idea as this shape of externality is inadequate to itself', which is to say that 'as it *is*, its being does not correspond to its concept, but is rather the *unresolved contradiction*' (*Enc* §248R). This contradiction sets in motion a dialectic that induces a stepwise development, a 'development of the concept' underlying nature with the 'goal' of manifesting 'what it is in itself', namely, 'something ideal [*ein Ideelles*]' (*Enc* §251A). The concept aims, as it were, to 'break the rind of externality and become for itself' (*ibid.*; cf. §381A). In other words, it wants to validate the ideal form that is the only form adequate to it.

It may seem that the motor of nature's real evolution can be discerned in the tendency towards idealization just described. On Hegel's understanding of nature, however, that would be a misinterpretation.⁴ Nature's idealizing tendency does not *cause* the development of real natural forms. Instead, it involves the development of the conceptual determinations of such forms in the framework of natural philosophy. Thus, nature is indeed 'to be regarded as a *system of stages*, the one proceeding of necessity out of the other, being the proximate truth of that from which it results' (*Enc* §249). But this should not be thought of in such a way that 'the one [stage] *naturally* generated out of the other'

(*ibid.*) since to 'imagine genera as gradually evolving themselves out of one another in time is to represent them in a completely empty manner' (*Enc* §249A). The thinking consideration of nature as a system of stages 'must therefore relinquish such nebulous and basically sensuous concepts as for example the so-called *emergence* [*Hervorgehen*] of plants and animals out of water, and of the more highly developed animal organizations out of the lower, etc.' (*Enc* §249R).

Some 30 years before the publication of Darwin's *On the Origin of Species*, then, Hegel rejects the idea of natural evolution. He justifies this verdict by taking the position that development belongs to the *concept* alone (*Enc* §249). 'Development', in Hegel's sense, signifies the conceptual explication of what is already implicit in a determination (*Enc* §161A). Taken in this sense, it is not something encountered in real being. Hegel does, of course, provide formulations that appear to endorse a conception of real natural evolution. He holds that philosophy has 'in a certain way only to look on at how nature itself overcomes its externality . . . at how it liberates the concept concealed in nature from the cover of externality', and he maintains that nature is in this way 'driven onwards beyond itself to spirit as such' (*Enc* §381A, cf. §389A). According to these formulations, it is nature itself that carries out the process of idealization as natural evolution. Yet Hegel immediately goes on to deny this as well (*Enc* §381A).⁵

Hegel's philosophy of nature has three main parts: 'Mechanics', 'Physics' and 'Organic Physics'. His Mechanics treats space, time and motion. It also treats matter as something without specific properties, that is, as mass. What Hegel calls 'Physics' encompasses the domain of qualitatively different forms of matter such as light, the classical 'elements' (air, fire, water, earth) as

well as phenomena like cohesion. In addition, Physics treats acoustic, thermal, optical, electrical, magnetic and chemical properties of matter. Clearly, the Hegelian conception of physics is not fully congruent with our contemporary conception. Nor is the idea of an 'organic physics' employed today, and the subject matter of Hegel's Organic Physics pertains above all to the specific phenotypes of plant life and animal organisms. The highest form of organic life is reached in the occurrence of the *psychical*. Only the human being is able to go beyond this highest stage of nature's development towards the forms of mental life that in turn lead into the sphere of spirit.

In what follows I will present and interpret the three parts of the Philosophy of Nature in connection with Hegel's text, but I will not give a point by point treatment of the work. Instead, I will give preference to certain features of Hegel's text in view of their possible contemporary relevance.⁶ There can be no doubt that Hegel's intention was not to present antiquated and nowadays outdated scientific views, but rather to engage in the philosophical penetration of natural being. On the other hand, we can hardly overlook the fact that the Philosophy of Nature contains a good deal of dated material – especially if we consider the second part of this work with its treatments of heat, electricity and magnetism. In view of these factors, and given the allotted space for discussion, it is advisable to proceed selectively by discussing insights that are of interest to debates in contemporary natural philosophy. I will therefore concentrate on Hegel's views concerning space, time and matter in the first section of his Philosophy of Nature; concerning light and chemical processes in the second section; and concerning the interpretation of organic and psychical phenomena in the third section.

MECHANICS

SPACE AND TIME

In keeping with Hegel's conception of nature as the 'otherness [*Andersseyn*]' of the idea, the Philosophy of Nature begins with *pure separateness*, that is, with what is completely unstructured and 'contains no determinate difference' (*Enc* §254). Nevertheless, something results from this separateness despite its lack of structural differentiation. I will summarize here Hegel's argument concerning this result.

Just because it lacks all differences, *pure separateness* is actually *no separateness* since things must be distinct if they are separate from one another. In a dialectical sense, the concept of pure separateness collapses into that of non-separateness, that is, the concept of a *point*. Both belong together and they exclude one another. This dialectically contradictory state of affairs, then, requires a new structure in which both separateness and punctuality are compatible. This becomes possible in the form of a *line*. Considered lengthwise (or longitudinally), a line is extension characterized by separateness. Considered crosswise (or transversely), however, it is non-extension characterized by non-separateness, in which case its 'transverse direction' at the same time brings into play a new spatial dimension.⁷ Hegel's procedure of conceptual development thus leads to an explanation of the three-dimensional character of intuitional space.⁸

The concept of pure separateness has thus been shown to contain an internal dialectic the explication of which gives rise to new categorical structures – at this initial juncture, the concepts of point, line and further spatial determinations.

'*Limit* [*Grenze*]' is in this way shown to be essential to spatial structures. A limit is what

separates parts of space, though it belongs to none of them. Thus, a limit is itself non-spatial inasmuch as it is, as it were, thin as a point. But if this is so, what exactly is it? As a limit, it is essentially a negating – the excluding or, respectively, the leaving of a part of space. In the concept of space, then, negation (in the sense of change) and hence the concept of time are always implied. For the non-spatial character of the limiting function rests on its point-related character: 'The negativity which relates itself to space as a point . . . and is thus posited for itself . . . is *time*' (*Enc* §257, cf. 257A). Contrary to spatial being, which as such just is what it is, time is 'the being which, in that it *is*, is *not*, and in that it is *not*, is' (*Enc* §258; see Richli, 2002).

Hegel continues by determining time as '*intuited becoming*' (*Enc* §258). He does this because '*becoming*' signifies the *now* occurring transition from a past to a future that is about to be realized. Hegel calls past, present and future 'the dimensions of time' (*Enc* §259) which, on account of their differing ontological modalities, are nowadays designated as the *modes of time*. The 'triadic' overarching structure of time, however, can become tangible only by representing the modes of time in the form of simultaneous juxtaposition. But this is to represent time in a spatial form since '[t]he past . . . and the future of time, in so far as they have *being in nature*, is space' (*Enc* §259R; cf. §260A). A temporal structure is therefore one that is only spatially – that is, intuitively – representable. Moreover, only spatial representation allows for time to be 'fixed', which is a basic requirement of scientific method. Consider, for example, what occurs in the determination of time by means of a clock. Earlier temporal states have in a sense left their traces behind in space. It is only in this way that they can be confronted with the later temporal states by which they

are determined *as earlier*. While Hegel does not develop this point in detail, it is by building on his analysis that time's property of irreversibility becomes intelligible. Time must appear as anisotropic and unidirectional since what is later is ascertainable only by recourse to what is earlier. A new occurrence appears in view of an earlier one, and the progression of time is thereby univocally defined by additive augmentation. But a well-defined direction of temporal progression can only be drawn in a uni-dimensional manifold (Lucas, 1973, pp. 178–9), which is what likely provides the simplest argument for the one-dimensional character of time (Hösle, 1987b, p. 307).

MOTION AND MATTER

The spatialization of time has widely been regarded as a falsification of the concept of time.⁹ Opposing this view, however, is the consideration that Hegel's explication of spatial limit, and thus his explication of the negativity latently contained in space, makes evident the intrinsic connectedness of space and time (see *Enc* §257A; cf. Inwood, 1987, p. 59). The truth of both is thus a synthetic determination: spatial limit – or more accurately, the spatial point – is now *also* expressly determined as a temporal point. This sort of point, which intrinsically connects space and time, is what Hegel calls (in a linguistically unusual manner) *place* (*Enc* §260). Whoever schedules a meeting, for example, at a certain place must provide a temporal specification in addition to a spatial identification.

A place is a 'spatial now' (*Enc* §261). As such, however, a place is also essentially determined by *change* on account of its intrinsic temporality. As one place in space and time, it continually becomes another place. In other words, 'place' in Hegel's sense is in principle 'motion' (*ibid.*). Since even a

spatially fixed place changes temporally, it is fundamentally a movement – in this case, a motion with zero velocity.

Now motion takes place not only in time but also in space. A place changes its spatial and temporal position while remaining a moving place. As such, it maintains itself in motion and thus has a sort of a substantial character. It is a something that moves – a something that Hegel identifies as 'matter' (*Enc* §261). Hegel grants that this 'transition . . . to the reality that appears as *matter*' is 'incomprehensible for the understanding' (*Enc* §261R). But this is only because the understanding regards matter as something 'indifferent towards space and time' (i.e. as something completely different from space and time) and at the same time regards material things as 'essentially spatial and temporal' (*ibid.*). This internally contradictory conception of matter has to be overcome. It has to be recognized that the logic of the concept of motion contains the determination of something moved – that is, the determination of something that in its motion preserves its identity as 'a singularity that is *for itself*' and that therefore possesses substantial character. According to Hegel, this something is matter. At this juncture, of course, it is matter without any properties apart from those required by its determination purely as mass (*Enc* §261, 261A). As Hegel puts this point: 'Where there is motion there is something that moves; and this durable something is matter . . . Just as there is no motion without matter, so there is no matter without motion' (*Enc* §261A).¹⁰

Now, by enduring – that is, by preserving itself in its motion as something identical – matter is something that

occupies one place, and then changes its place, passing thereby into another place, but both before and after this, it does

not leave, but occupies, its place. Zeno expresses this dialectic by demonstrating immobility; [by showing that] to move would be to change place, but the arrow never leaves its place. (*Enc* §261A)

Thus, what is moved so to speak defines its own place. This is a place that does not change for what is moved, which means that something moved is there at rest. The determination of rest, then, is always contained in the concept of motion. That, however, is precisely the core of Zeno's paradox of the arrow, that is, the paradox according to which a flying arrow remains at rest.

Motion is determined only *in relation* to something that – in its motion – rests. This means that motion is determined only in relation to a place that is likewise a material place, that is, a mass. Thus, if both of these instances of place are masses, then the relation of motion is symmetrical in the sense that each mass is at rest in relation to itself while it is moved in relation to the other. This is the *principle of the relativity of motion*, which can be abbreviated as follows: the motion of a mass is equivalent to a relative motion. As we will see below with regard to the motion of light, an 'Einsteinian' perspective is already in evidence with this principle.

GRAVITY

The concept of matter or mass has been determined first of all as 'singularity that is *for itself*' (*Enc* §261R). According to this concept, masses are basically many singular entities that in an 'abstract' sense are characterized by *repulsion*. Since all of them are in equal measure separate and isolated, however, they are all alike; and insofar as they are alike, they show themselves to be (in the same abstract sense) *attraction* (*Enc* §262). Repulsion and attraction are here

not to be understood as natural forces, but rather as conceptual determinations of 'singularity'. In keeping with this understanding, Hegel seeks to establish argumentatively the 'construction of the concept of matter' in terms of opposing forces of repulsion and attraction, which Kant undertook in *MAN* (see AA 4:498, 505, 518, 534; for discussion, see Edwards, 2000, pp. 132–44). Hegel's decisive point in this regard is that singularization is the ground of both the difference and the sameness of singularities. These exist so to speak in the stress field of a contradiction that drives towards its sublation. At issue, fundamentally, is the *concept of field* that is indispensable for the modern understanding of nature.

In this context, Hegel discerns the origin of gravity (*Enc* §262) as something that is, as it were, 'an ought, a yearning, the most unhappy striving to which matter is eternally damned; for its unity does not come into its own – it does not fulfill itself' precisely because singularization (as repulsion) 'is just as much an essential moment of matter as attraction' (*Enc* §262A).¹¹ Such is Hegel's visionary intuition of physical 'singularity'.

Hegel treats the property of gravity, which is constitutive for mass, in three steps that concern corporeal inertia, the impact of bodies, and falling motion.

The single body is 'indifferent' towards motion. Motion 'is *external* to the body in the same way as its negation of motion, or rest – the body is in fact *inert*' (*Enc* §264). Given its indifference to motion and rest, the single mass is something that 'in itself neither rests nor moves, but merely passes from one state to the other through external impulse, i.e., rest and motion are posited within it by means of another' (*ibid.*). A motion makes its appearance in the single, isolated mass – but not yet explicitly as the proper essence of the latter (*Enc* §264R).

According to Hegel, the 'indifference' of inert matter is negated in *impact*. In the interaction of any two bodies that are party to impact, motion is 'one movement of both bodies though they also resist one another inasmuch as each of them is likewise presupposed as an immediate unity' (*Enc* §265). This inertial effect occurring in the impact of bodies is what Hegel calls their 'relative gravity' (*ibid.*).

The isolation of inert masses is in principle overcome in *falling motion*, that is, in bodies' free striving towards one another. The movement of these bodies has thus become their 'essential' motion; it is no longer only the 'accidental' motion of impacted inertial masses (*Enc* §266). The essential gravity by which falling masses are 'inseparably combined' is the striving by which bodies seek to 'posit and have their centre *outside themselves*' (*ibid.*). This is a figurative formulation for the idea that each mass tends of itself to move towards other masses that, taken together, virtually constitute a common centre:

It is . . . not the centre, but the tendency towards the centre, which is immanent in matter. Gravity is so to speak matter's acknowledgment of the nullity of the self-externality of matter in its being-for-self—of its lack of independence, of its contraction. (*Enc* §262R)

Such is matter's tendency to sublimate its externality. But as long as matter is taken as a singular body, this tendency is only an inner disposition. As such, it does not manifest itself in an external form. Matter is 'still indeterminate, undeveloped, occludent' since its 'form [itself] is not yet material' (*Enc* §262R). It is only at the highest stage of mechanics that form becomes material. At this stage, which Hegel titles 'Absolute Mechanics' (*Enc*

§§269–71), matter's form becomes material in the totality of the *solar system*.

Hegel characterizes the solar system as 'absolute', and consequently as un-conditioned (*un-bedingt*), because as a whole it appears as something self-contained. It requires no external impulse, but is rather supported and preserved by itself. In the solar system as a whole, then, 'the externality of matter is no longer external to itself' (*Enc* §271). With this 'system of *many bodies*' Hegel has in mind a system of masses that maintains itself through 'gravitation' (*Enc* §269; for detailed discussion, see Ihmig, 1989, ch. 3) and that is completely determined internally by *Kepler's laws*. According to Hegel, it is in this Keplerian system that everything implicitly contained in the concept of matter is explicitly developed: thus 'developed into the *totality* of form', the 'merely sought centre' (*Enc* §271) that is virtually posited by singular masses is now realized in the shape of the 'central body' (*Enc* §269A), namely, the sun.

Hegel is fascinated by Kepler's laws. They embody for him 'a discovery of immortal fame' (*Enc* §270R) – of fame wrongly conferred upon Newton and his law of gravity. According to Hegel, what 'Kepler expressed in a simple and sublime manner in the form of *laws of celestial motion*' is changed by Newton 'into the *reflectional form* of the *force of gravity*' (*ibid.*). The concepts of 'independent forces' such as those of 'centripetal and centrifugal force, etc.', are likewise but 'empty reflectional determinations' in the sense of being 'fictions of the understanding' (*ibid.*; see also Neuser's introduction to Hegel's dissertation [Hegel, 1986b], as well as Ihmig, 1989, ch. 2).

Hegel has in mind here the ideal of a 'rational proof' (*Vernunftbeweis*) of Kepler's laws (*Enc* §270R) as the foundation of

absolute mechanics. In his extensive considerations on this topic Hegel demonstrates his competency in contemporaneous physics (even if he does hold that the force effective in capillary action is a form of gravitation (*Enc* §269R). His invective against Newton, though, shows him to be something of a Don Quixote as far as this aspect of his natural philosophy is concerned.

TRANSITION TO QUALIFIED MATTER

The determinateness of form of *matter as such*, and hence that of unqualified mass, is completed and finalized in the solar system. Matter has therefore been 'disclosed to form [*zur Form entschlossen*]' (*Enc* §271). In other words, the concept of matter has been developed to the stage at which it is prepared to feature forms of matter that are of greater specificity. At issue, then, is 'qualified matter' (*ibid.*), and thus the thematic content of what Hegel calls physics.

With regard to the argumentative structure of Hegel's natural philosophy, it is not readily apparent why the treatment of matter's qualified determinations should occur at this point. It will therefore be helpful to have recourse to Hegel's science of logic since this is what is supposed to furnish the structural basis of the Philosophy of Nature. The Logic of Being is the part of logical science to which Hegel's Mechanics corresponds; and the transition to Physics, which is here the point in question, corresponds to the transition in logic from the sphere of *being* to that of *essence*. The logical transition between these spheres is mediated by the category of 'measure [*Maß*]'. For the sake of illustrative brevity, let us consider how this category relates to the phase change between water and steam. Regarding this physical phase, the quantitative increase in temperature

makes evident intrinsic relations of measure by which continual change in quantity – as governed by these relations – is transformed into qualitative change in the sense that there is the emergence of new qualitative determinations. Ice, water and steam figure here as *forms of appearance* of an underlying *substrate* (designated by the chemical formula H_2O) that represents the *essence* of what appears.

The relation of planets in the solar system is also defined by fixed relations of measure (Ferrini, 1998), which is what Hegel finds so highly fascinating in Kepler's laws of planetary motion. It is in view of that relation that Hegel seeks to get closer to the *essence* of matter:

. . . that which the solar system is as a whole, matter should be in particular . . . the complete form of the solar system is the concept of matter in general . . . the determinations of form which constitute the solar system are the determinations of matter itself, and these determinations constitute the being of matter. (*Enc* §271A)¹²

In a certain sense, this sounds quite modern since Bohr's pictorial model of the atom is also orientated towards that of the solar system. Hegel is so to speak intuitively correct (even if the example of the solar system is misleading when taken literally). As we hold today, the intrinsic 'structure of measure' of a material's electronic configuration is indeed the actual basis for the emergence of qualitative determinations of matter. And matter is thereby no longer mere mass. It has become something that '*is determined in itself*' – something that 'determines by the immanent form' which constitutes its inner essence and that enters into appearance as qualitatively determinate 'individuality' (*Enc* §272).

The transition to the sphere of essence, as it is understood in the context of Hegel's science of logic, is hereby completed. It is characteristic of this sphere that determinations are 'only relational' (*Enc* §112), that is, are essentially referred to one another, as is the case with essence and appearance, identity and difference, content and form, etc.

PHYSICS

The subject matter of 'physics' (again, bearing in mind that Hegel's use of this term is not entirely congruent with its contemporary usage) consists in the specific qualities of the various forms of matter – for example, light, the traditional four elements (air, fire, water, earth), solid-state properties, acoustic and thermal phenomena, electricity and magnetism, as well as chemical processes. This list lends itself to the supposition that the part of Hegel's natural philosophy now under consideration is one that, given the empirical research landscape of his time, contains views that are quite outmoded. But this is not the place to go into detail concerning this supposition.¹³ Instead, I will concentrate on two particular topics in Hegel's physics that I hold to be worthy of special attention, namely, Hegel's account of light and his treatment of the chemical process.

LIGHT

As we have seen, physics corresponds to the logical sphere of essence, which in Hegel's logic begins with the following 'determinations of reflection' (*Reflexionsbestimmungen*): 'identity', 'difference' and 'ground'. Accordingly, matter as it is first qualified' is characterized by its 'pure identity with itself' (*Enc* §275).

In keeping with what was shown above, the self-contained totality of the solar system as a whole, which maintains its own identity in nearly complete independence from external influences,¹⁴ should be the actual essence of matter. In a preliminary and abstract sense, then, the determination of 'pure identity' is what constitutes the 'existent universal self' – the abstract essence – of matter (*ibid.*). As natural determinateness, this universal 'self' must also have a self-subsistent existence, which Hegel identifies as *light* (*ibid.*). This determination of light is unquestionably indebted to Schelling's early natural philosophy, where light is opposed to gravitational force and – in the particular framework of Schelling's 'philosophy of identity' – is grasped as the real raising of 'absolute identity itself' (see Schelling, *SsW* IV:163, also 162 ff. and 174; *SsW* VII:358). Hegel holds light, as identity, to be free of all difference and material singularization. Contrary to the reality of heavy matter, light is thus 'material ideality' (*Enc* §276).¹⁵

Correlative to light's determination as pure identity is the demand 'to discard all determinations relating to composition' (*Enc* §276A). In its quality as 'incorporeal and in fact immaterial matter' (*ibid.*), light 'can no more be packed into bundles than it can be separated into rays' (*Enc* §276R). Rays, bundles (or packets), particles and even waves as well as vibrations are inadequate categories for the account of light because of their relatedness to bodies. Hegel is thus decidedly opposed to Newton's particle theory as well as to the wave theory of light to the extent that these theories are in effect borrowed from the domain of material corporeality. Contradicting the dominant theories of his time, Hegel radically insists on the *opposition* between light and corporeal matter. He thereby rightly seizes upon something

quite fundamental to physical reality. (His dogged but misdirected appeal to Goethe's theory of colours as a basis for criticizing Newton's experiments and theories – see, e.g. *VNat*₁:55–62) – is, however, quite another matter.)

Hegel goes on to treat questions of visibility as well as optical reflection and the polarization of light before turning to a closer consideration of 'darkness' – of its 'rigidity' and 'neutrality' in the appearance of lunar and cometary bodies – and then to further forms of qualified matter leading beyond the 'abstract identity' of light.

Hegel's conception of light has crucial implications that point towards key insights of contemporary physics. Corresponding to the determination of light as 'incorporeal and in fact immaterial matter' (*Enc* §276A) is the assertion that light must also be 'absolute levity' (*Enc* §276). In other words, to use a more modern formulation, light is something that possesses no *rest mass*. For the *motion* of light, however, this means that light is not subject to the principle of relativity as it results from the 'logic' of the concept of motion. If corporeal motion is equivalent to relative motion (see above, 'Mechanics'), then non-corporeal motion must be a *non-relative* motion.¹⁶

Let us consider what this means in concrete terms (for detailed discussion, see Wandschneider, 2008, ch. 4.9). Since it is something that is not body, light cannot be at rest. Light itself can only be moving even if the reference instance for the determination of light's motion has to be a body. But this implies as well that the velocity of light must be *independent* of the state of motion of a given body of reference. Otherwise, a body that furnishes the relevant reference instance could be moving in such a way that light has zero velocity relative to it, which would be

inconsistent with the aforementioned circumstance that light, as non-corporeal, can only be something moving. Should the velocity of light be independent of the body of reference, however, then that velocity must remain the same in relation to every body. The character of light's velocity is therefore *absolute*; it is no longer relative. This means, further, that the velocity of light must be the *greatest possible* velocity. For if a body could have the same velocity as that of light, then light – with reference to such a body – would be determined precisely as something at rest. The velocity of light, then, is the physically limiting velocity that cannot be exceeded.¹⁷

Furthermore, if light can only be something in motion, then it must also be true that *every* body, taken in its kinematic relation to light, is determined as resting. Consequently, what each body is (as something that is first of all *for itself* to the exclusion of other bodies) is now also manifested, in connection with the motion of light, as a property that is *common* to all bodies. The real singularity and diversity of bodies becomes irrelevant in relation to light. Light proves to be the common denominator, as it were, in everything diverse. It is by light that the *ideal identity* of bodily things becomes manifest beyond all corporeal singularity and difference. Thus, according to Hegel's characterization, light qualifies as something like the ideal substrate of matter: the underlying ideal '*self*' of matter' (*Enc* §275) that provides for the ideal identity of all things corporeal.

The insights just developed from Hegel's concepts of motion and light are in line with basic features of Einstein's (special) theory of relativity. John N. Findlay has thus correctly claimed that there is 'a flavor of relativity-physics in some of the things Hegel says about light' (Findlay, 1964, p. 279). Yet it would also be perverse to maintain that

Hegel anticipated twentieth-century relativity theory. Einstein's great accomplishment in fact lies in his conception of a theory that provides a framework in which the relative motion of bodies and the non-relative motion of light are *mathematically* compatible despite their apparent incompatibility as physical contraries (which, however, truly belong together). By contrast, Hegel's considerations pertain to a more basic theoretical level. They reveal to the (special) theory of relativity a philosophical perspective that remains concealed within the theory itself.¹⁸

THE CHEMICAL PROCESS

Also of fundamental interest – though, again, along with much that is outdated – is Hegel's interpretation of chemical processes. In keeping with his conception of physics, this interpretation is found in the concluding chapter of the second main part of the Philosophy of Nature. It is in this chapter on the Chemical Process that the structural determination of physics by the logic of essence is perhaps most clearly evident, as can be seen in the essential reciprocal relatedness of the chemical determinations in question (Burbidge, 1993, pp. 609–17). Acids and bases, for example, are understood as opposites that are per se not neutrally related to one another, but must instead react upon one another and change accordingly on account of their opposing natures. Only the product of a chemical reaction (e.g. $\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$) has a neutral character (in this case, salt and water). The opposition of elements is thus sublated, and the chemical process comes to a rest.

Hegel treats the nature of the chemical process in his science of logic (for extended discussion, see Burbidge, 1996). It is distinctive of

a chemical object that 'the *reference to other*, and the mode and manner of this reference, belongs to its nature' (WL GW 12:148). Thus, 'in this there is immediately posited the striving to sublimate the one-sidedness of the other and, through this reciprocal balancing and combination, to posit a reality conformable to the concept that contains both moments' (WL GW 12:149). Each chemical object has 'within it the *necessity* and the *drive* to sublimate its opposed, *one-sided subsistence*, and to make itself . . . into the *real whole*' (WL GW 12:148). It thus strives to bring out its underlying '*universal determinateness*, not only the determinateness of the *one* [italics mine, D.W.] *singular object*, but also of the *other*' (ibid.).

Once this is accomplished, the chemical process is extinguished. It therefore 'does not spontaneously restart itself, for it had the difference only as its *presupposition* – it did not itself *posit* it' (WL GW 12:150). To this extent, then, the chemical process is 'still *finite* in comparison with the organic process' (Enc §329A). Hegel holds that biological life is indeed 'implicit within the chemical process' and that life is itself 'a perenniating chemical process' (Enc §335A). Yet he also maintains that the products of the chemical process would be living only if they 'spontaneously renewed their activity' (ibid.). It is striking that Hegel already has a *biochemical* perspective in sight when he thinks of the organic from the standpoint of the chemical process.

ORGANIC PHYSICS

The transition from inanimate to animate nature is, in Hegel's view, so to speak the transition 'from the prose of nature to its

poetry' (*Enc* §336A). It must be understood as the emergence of *determinations of form* in the organic (Neuser, 2002a). In a chemical reaction an object changes, but 'the totality of shape does not endure' in this process (*Enc* §336A). An organism, however, is essentially characterized by its self-preservation as its own end (*VNat*:140). It is thus distinguished by its ability to preserve its own *form*, including its specific functions in the life process (Breidbach, 2004). Similar to the way in which the general form of a poem is preserved through change of that poem's lines, the 'flyishness' of a particular fly – its genus-universal – is always preserved throughout the life process of such an organism. As an individual, an organism is at the same time something *universal*; and insofar as it is universal, it obtains what is in effect a *conceptual* character (Spahn, 2007): 'Nature has here reached the determinate being of the concept' (*Enc* §336A). An organism is in effect a concept become active. It is a *subject* (though not yet one in the human sense, of course). It is in view of the organism's capacity for self-preservation *qua* preservation of genus universality – hence its ability to preserve its specific essence together with its self-identity, for example, the 'flyishness' of a fly – that Hegel describes organisms as having a 'self-centred' character, that is, as having the 'subjectivity' that is characteristic of a *self* (*Enc* §§337, 350).

In the following I will concentrate above all on the distinction between plant and animal that is essential to organic nature's forms of appearance. This will allow us to focus on Hegel's insights concerning the emergence of the *psychical*, that is, the occurrence of organisms with sensory capacity. The conclusion to this section treats the transition from nature to spirit, which is both the completion and the surmounting of nature itself.

Given the concept of self mentioned above, Hegel provides the following typology for the forms of life: (1) 'geological organism': self-preservation *without* a self (*Enc* §§338–42); (2) 'vegetable organism': self-preservation with a *non-reflexive* self (*Enc*. §§343–9); (3) 'animal organism': self-preservation with a *reflexive self* (i.e. the self that is for itself) (*Enc* §§350–76). Let us consider this systematic classification of life forms, paying particular attention to the characterizations of 'self' that it involves.

GEOLOGICAL ORGANISM, PLANT, AND ANIMAL

Since what Hegel calls *geologischer Organismus* is without a self, it is not an organism in the proper sense. Hegel speaks of the terrestrial body (*Erdkörper*), for example, as having the capacity for self-preservation, but not as having the subjectivity and genus-universality that are otherwise essential features of organic life forms (*Enc* §338A). A familiar contemporary example – namely, our notion of an ecological system – may here be useful for clarifying what Hegel means by 'geological organism'.¹⁹ Like Hegel's geological organism, an ecological system is characterized in terms of self-preservation – in this case, in terms of its maintaining a dynamical equilibrium that may also be overturned under changing conditions and transformed into a different balance. An ecological system is not yet a *subject*. What it lacks is in fact permanent control over its own form (*qua* form of a specific genus-universal) by a self that is something like a subjective valuation system. It thus lacks a subject-like system that, as a matter of self-preservation, existentially assesses and regulates everything that internally and externally concerns an organism in its proper sense. (If a fly is threatened with respect to its existence *as a fly*, then it flies away.)

SENSATION AS THE ELEMENTARY FORM OF THE PSYCHICAL

In contrast to the geological organism, a plant is a genuine organism. As such, it is determined by a self that aims to preserve the organism under changing external conditions. According to Hegel's concept of organism, a plant possesses the kind of subjectivity by which it teleologically strives to preserve its genus-universality, also in view of obstacles.

None of this, of course, can be experienced by the organism here at issue. The plant does not possess 'sentience [*Selbstgefühl*]' (*Enc* §344A). It is 'not yet subjectivity that is for itself' (*Enc* §344). While the plant's vegetable self is indeed related to the organism as a whole, it is not yet related to itself as well. The vegetable self, then, is without reflexivity. It corresponds morphologically to a rather loose form of organic unity according to which 'the process of articulation and self-preservation of the vegetable subject is one in which it comes forth from itself, and falls apart into several individuals' (*Enc* §343) – as happens, for instance, when a part of a plant – a 'scion' – can again become the whole plant.

What a plant still lacks is realized in an animal's structure of subjectivity. A plant is a subject, but an animal also exists as a subject (*Enc* §350). The subjectivity of an animal is thus present to the animal itself. Essential to this self-presence of animal subjectivity is the emergence of 'the self that is for the self' (*Enc* §350A), that is, the self that so to speak encounters itself. Hegel sees the distinctive 'self-for-self' structure here at issue (*Enc* §351A) as something first realized in animal subjectivity. In this regard, one has to consider that an animal, in contrast to a plant, must move and find its orientation within its environment. Hegel has basically this in view when he refers to animal 'self-mobility' and 'interrupted intussusception' (*Enc* §351) as well as to the animal's nervous system (*Enc* §344).

Hegel does not go into detail concerning the import of the considerations just mentioned for the structure of the animal self. But to bring out this import, we can pursue the following line of argument in connection with some early considerations on 'cybernetics' put forward by W. Ross Ashby (1966). An organism must regulate its biochemical functions, whether its regulative function requires a central organ or is distributed over its entire biochemical system. For the sake of brevity I will refer to this instance of regulative function as an organism's *function-self*. Since a plant has to regulate only its internal biochemical functions, its form of self-regulation is limited to that of the function-self. An animal, however, must also be in control of its actions within its external environment. Thus, in addition to the function-self, the animal organism requires an arrangement of nerves and sensory organs corresponding to a form of self-regulative activity that oversees and controls an animal's actions in view of its self-preservation. This is what I will call an *action-self* (Wandschneider, 1987).

The crucial thing to notice here is that the action-self of the animal organism *remains reflexively bound* to the function-self because an animal's actions must be existentially purposive in the sense that they have to be in keeping with the organism's needs. Consequently, all such actions are subject to existential evaluations on the part of the function-self.²⁰ But what does this mean in concrete terms? (For extended discussion, see Wandschneider, 2008, ch. 7.3.) To take an instructive example, consider what happens when a hot stove burner is touched. The externally perceived tactile impression is first presented to the function-self and is thereby subjected to existential assessment. This is given back to the

action-self and blended into its outer perception. As the sensation of pain, it is thus 'the immediate unity of being and of that belonging to it [*die unmittelbare Einheit des Seyns und des Seynen*]' (*Enc* §358A). While this characterization is, of course, Hegel's play on words, his meaning is that perception in this form is no longer concerned only with the animal organism's external situation (*das Seyn*). It also makes the organism's own internal evaluative condition (*das Seyne*) something that can be experienced – which is something fundamentally new. Perception, which first of all is directed externally, has hereby achieved an internal dimension. Thus, Hegel's characterization of sensation as a 'finding of oneself within oneself [*Sich-selbst-in-sich-Finden*]' (*Enc* §337A) designates inner sensation's appearance on the perceptual stage, which is made possible by the structure of the *double self* that is distinctive of the animal subject. Given this structure, it also becomes possible for the existential assessments performed by the function-self to be subject to perceptual experience. Qualities such as 'hot', 'sweet' or 'disgusting' are in fact significant factors in organismic self-preservation. Indeed, the animal soul and self-preservation go essentially hand in hand. It is in the co-operation of function-self and action-self that an inner dimension is spanned:

... the self forms both sides of this relationship, which is therefore an internal circuit of the soul, keeping itself aloof from organic nature. As the plant has not yet attained to this selfhood, however, it lacks inwardness. (*Enc* §344A)

We can see what is specific to behaviour regulated by sensation by comparing programmed robotic actions with the bare reflex actions of an animal organism. A

robot, lacking a self, is deprived of the existential dimension of self-preservation. It simply does what it has been programmed to do as the result of its programmer's intentions; and on account of its lack of that existential dimension, it does not worry about its own being since '[o]nly a living existence senses *deficiency*' (*Enc* §359R). In contrast to this, an organism's reflex action – an action defending the organism against danger, for example – is existentially determined through and through, and it should therefore not be confused with any robotic action. Still, an organism's reflex action does exhibit something robot-like to the extent that it lacks sensation. In this case the existential assessment of perception is not fed back into perception as something to be integrated into it (in which case it would be sensation), but instead goes directly into triggering a motoric action.

With this Hegel-inspired interpretation of sensation we come upon an important pathway for approaching the so-called mind-body problem (Wandschneider, 2008, ch. 7). But if sensation is not properly understood as the most elementary form of the psychical, it seems that there is little hope of illuminating the far more complex connections involved in our higher mental processes.²¹

GENERIC PROCESS, DEATH AND TRANSITION TO SPIRIT

Having the capacity for self-preservation is a constitutive property for being an organism. As was explained above, an organism is self-identically preserved through all internal and external changes to which it is subject. As an individual, then, an organism is at the same time a universal, an instance of a species. The inner tension between singularity and universality finds its basic expression in the sexual

differentiation to which higher forms of the organic are subject. The singular individual cannot, *qua* singular, be the truth of species-universality. But insofar as it is nonetheless related to its species as a whole, it has (in the most elementary form) the instinct (*Trieb*) driving it towards unification with another instance of its species. The natural basis for this instinctual drive is the differentiation of individuals into the *male* and *female principle*, which in each individual gives rise to a feeling of 'deficiency' (*Mangel*). The singular individual is thus subject to

the drive to attain its sentience [*Selbstgefühl*] in the other of its genus, to integrate itself through union with this other and by means of this mediation, to bring the genus into existence by linking itself into it – *sexual copulation* [*Begattung*]. (*Enc* §369)

This realization of the species in the unification of male and female individuals, which in higher animals gives rise to 'a feeling of universality' (*Enc* §369), is on Hegel's view the supreme moment of an animal's capabilities' (*Enc* §368). It is in effect a genetically anchored and most primitive form of intersubjectivity by which individual separation is overcome and species-universality is realized.

Since the natural result of sexual generation is always yet another individual, this 'process of propagation issues forth into a spuriously infinite progression' (*Enc* §370). At the same time, though, the individuals involved have fulfilled 'their determination in the process of generation' and 'must pass on to death in so far as they have no higher determination' (*ibid.*). Their very 'inadequateness to universality', then, is their 'original *disease* and *inborn germ of death*' (*Enc* §375).

Nevertheless, Hegel continues, 'superseding this death of nature, *proceeding* from this dead husk, there *rises* the finer nature of *spirit*' (*Enc* §376A). Inasmuch as spirit is 'the universal which exhibits itself as universal' (*Enc* §375A), nature's immanent tendency towards idealization here reaches its conclusion. The universal that is realized through spirit no longer has the organism's spatio-temporal and material mode of being. As logical and ideal, spirit is something non-spatial, super-temporal and immaterial. It is, then, immortal – 'the divine, the eternal' (*Enc* §376A). Spirit – the apprehension of the universal as universal, and hence the possibility of objective cognition – rests upon the capacity for thinking (see de Laurentiis, 2002) as distinguished from the subjectively tinted cognitive forms of perception and animal sensation. In its cognition of the laws that determine nature as nature's underlying ideal essence, spirit accomplishes something that nature itself is not in a position to achieve. For the essence of nature – nature's immanent logic of natural laws – is not itself a natural entity. It is rather of an entirely different order of being – a transnatural mode of being, as it were. Nature merely *is*, and it *knows* nothing thereof. Only spirit is capable of accomplishing that which nature is incapable of doing, namely, achieving knowledge of nature (Wandschneider, 2005a, pp. 206–12). In natural science spirit grasps the ideal that underlies nature in the form of natural laws. A natural philosophy in Hegel's vein comprehends spirit itself as the highest manifestation of this ideal.

Nature's development towards spirit as the realization of its underlying ideal essence can be summarized as follows. The basis of nature's development lies in fundamental logic. In its completion as the absolute idea, the logical is determined as un-conditioned, that is,

as absolutely independent of the non-ideal. Precisely in virtue of logic's absolute independence and unconditioned character, however, the non-ideal is co-positing as the other of the idea – namely, as nature. And in so far as nature is as this other of the idea, it remains related to and determined by the latter. The expression of this relatedness and determination is the lawfulness of nature understood as the ground of nature's immanently self-realizing tendency towards idealization – a tendency that culminates in spirit, and thus in the reflective self-comprehension of the logical idea (Drees, 1992; Burbidge, 1996, ch. 32).

This means, however, that nature, as the necessary accompanying phenomenon of the idea, is unavoidably determined to develop towards the emergence of spirit. Put differently, the laws of nature must be such that the existence of spirit is both possible and actually achieved in nature. Now this is exactly what is asserted by the so-called anthropic principle, which has been discussed mainly by physicists for the past three decades (Barrow and Tipler, 1986; Carr, 2006). Scientific discussion of the anthropic principle has arguably yielded no solid results to date. On its objective-idealistic interpretation, however, nature is comprehensible as the development towards spirit, and thus as the full-circle return to the idea. From the encompassing *metaphysical* perspective of objective idealism, the question of whether nature – *physis* – could fail to achieve such a goal is not posed since the idea *must* find its way back to itself by way of the stages of nature and spirit.

But why this detour from the logical idea through nature to spirit and back again to the idea? Following Hegel, it is because the idea, as we have seen, cannot simply remain 'by itself [*bei sich*]' since nature is dialectically co-positing with it. The detour

through nature is thereby unavoidable. But if there is nature, then nature must be given as the idealizing tendency that is directed towards the anthropic goal called spirit. This is the end in which nature finds both its completion and its self-transcendence in the human being, that is, in the type of being that is able to survey and comprehend nature's systematic connectedness in its totality.

When seen from a fundamental viewpoint, Hegel's philosophy provides the most well-considered concept of nature in the entire tradition of natural philosophy. Given its foundation in the system of objective idealism, Hegel's philosophy of nature has a theoretical grounding that is superior to other approaches to natural philosophy – to the Leibnizian, the Kantian or the Schellingian metaphysical systems of nature, for example. By setting out from the objectively binding character of logic – which, as we have seen, can only be called into question at the cost of self-contradiction – Hegel's philosophy of nature obtains a rationally supportable foundation. And proceeding from this foundation, it frames a fascinating overall picture of nature (Schmied-Kowarzik, 1998; Fulda, 2006). In doing this, it makes possible a holistic view of reality in which nature and spirit essentially belong together precisely in and through their opposition. Moreover, Hegel's philosophy of nature opens up new perspectives – new options for the philosophical interpretation of relativity theory, for example, or for the explanation of the emergence of the psychical in nature. More generally, it leads to the further advancement of Hegel's project of providing *comprehending* knowledge of nature in the form of an elaborated dialectic of nature.

NOTES

- I would like to express my cordial thanks to Jeffrey Edwards (Stony Brook) for a sensible and thorough translation of my German text.
- ¹ 'The understanding does not derive its laws (a priori) from nature, but rather prescribes them to nature' (*Prol AA* 4:320).
- ² In a similar vein, Hegel writes in his Berlin Inaugural Address of 1818: 'In its ground-ing. . . , philosophy, like the universe, is round within itself. Nothing is first and nothing last. Instead, everything is supported and main-tained – mutually and in oneness' (*Antrittsrede 1818 GW* 18:18–19).
- ³ This reply, of course, does not do full justice to the basic problem contained in Krug's chal-lenge (on this, see Klein, 2002).
- On Hegel's assessment of the notion of evolu-tion, cf. Findlay (1964), Breidbach (1967) Hösle (1987a, pp. 383–91), Harris (1998) and Wandschneider (2001).
- ⁴ I have elsewhere argued in detail that, despite this denial, Hegel's philosophy of nature does offer a persuasive ontological framework for the explanation of the stage-like developmental process of nature that we today call evolu-tion (Wandschneider, 2001; cf. Findlay, 1964, p. 272; Harris, 1998, p. 206; Hösle, 2005; Spahn, 2007, ch. 3.3.3).
- For criticism of this interpretative approach, see Rinaldi (2002).
- For further elaboration, see Halper (1998).
- ⁵ As far as I can see, this is something unique in philosophy. Even for Kant, spatial tri-dimensionality is not proved, but is instead declared to be a *fact* of our a priori intuition of space. For detailed treatment of Hegel's interpretation of space's tri-dimensionality, see Wandschneider (1982, ch. 2).
- Paradigmatically by Henri Bergson: see Bergson (1949), especially pp. 78, 84, 86, 90, 93–4.
- ⁶ A passage from Hegel's Jena period puts the point similarly: 'Just as there is no motion with-out matter, there is no matter without motion. Motion is process, the transition from space to time and the reverse; matter, however, is the relation of space and time as resting identity'. Friedrich Engels later adapted the relation in question to his view of materialism. See Engels, *Marx-Engels Gesamtausgabe (MEGA)* XX:55.
- ¹¹ Repulsion is as essential as attraction since matter 'would fuse together in a single point' if it 'reached what it aspires to in gravity' (*Enc* §262A).
- ¹² The circular nature of the planetary orbits characterizes the solar system. If, according to Hegel, the essence of matter is manifested in the solar system, then circular motion (as the simplest example of planetary motion) must be essential to the understanding of matter. On Hegel's approach to the interpre-tation of mass from the symmetrical structure of circular motion, see Wandschneider (1993).
- ¹³ On Hegel's relation to the natural sciences of his time, see Petry (1970, vol. 1, pp. 11–190) and Engelhardt (1972, 2002). On the theory of heat, see Posch (2002).
- ¹⁴ We may disregard here whatever astro-physical scruples we might have concerning this claim.
- ¹⁵ See Schelling's related considerations in *SsW* II:107; *SsW* V:330, 379; *SsW* X:105.
- ¹⁶ This implication, which at first glance may seem bizarre, was already formulated by Hegel in 1805–6 (though without explicit reference to the kinematic principle of relativity) when he attributed 'absolute velocity' to the 'being' of light (*Jena Systementwürfe [JS] III GW* 8:35; see also *Enc* §275A).
- ¹⁷ Hegel's position on the physical reality of light's absolute velocity thus holds against whatever Gerald Feinberg may have demon-strated concerning the theoretical possibility of 'tachyons', that is, *imaginary* masses with velocities *exceeding* the speed of light (see <http://de.wikipedia.org/wiki/Tachyon>).
- ¹⁸ See for instance the specifically physical orientation of the investigations on the special theory of relativity by Hans Reichenbach (1928) and Ernst Cassirer (1972). On the options for interpreting the *general* theory of relativity in the framework of Hegel's natural philosophy, see Wandschneider (2008, ch. 4.10).
- ¹⁹ This exemplification goes beyond E. Harris's explication of Hegel's text: Harris (1998, pp. 197–201).
- ²⁰ As Hegel expressed this thought during his Jena period, the animal organism is 'as the unity of two selves – first, a whole as individ-ual, as self-sensing in desire; then, a whole that

excludes from itself this abstract *I*, a whole for which another exists' (*JS III GW 8:166*). I find this characterization noteworthy because Hegel distinguishes between two selves that he otherwise speaks of in an undifferentiated manner. We have here the unity of the function-self (as the self that evaluates and

senses the internal state of want) and the action-self (which perceives an external object).

²¹ For the place of the mental in the systematic framework of Hegel's philosophy of spirit, see Wolff (1992).

translated by J. Edwards