

# Kant's Conception of Ether as a Field in the *Opus postumum*

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## §1. Introduction

In this paper, I will bring into focus Kant's speculation on the nature of physical reality documented in the manuscript he left unfinished when he died, the manuscript which has come to be known as the *Opus postumum*. Throughout his entire career, Kant maintains a keen interest in the metaphysical foundation of physics. And I find Kant the philosopher of nature at his best in the *Opus postumum*. Kant has deep insight about the nature of physical reality, and I shall attempt to show that some of the things he says in the *Opus postumum* are still relevant to contemporary thoughts on the foundation of physics.

The outline of my paper is as follows. I will begin with a review of Kant's notoriously obscure theory of space. Then I will relate Kant's concept of space to the concept of force. I will show that the fusion of the two gives rise to the idea of ether as an elementary material filling the whole of space and time. Kant's conception of ether, I propose, anticipates the modern conception of a field. As a corollary to this thesis, I will briefly indicate how Kant's conception of ether provides a conceptual foundation for a holistic ontology of physical reality.

## §2. Kant's dynamic view of space

Kant's ontology of space is anti-Newtonian in the sense that space is not an object, but the form of representing a physical object. The form of representation Kant calls pure intuition is an activity that we perform. According to Newton, space is an absolute entity which is ontologically independent of matter. If you take away all matter in the universe, empty space still remains. It is helpful to think of Newtonian absolute space as an empty container. But space for Kant, unlike the Newtonian container, is not an entity at all. An infinite container without boundary does not make sense for Kant. Space is not an object which contains matter, but a mode of representing matter. Physical reality is conceived as amorphous matter that exists independent of our mind. In this sense, Kant is an empirical realist. But it is well-known that Kant is also a transcendental idealist, in the sense that the form of physical reality is contributed by the mind, namely, space and time. As Kant says, "while the matter of all appearance is given to us a posteriori only, its form must lie ready for sensations a priori in the mind..." (A20/B34).

On my view, Kant's conception of space entails that space is inseparable from matter. If space is the form of outer intuition, then it must be matter that is being intuited. Intuition pertains to something real, for Kant says quite clearly in the *Critique* that empty space is not intuitable.<sup>1</sup> Since space is the form of outer-intuition, without the presence of matter, we will have nothing to intuit. Intuition is a capacity or activity which hooks us up to a given external material reality. Since the function of intuition is to exhibit physical reality, if matter is not given, then there is nothing to exhibit. If there is nothing to exhibit, intuition cannot be operative. Since the function of intuition is directed towards reality, we can characterize intuition as a *reality pointer*.

To put in a nutshell—Newtonian space is entitative and we can think of it as a noun, while Kantian space is *intuitive* and we can think of it as a verb. Space for Kant is not static, but *dynamic*. If you like, in Kant's semantics, space means *spacing*. Space is the form of outer intuition in the sense that it is a procedure or activity. Although Kant holds that our representation of space originates from the mind, it will be misleading to think of space as a mere product of imagination. For our representation of space is grounded on a dynamic interaction with physical reality. In the *Critique of Pure Reason*, Kant says that all sensible intuitions are grounded on what he calls *affection*: "all intuitions, as sensible, rest on affections..." (A68/B93). Kant's notion of affection can be understood as a physical action that influences our senses. In the *Opus postumum*, Kant says explicitly that it is the moving forces of the ether that affect us. Since Kant says that all sensible intuitions are grounded on affection, our representation of space must somehow be related to force. If space is a production at all, then its production must presuppose a certain dynamic capacity or power in order to do the job. Crudely speaking, a certain power is required to extend in space and to last in time. Spatial extension and temporal extension can be thought as different manifestations of force. This, I believe, is the thrust of Kant's dynamic conception of space and time in the *Opus postumum*.

In the *Opus postumum*, space is not merely the form of intuition, but also the carrier of force. As Kant says, "The moving forces, attractions and repulsions, are in space" (22:435).<sup>2</sup> But in what sense is force "in space"? This question is not easy to answer because force is not something tangible like a solid substance that is localized and spatially ostensible. Kant gives us a clue when he says that force does not "occupy" but "fill" a space. So to say that force is "in space" is to say that space is filled by force. But what does that mean? How does force fill a space? First, force fills a spatial region by distributing its effect in that region. Second, when force fills a space, it covers it *completely*. That is, if a certain magnitude of force is applied to a spatial region, the total effect of the force is distributed to every single point in that region, i.e. every point will "feel" the effect of the force. In the *Opus postumum*, Kant holds that force is everywhere in space: "[the] primordial attraction and repulsion of the elementary material, which is thoroughly and homogeneously distributed in [the whole of cosmic] space" (21:553). The thrust of Kant's dynamical

view of space in the *Opus postumum* is the fusion of the concept of force with the concept of space, which provides a conceptual basis for the idea of an all-pervasive substrate for physical reality—the ether.

### §3. Hypostatized space as a field

Kant conceives of the ether as a matter present in the whole of space and time: "There exists a matter, distributed in the whole universe as a continuum, uniformly penetrating all bodies, and filling [all spaces] (thus not subject to displacement). Be it called ether, or caloric, or whatever..." (21:218). In saying that the ether "fills all spaces," Kant does not mean that the ether is an object located in space. It will be misleading to think of the ether as an entity contained in an empty container. For Kant says that the ether is nothing but "space thought hypostatistically" (21:221). A hypostatized space is space filled with moving forces (the fusion of force and space). Kant says, "Space which can be sensed (the object of the empirical intuition of space) is the complex of the moving forces of matter—without which, space would be no object of possible experience" (21:219).

Kant's concept of ether as hypostatized space anticipates what we call a field conception of physical reality. In general, a field is a continuous medium where a quantity is defined on every point in the manifold. In a field conception, space is packed with material stuff. The best way to understand the field conception of physical reality is to contrast it with the corpuscular view of matter in classical mechanics. In classical mechanics, the fundamental substrate of physical reality is a plurality of individual substances localized and separated from one another in empty space. But in a field conception, the fundamental substrate of physical reality is a single material continuum which spreads out in space. A field is an elastic medium which encompasses the whole space completely, leaving no spatial region empty.

The ether for Kant is not merely a conceptual artifact, but is something real. Space is filled with a continuum of forces. Kant is ontologically committed to the existence of the ether as a material continuum. Since space is filled by a continuum of forces, and it is an ontological mistake to think of forces without a supporting medium, the ether provides the material basis for a continuum of forces. The objective reality of a field of forces constitutes the fundamental substrate for physical reality for Kant. This is precisely the thrust of a field conception of matter—the material reality in the whole of space and time unified by a single substrate. In Kant's late ontology, what constitutes the substrate of physical reality is not a plurality of localized substances, but a single field encompassing the whole of space and time. When Kant wrote the *Opus postumum* the field conception has not yet emerged in physics. Now we are equipped with the concept of a field, and this will help us to come to a better understanding of Kant's ether. I shall now argue, with textual evidence, that Kant's ether as conceived in the *Opus postumum* indeed has the structure of a field.

#### §4. The Ether as a field

In general, a structure  $\Omega$  is a field if it satisfies the following:

- 1)  $\Omega$  is a continuous medium.
- 2) A quantity is definable on every point in  $\Omega$ .<sup>3</sup>
- 3)  $\Omega$  functions as a medium for action to be transmitted across space.

Any structure that has all these properties we call a field. I shall now show that Kant's ether has all these three properties.

##### A. The ether as a continuum

The ether, according to Kant, has the following peculiar structure: it does not consist of simple parts. Kant says, "Matter does not consist of simple parts, but each part is, in turn, composite..." (22:212). The ether as a single continuous whole is not made up of indivisible material points. The very idea of material points is a contradiction in term for Kant. As he says: "Each part of matter is a quantum; i.e. matter does not consist of metaphysically simple parts, and Laplace's talk of material points (which were to be regarded as parts of matter) would, understood literally, contain a contradiction." (22:205). Kant's conception of ether reflects his position against atomism. Kant says: "atomism is a false doctrine of nature" (22:212). If the ether is made up of individual atoms, then there will be gaps of empty spaces in between two atoms. The ether as a single substrate of physical reality has absolutely no gaps; it is completely smooth. That is to say, the ether is present in every region of space, no matter how small it is. The ether as a material continuum is governed by the following topological principle: the ether as a whole is prior to its parts. Recall that in the *Critique* Kant holds that the whole of space and the whole of time are "given" to us *a priori*. What happens in the *Opus postumum* is that Kant extends this topological principle to the *material condition* of experience. The ether as a material continuum is not composed of point-like substances. The significance of this is that Kant does not conceive of the substrate of physical reality as an aggregate of individuals, but a single continuous whole. Such a continuous manifold has absolute unity in space and time and provides a single material basis for our ontology of material reality.

##### B. The intensity of the ether

The ether as a material continuum is permeated with what Kant calls moving forces. The moving forces of the ether fill space completely in the sense that the magnitude of force is definable at every single point in space. In other words, force is everywhere. According to Kant, the moving forces of the ether "fill a space [both] extensively and intensively" (22:211). The ether is a material which has both extensivity and intensity: the extensivity of the ether can be understood as the volume of space being filled, while the intensity can be understood as the strength of its dynamic power present at every point in space. Notice that both the extensivity and

intensity of the ether can be measured. Hence, it makes sense to talk about different degrees of filling a space. As Kant points out: "One will have to ask not only: How much space? but also: To what *degree* is it filled?" (22:206) The intensity of the ether varies from one spatial region to the other—it may have a high intensity in one region and a low intensity in another. Nevertheless, the various intensities are distributed continuously in space. This property is typical of a dynamical theory of matter.

Since the ether fills space completely, its intensity is definable on every point in space. For regions of space that seem to be void of matter, Kant suggests that the apparent emptiness of those regions of space is due to the low intensity of the ether. Kant says, "Empty but perceptible intermediary space is, thus, really a matter which, in degree, is imperceptible relative to our sense; it is an object of possible but mediate experience, e.g. light-matter which occupies the space between the eye and the object, and [which] can become an object of experience only by its excitation" (21:229). The intensity of the ether that Kant talks about comes very close to what we call field-intensity. The different degrees of the filling of space corresponds to different dynamic specifications of the field. Hence, a quantity is definable on every point in the ether, thus satisfying the second criterion for a field.

### C. The ether as a medium for the transmission of action

In the *Opus postumum*, Kant argues against the possibility of action at a distance. The idea of action at a distance is this: pick a point A in space and another point B; then some physical entity at point A can influence another entity at B by exerting an *instantaneous* action from a distance across empty space. Action at a distance is troublesome because no known laws of physics can explain how action can be transmitted across empty space instantaneously. Kant says, "The transition from one object of the senses to another cannot be an experience if there is an intervening void; the two objects can be combined with each other within one experience only by means of the intermediary object of perception, which is moving forces and real material" (21:229). With the ether acting as a material medium, Kant favors contact action over action at a distance.

Kant's argument against action at a distance is motivated by his conviction of the impossibility of empty space. In the *Critique of Pure Reason*, Kant leaves the existence of empty space an open question. But in the *Opus postumum*, Kant is determined to refute the possibility of empty space. Kant says, "No effect of the moving forces of matter can reach our senses through empty space" (21:220). Once empty space is dispensed with, it is not difficult to see why action at a distance has to go as well. If space is not empty, it must be filled with material stuff. Hence, the transmission of action from one spatial region to another must be supported by a material medium, but not empty space. Kant says, "To repel at a distance and to attract in contact, so that the one is the condition of the possibility of the other, is contradictory, except by means of an intermediary matter which must surround all

bodies" (21:376). Hence, it is clear that Kant's ether satisfies the third property of a field, namely that it functions as a continuous medium for the transmission of action across space.

With the ether as a continuous medium, Kant conceives of all individual bodies as inter-connected in a single space through the ether. The idea of a continuous material medium as a carrier of action, is fundamental to Faraday's conception of a field. But long before Faraday's formulation of the idea of a field, Kant has already conceived of the *necessity* of a material medium for the transmission of action across space. Kant is almost talking like Faraday when he says, "In magnetism and electricity there occurs an attraction at a distance—through an intermediary matter, however" (22:215). With his postulate of the existence of the ether, Kant lays down a philosophical foundation for a new paradigm in natural philosophy, a conception which bears its first fruit in Faraday, and comes into full bloom in Einstein—a field conception of physical reality.

#### §5. The ether-field as a phenomenon

When we talk about the ether as a field, we need to keep in mind that the ether-field has to be considered a phenomenon. Although the ether is a substrate which underlies the appearances of bodies, it is not a thing-in-itself because it is empirically determinable. The ether is a material which admits of empirical predications—it is a vibrating and all-penetrating material which possesses moving forces. Despite its metaphysical overtone, the ether is too empirical to be considered a thing-in-itself. But the appearance of the ether cannot be put at the same ontological level with the appearance of a body either. So we have a problem with the ontological status of the ether: Is it an appearance? Or is it a thing-in-itself?

In solving this problem, Kant conceives of different layers of appearances in order to accommodate the ether. What results is a new ontological structure which incorporates a hierarchical distinction between primary and secondary appearances. Kant says, "The appearance of things in space (and time) are twofold: (1) that of objects which we insert in space, and (2) that which is empirically given to us. The latter is direct appearance, the former indirect—that is, appearance of an appearance" (22:340). Secondary appearances consist of our perceptions of physical bodies with all their primary and secondary qualities, while primary appearances consist of a continuum of moving forces stripped of all sense-qualities. Hence, our perceptions of individual bodies in space are nothing but appearances of a yet deeper level of appearances—a continuum of moving forces. The metaphysical principle of appearance of appearance provides a thick layer of appearances in Kant's ontological scheme. In this way, Kant does not need to invoke the thing-in-itself as the substrate for a field ontology. Once a hierarchical structure is imposed upon the realm of appearances, the problem with the ontological status of the ether is solved, and the consistency of Kant's notion of appearance is also salvaged.

Kant's conception of the ether undoubtedly points towards a holistic ontology. The fundamental substrate of physical reality, as conceived by the elderly Kant, does not consist of a plurality of individual bodies or particles, but a single material field—the ether, filling the whole of space and time with its moving forces. The physical theory which supports Kant's holistic ontology is precisely that of a field theory. In a field ontology, it is not the individual particle, but the field as a single physical system that is considered fundamental. As the well-known physicist Lanczos points out, "The particle is no longer an isolated unit but part of a 'system'.... The single particle has no significance; it is the system as a whole which counts."<sup>4</sup> With the concept of an all-pervasive ether, all the individual bodies are connected and unified into a single system.

### Notes

1. "We can never represent to ourselves the absence of space, though we can quite well think it as empty of objects" (A24/B38).

2. All quotations from the *Opus postumum*, unless stated otherwise, are taken from Eckart Förster's recent translation published by Cambridge University Press. See *The Cambridge Edition of the Works of Immanuel Kant: Opus postumum*, Cambridge University Press: 1993.

3. The quantity defined on each point could be a scalar, vector, or tensor.

4. Lanczos, *The Variational Principles of Mechanics*, 4. New York: Dover Publications, Inc., 1970.