

TIME IN PHILOSOPHY AND IN PHYSICS: FROM KANT AND EINSTEIN TO GÖDEL

For the physical world, the four dimensions are natural. But for the mind, there is no such natural coordinate system; time is the only natural frame of reference.

Gödel, conversation on 15.3.72

ABSTRACT. The essay centers on Gödel's views on the place of our intuitive concept of time in philosophy and in physics. It presents my interpretation of his work on the theory of relativity, his observations on the relationship between Einstein's theory and Kantian philosophy, as well as some of the scattered remarks in his conversations with me in the seventies – namely, those on the philosophies of Leibniz, Hegel and Husserl – as a successor of Kant – in relation to their conceptions of time.

Both physical and mental processes take place in time – 'that mysterious and seemingly contradictory being, which, on the other hand, seems to form the basis of the world's and our own existence' (Gödel 1990, p. 202). As Augustine puts it in his *Confessions* (Book 11, Ch. 14):

For what is time? Who is able so much as in thought to comprehend it, so as to express himself concerning it? And yet what in our usual discourse do we more familiarly and knowingly make mention of than time?

Time plays an important part in everyone's life and there is a vast literature – in psychology, in physics, in biology, in philosophy, in history, in literature, and elsewhere – devoted to the various aspects of time. For instance, a survey of the philosophical issues and familiar studies of them is given under the entries on time (by J. J. C. Smart) and on time-consciousness (by C. W. K. Mundle) in Edwards' *Encyclopedia of Philosophy*. – The relation between time and its mathematization is a specialized concern of physics, which illustrates the applications of mathematics and the pervasive task of giving form to our experience.

The familiar representation of time by a directed line in Newtonian physics is based on an analogy with space. Time itself is in the first place a frame of our inner states; it has nothing to do with shape or position – in its literal spatial sense. Its spatial representation by a line, nonetheless, facilitates our thinking about it and, in particular, brings the organization of our operations with it into a mathematical frame. In Kant's words (*Pure Reason*, A33 or B50):

We represent the time-sequence by a line progressing to infinity, in which the manifold constitutes a series of one dimension only; and we reason from the properties of this line to

all the properties of time; with this one exception, that, while the parts of the line are simultaneous, the parts of time are already successive.

By way of this spatial analogue of time, we are able to represent space and time mathematically in such a manner that much of what is in our intuitive conception of space and time is preserved. Given the fact that time is primarily a frame of our inner sense, it is remarkable that this mathematization, through spatialization or externalization, of time – a highly precise but inflexible way of giving form to experience – has turned out to connect our inner and outer senses so well as to agree so completely with our observations of the external world for so long.

At the same time, it is not clear how we are to understand time as thus represented. On the one hand, it is generally believed that time and change are objective in the sense that the physical world ‘consists of an infinity of layers of “now” which come into existence successively’ (Gödel 1990, pp. 202–3). On the other hand, Kant and some other philosophers consider time and change as an appearance due to our special mode of perception. In Kant’s philosophy, in particular, the structure of space and time for physical reality in itself may be totally different from that of the appearance, even though we have no way of knowing what it is like.

Eventually the increase of our physical experience and the refinement of its organization led to the introduction and the general acceptance of the theory of relativity in the early part of this century. – In this theory, the global organization of local observations reveals a more complex relation – than the Newtonian scheme – of the locally observed simultaneity and temporal succession to the assumption of a uniform lapse of time which sees the world as one infinite sequence of successive layers of ‘now.’

There is a definite sense in which Einstein’s theory is an improvement of Newton’s: this sense could be extracted from the extended considerations which had led to the general acceptance of it. – Since Kant based his philosophy of our scientific knowledge on Newton’s physics, a natural question is to determine the extent to which this progress in physics affects the relevant parts of Kant’s philosophy. The usual emphasis is on the conflict between these parts and the philosophical implications of the new physics. In contrast, Gödel chooses to uncover and argue for a surprising similarity, in some respects, between relativity theory and Kant’s doctrine about time and space.

In 1976 Gödel told me that his work on relativity theory had been caused by his interest in Kant’s philosophy of space and time rather than by his frequent talks with Einstein. – Later in his 1949b, he stated more specifically that he had been struck by the agreement ‘between Kant and relativistic physics insofar as in both theories the objective existence of a time in the Newtonian sense is denied.’

Gödel’s interests in physics and in Kant’s philosophy began early. At the age of 16 he read some of Kant’s work; at about the same time, he