

also physically possible, that is, not precluded by any law of the statute book kind. On this assumption he predicted that a state of negative kinetic energy would be observable in the form of the positive electron. This startling discovery justified the assumption made by Dirac that the laws of physics are not of the statute book kind. The important question is whether the same assumption can always be made.

The illustration taken from Dirac's work shows that the question belongs more to the methodology than to the metaphysics of science. The implication in Dr. Grant's quotation from Russell that it is easy to suggest what is logically possible leads one away from the question, while I want it to be faced. In fact, it is extremely difficult to know what is logically possible in the sense of logically consistent with the whole body of scientific knowledge. Mathematics is wholly concerned with discovering one part of just that. The important question is whether the same applies to physics, or whether some of the laws in physics preclude classes of events that would nevertheless be consistent with the whole body of knowledge. Had Dirac assumed that the laws of physics are of that restrictive kind, he might not have predicted the positive electron.

The second very basic question is about the laws of biology. If the laws of physics do not preclude any events that are logically possible, those of biology seem nevertheless to do so. For there is evidence that the laws of biology lead to specified order whereas the laws of physics do not. The label given by Dr. Grant to both kinds of law, namely, descriptive law, does not provide a means of testing this evidence for its validity. By giving one name to two things one cannot prove that they are the same thing. To dismiss the apparent differences between the laws of physics and those of biology as lightly as that is to do poor service to the methodology of science.

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PROF. KAPP'S remarks have brought out one important respect in which we are at cross-purposes—and also in agreement. This concerns the notion of 'logical possibility'. Prof. Kapp contends that I have misunderstood his views on this matter; this may well be so, for it is now clear that he attaches to the phrase 'logical possibility' a somewhat unusual meaning, quite different from that which I have assigned to it. He asserts that " 'Logically possible' means, in scientific methodology, logically consistent with the complete body of scientific knowledge". Now Prof. Kapp, like anyone else, is entitled to attach any meaning he likes to any word or combination of words, and no one can gainsay him—except to point out that certain forms of words are misleading. I would like to persuade Prof. Kapp that his terminology is liable to lead to confusion.

I agree with Prof. Kapp, if I understand him rightly, that 'logically possible' is an expression that occurs not in accounts of scientific investigations or theories, but in what he calls the 'methodology of science' for which I should prefer the name 'philosophy of science'. This is a branch of logic, in a wide sense of that term. It therefore seems both relevant and important to make clear the generally accepted

philosophical meaning of the phrase 'logically possible'. This notion is applicable in two different ways.

(i) Application to an individual proposition, p . ' p is logically necessary' means 'not- p is a self-contradiction'. It is logically necessary that bachelors are unmarried because the denial of this proposition is self-contradictory—and this is what is meant by a logically impossible proposition. This is quite different from a false proposition; we do not find out that no bachelors are married by conducting a survey of bachelors; we can assert *a priori* that no bachelor can be married in virtue of the meaning, or rules for the use of, 'bachelor'. It is clear from this that to say that a proposition is 'logically possible' is to say only that it is internally consistent; my quotation from Russell was designed to illustrate this, although I quite agree with Prof. Kapp that Russell should have talked of 'the illusions of memories'.

(ii) The notion of 'logical possibility' may also refer to the relation between one proposition or set of propositions and another set of propositions; here we are concerned with compatibility—or 'compossibility', to use Leibniz's phrase. Here again the issue is one that must be settled *a priori*, although, as Prof. Kapp points out, it may be very difficult to do so. Prof. Kapp's account of the problem of the relation between a certain hypothesis and the rest of the system is put in the form of the question of whether physical laws "preclude classes of events that would nevertheless be consistent with the whole body of knowledge". This is to confuse the vital distinction between an *a priori* and an empirical problem. If p and q are logically incompatible, we can assert *a priori* that both cannot be true; but which of them is true, if either, is an empirical issue. In Prof. Kapp's usage, if p is incompatible with the rest of the system, it is "logically impossible"; this implies that it is unnecessary to investigate its empirical truth. But, of course, the question of its truth has not been touched and remains a problem. For Prof. Kapp to use the expression 'logically possible' in such a way that a proposition can be logically impossible and yet true is, to quote him, "likely to obscure . . . the problem". Although not explicitly stated, this conclusion is entailed by the conception of 'logically possible' as meaning 'consistent with the rest of science'. Discoveries of fact (for example, the duck-billed platypus) and of theory (for example, the heliocentric theory) are often logically impossible in this sense, that is, incompatible with the body of scientific knowledge.

Prof. Kapp's use of the word 'preclude' shows that he does not recognize the essential difference between descriptive and prescriptive laws; only the latter can be properly said to preclude anything.

In calling biological, as well as physical, laws 'descriptive', I merely wished to direct attention to the fact that they possess an indicative or descriptive character, as distinct from the laws of the land which are imperative or coercive in form, and which may be properly said to 'make for order'. In applying this label to the laws of both biology and physics I did not, of course, try to prove that they are 'the same thing', any more than one who says that both apples and peaches are fruit is trying to deny their differences.

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