PHYSICAL EXISTENCE : MEANING & TEST

McGill University
Foundations & Philosophy of Science Unit

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Professor Roger Angel

Dear Roger

You told me that in your book you take the view that spacetime exists by itself, independently of matter. Because of this I did not want to referee it for, had I criticized it, the publisher would not have taken it--and I wanted the book published. Now that publication is certain I can afford telling you why I believe your thesis is false.

Any thesis of the form "X exists really, i.e. other than as a construct" poses two problems. One is the semantical problem of what it means to assert that X exists, the other is the methodological problem of testing the existence hypothesis by some empirical means. Hence a responsible answer to the existence problem presupposes having done one's homework in the theory of existence (ontology) as well as in methodology. I have done mine. Have you done yours?

As far as I am concerned only a theory about entities in general gives meaning (sense cum reference) to a concept about an entity. In turn, such a theory, if it is to be compatible with science, must construe entities (things) as objects possessing substantial (nonconceptual) properties, so they can be in some state or other. Moreover, contrary to constructs, which neither change nor fail to change, entities are supposed to be changeable, i.e. to be capable of jumping from one state to another. Hence the very first thing to ascertain when investigating whether X exists (physically) is to find out whether X has a state space containing at least two elements (states). This investigation is prior to the methodological one, which will focuse on particular properties and changes thereof. So much for the general background of any particular investigation into the existence of any particular object.

If there is a theory about X then this theory should specify the properties and laws of X and thus the state function of X and its evolution, hence its state space (the set of all possible states of X). In such a case empirical operations should be able to find out whether the theory is at least partially true--e.g. first shielding X from all other existents and showing that it does not "evaporate", then showing that, when not so shielded, X can modify, or be modified by, some physical entity about whose existence there is little if any doubt.

Apply the foregoing considerations to spacetime. Does it exist by itself, i.e. independently of matter and fields? Equivalently: Do the field equations of GR have any physical meaning in the case where the matter tensor T vanishes everywhere and everywhen? Clearly in this case there are no physical properties left, for they all vanish together with T, and so the state function of the system vanishes and correspondingly its state space shrinks to nothing--

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the mark of constructs not of things. In other words, spacetime by itself is in no physical state, and a fortiori cannot jump to a different state. I.e. nothing would happen in a hollow "universe". In other words spacetime is not a thing or entity, i.e. it does not exist by itself. Equivalently: "$G = 0$ everywhere and everywhen" describes a mathematical space not a physical spacetime. Therefore, i.e. because spacetime is not absolute, it cannot adequately be described except by a relational theory.

Look now at the methodological problem of supplying evidence for your thesis. Theory (both ontology and GR) tells you that you cannot shield spacetime, as if it were a charged body, in order to find out what its intrinsic properties are. And common sense tells you that, since "$T = 0$ evrywhere and everywhen" writes off all existents, in particular it is incompatible with the existence of reference frames and measuring instruments. Further, if you wished to examine the interactions between spacetime and genuine entities, you would not know how to proceed, not even how to describe them, for (at least in my ontology) a thing Y acts on a thing X iff the states of X in the presence of Y differ from those of X in the absence of couplings with Y.

In summary, I believe that your thesis of the existence of spacetime is not only false but also groundless, for you have (so far as I know) not provided the proper ground--a theory of being, a theory of meaning, and a methodology. The only way you could defend your thesis is by adopting a Platonistic ontology, according to which all "forms" (ideas), in particular all properties and relations, enjoy independent existence. But of course you could not claim that such ontology is consistent with science, in particular with GR.

Cordially

Mario Bunge