# Physics for philosophers and philosophy for physicists

D. ter Haar

*Superposition and Interaction: Coherence in Physics.* By Richard Schlegel. Pp.302. ISBN 0-226-73841-8. (Chicago University Press: 1981.) $22.50, £13.50.

THIS is an interesting book but — to my mind — very much a curate's egg. The first question which comes to mind is: for whom is the book meant? The author himself states that although at times he had thought of philosophers as his audience, his primary prospective audience is among physicists or other physics-minded scientists "who have some technical knowledge of special relativity theory and of quantum theory — as given, say, in introductory courses in those topics in American universities". The next question is: what is the message which the author wants to convey? The answer is that he wishes to suggest that there is a fundamental coherence in physics which can be shown especially to exist when we consider the two main pillars of what is still called "modern" physics, namely, the special theory of relativity (now 76 years old) and non-relativistic quantum theory (in its late sixties). The suggestion is that in both of these theories superposition (that is, the fact that if one has two separate solutions of the equations, a line or combination of them is also a solution) plays an essential part and interactions with an observer are a deciding factor. This is orthodoxy as far as quantum theory is concerned, but takes some swallowing when we come to special relativity. However, while this book does not give any compelling reasons — in my view, not even aesthetic reasons — to accept this thesis, there do not seem to be any experimental data which contradict it. This is, perhaps, not surprising, as no *experimenta crucis* are suggested to decide for or against the author's views.

Let me first of all list those aspects of the book which I found most admirable and from which I benefited most. For a careful and well-informed reader it contains much that is illuminating. In particular, I found the first and last chapters of great interest. The discussion in the first chapter of the contents of classical physics — going back to Aristotle — and of the importance of models in theoretical physics in general and in classical physics in particular is excellent. The last chapter containing a "summertime conversation" between two physicists, the wife of one of them and a philosopher gives a cogent and on the whole clear account of most of the important points made in the main body of the book. One might object to quantum mechanics as a *deus ex machina* and the relegation of God to a superior watchmaker — miracles seemed to have no place in the Universe inhabited by these four people — but these are minor objections. Another excellent discussion is the one of the clock paradox, where the author follows a suggestion made to him by Einstein himself and uses three uniformly moving inertial systems to resolve this paradox.

I now come to a number of points where I feel the author has seriously diminished the usefulness of this mainly philosophical treatise, especially for younger physicists. I would hesitate to give the book to my own pupils without a number of caveats, since in a number of places the theory given is wrong (or at least so poorly formulated as to be seriously misleading). In the account of measurement in quantum theory there is, in my opinion, insufficient emphasis on the difference between the preparation for a measurement and the measurement itself. However, the most fundamental error — and one which crops up several times — is in the discussion of pure states and mixtures. A mixed state *cannot* be represented by a wavefunction, but needs a density matrix. The concept of a density matrix — so central in the theory of measurement — is, in fact, nowhere mentioned in this book.

Other points where the text is, to say the least, misleading are where the author states that the Maxwell equations are linear (homogeneous) differential equations for which the superposition principle holds, without stating that this is only true for the Maxwell equations *in vacuo*. It is also confusing to stress de Broglie's introduction of the relations between energy/momentum and frequency/wavevector as against Schrödinger's introduction of the wave equation in order to find a close relation between special relativity and non-relativistic quantum theory. After all, we still do not have a complete relativistic wave equation, but only approximate equations such as the Dirac and Klein–Gordon equations which are valid in the not-very-relativistic domain.

In a book which is mainly philosophical in tone, one would expect careful use of language and it is disappointing to find a number of sloppy expressions. It is probably too much to expect that a careful distinction is made between utilize ("to make useful, turn to account" according to the *OED*) and use, but a vital point is missed when it is stated that "the Greek word atomos means 'individual'." As an important issue in the book is the distinction between macroscopic and microscopic systems, somewhere a careful definition of those terms should be given and the dividing line drawn between them — or it should be stated that it is often impossible to draw such a line. The general problem of what are physically meaningful questions and which are mainly philosophical ones, although hinted at several times, could also have been considered more carefully. For instance, I feel strongly that in a book of this kind there should be a clear discussion of the fact that a wavefunction only has a meaning in as far as it can predict the outcome of an experiment — this, after all, makes quantum theory a theory which can be falsified. □

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The second volume in the series *Genetic Engineering* (for a review of Vol.1 see *Nature* **292**, 480) has recently appeared. *Genetic Engineering 2* contains four contributions on gene evolution, genomic libraries, restriction enzymes and gene cloning in yeast. Prices are: £9.80, $24.

# What price the diversity of species?

A.D. Bradshaw

*Conservation and Evolution.* By O.H. Frankel and Michael E. Soulé. Pp.327. ISBN hbk 0-521-23275-9; ISBN pbk 0-521-29889-X. (Cambridge University Press: 1981.) Hbk £25, $49.50; pbk £7.95, $17.95.

THE natural ecosystems of the world are disappearing at a frightening speed. Tropical rain forests are being destroyed at a rate of 4.7 ha $min^{-1}$ and will be gone within 50 years. Every year sees a further 6 million hectares of arable land. Although some areas will be almost impossible to cultivate, the ingenuity of people pressed for space must not be underestimated; and even if cultivation is not possible, hunting, logging and grazing will inevitably increase drastically beyond their present high levels.

Against this scenario, what will be left of the wealth of plants and animals on this planet? Some species, *r* selected, of small size and with tolerance of man-made environments, will certainly survive. There are plenty of species left in England and China. But the great diversity will inevitably be reduced. This book is a critical analysis of what is likely to happen, written by two well-known population geneticists, highly experienced between them in both wild and cultivated species.

If species are to be conserved at all, the authors argue that they must be conserved without loss of genetic variability. For outbreeding organisms, from considerations of the effects of inbreeding/mutation/selection equilibria the authors conclude that a minimum effective population size of 50 is necessary.