Time Flow And Reversibility in a Probabilistic Universe

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ABSTRACT

A fundamental problem in understanding the nature of time is to explain its 'directionality'. The commonplace view is that this directionality is provided by the 'flow of time'. Unfortunately this concept of 'time flow', which seems to make perfect sense to us in our everyday lives, has resisted philosophical and scientific analysis so well that today it is widely regarded as having no place in the scientific account of the world. Instead, various alternative physical concepts of the directionality of time have been developed, principally the notions of the time reversibility of physical laws or theories, and of the time asymmetry of physical processes. It is frequently argued by philosophers of physics that the scientific account of the directionality of time must be framed entirely in terms of these physical notions.

The thesis of the present work is that this conclusion has been reached far too hastily. It is argued that the concept of time flow is a legitimate physical concept, and furthermore, that time flow plays a real part in quantum theory.

A number of conceptual investigations are necessary to support this argument. Firstly, it is necessary to give an analysis

of what a physical theory of time flow might be like, and how it might be empirically established. This is given in Chapter One, which at the same time is an overview of the results of later chapters. It is found in Chapter One that the concept of physical time flow has an important connection with the concept of time reversibility, which makes it necessary to give an analysis of this notion. A detailed discussion of reversibility and time symmetry is given in Chapters Two to Five. Here it is demonstrated that the orthodox analysis of the reversibility of probabilistic theories is flawed. This conclusion allows it to be shown, in Chapter Six, that, contrary to current scientific belief, quantum theory is profoundly irreversible.

This result, together with the argument of Chapter One, allows a strong *prima facie* case for an interpretation of quantum probabilities as involving time flow to be given. However, because of the traditional problems with the notion of time flow, for this interpretation to become respectable it needs to be demonstrated that it is possible to construct a formal model of a physical ontology in which time flow can be represented. This is undertaken in Chapter Seven. In Chapter Eight, various points about the role of probabilities in quantum theory are discussed. Finally, in Chapter Nine, the implications of relativity theory for the proposed theory of time flow are considered. It is found that relativity theory poses a serious problem for a physical theory of time flow, but the implications of relativity theory for the proposed interpretation of quantum probabilities is not clear because of deeper foundational problems with quantum theory.

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