Book Reviews

A Problem in Physics

Quantum Gravity. Papers from a symposium, Chilton, England, Feb. 1974. C. J. ISHAM, R. PENROSE, and D. W. SCIAMA, Eds. Clarendon (Oxford University Press), New York, 1975. xii, 606 pp., illus. $29.50.

The papers in this book are the product of an attempt to bring together people interested in various approaches to the problem of the quantization of gravity. Except for one, they were all delivered at a symposium held at the Rutherford Laboratory, and they range from an excellent introduction to the problem by C. Isham to detailed descriptions of current research.

The quantization of gravity looms as one of the key unsolved problems in theoretical physics. Quantum theory and the geometrical description of gravity given by Einstein have so far resisted all attempts at marriage. This volume is thus a report of the hopes and of the failures of some who have tried to achieve that union.

To me the most exciting approach is that of R. Penrose with his twistor theory. To Penrose, the fundamental "events" from which physics is to be built are the paths of massless particles. The points in space-time themselves are derived quantities, expressible as the intersection of such paths. While representing a radical change from the conventional view of space-time, the technique holds the promise of making contributions not only to a quantum theory of gravity but also to a theory of elementary particles. The unusual and difficult mathematics required, together with the scarcity of publications by the group around Penrose, have prevented ready access to the theory by most physicists, but I believe this approach holds as much hope for an eventual quantization of gravity as any of the more conventional approaches. The papers by Penrose expounding twistor theory and by G. Sparling giving an introduction to the algebraic topology necessary for work with twistors are thus very welcome.

The field-theoretic viewpoint in which the metric is regarded as a field to be quantized in the usual way remains firmly impaled on its infinities. Although it has had some success, as in showing that this viewpoint leads in a natural way to the geometrical viewpoint in the classical (low energy) limit, the second quantized version of this theory results invariably in unrenormalizable infinities. The techniques used and problems encountered are reviewed in papers by S. Deser and M. Duff.

An alternative approach, that of somehow quantizing the geometry itself, remains inundated by mathematical difficulties. Even highly simplified model geometries present seemingly unresolvable ambiguities and difficulties in quantization. The general techniques used and some of the simple models that have been examined are briefly reviewed by C. Isham and M. MacCallum, respectively.

Although he ignores the problem of quantizing gravity, the results presented by S. Hawking, that quantum effects can lead to evaporation of black holes by the quantum emission of particles, have been the greatest spur of the past year to workers in the field of quantum gravity. Although the exact mechanism of particle production is still in dispute, this result has highlighted the unusual effects that a union of quantum theory with gravitation could produce.

In the absence of any solid theory, however, one can but speculate. A. Salam again presents his hope that the quantization of gravity, properly done, will resolve most of the mathematical ambiguities and infinities affecting even other field theories. J. Wheeler and G. Patton, concerned with the question of the meaning of a fully quantized theory of the universe, present a report of their largely unsuccessful search for a philosophical and mathematical framework in which such a theory could be constructed.

For anyone interested in the quantization of gravity, this would seem a good introduction to the current state of the problem.

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Views of the Cosmos

The Nature of Scientific Discovery. A Symposium Commemorating the 500th Anniversary of the Birth of Nicolaus Copernicus. Washington, D.C., April 1973. OWEN GINGERICH, Ed. Smithsonian Institution Press, Washington, D.C., 1975 (distributor, Braziller, New York). 616 pp., illus. $15. Smithsonian International Symposia Series, 5.

Although the prediction of the future is a hazardous enterprise it would seem a fair assumption that in the year A.D. 2473 man will celebrate the one-thousandth anniversary of the birth of Copernicus with the same ceremony that the 1973 quincentenary occasioned. The heliocentric concept of Copernicus defied both common sense and millennia of tradition. In 1549, six years after the death of Copernicus, the influential academic and Protestant reformer Philipp Melanchthon challenged the idea that the earth was in motion by referring to the witness of the eyes that the heavens revolved in the space of 24 hours—"but certain men, either from the love of novelty, or to make a display of ingenuity, have concluded that the Earth moves . . . it is a want of honesty and decency to assert such notions publicly, and the example is pernicious. It is the part of a good mind to accept the truth as revealed by God and to acquiesce in it." Indeed, the Copernican concept, contrary to the apparent evidence of the senses, and breaching a thousand years of established philosophical and theological doctrine, must surely rank as one of the most courageous episodes in human thought.

The eventual rationalization of the heliocentric theory through the work of Kepler, Galileo, and Newton emphasized the revolutionary nature of the Copernican outlook—revolutionary not merely for astronomy, but for the whole of science and the entire philosophical framework of man's belief about the universe. It is therefore understandable that in 1973 Copernicus was honored on an international scale. In the United States the week of 23 April was designated by a presidential proclamation as "Nicolaus Copernicus Week." This book is a record of the festival, symposium, and collegia held in Washington at that time, organized by a joint program committee of the National Academy of Sciences and the Smithsonian Institution and serving simultaneously as the Academy's spring meeting and the Smithsonian's fifth international symposium.

It may be remarked without hesitation that this book, prepared under the skilled editorship of Owen Gingerich, is a most