The return of Salviati, Sagredo and Simplicio

Are Quanta Real?

J. M. Jauch
106 pp. Indiana U. P., Bloomington, Indiana, 1973. $6.95

Reviewed by R. Bruce Lindsay

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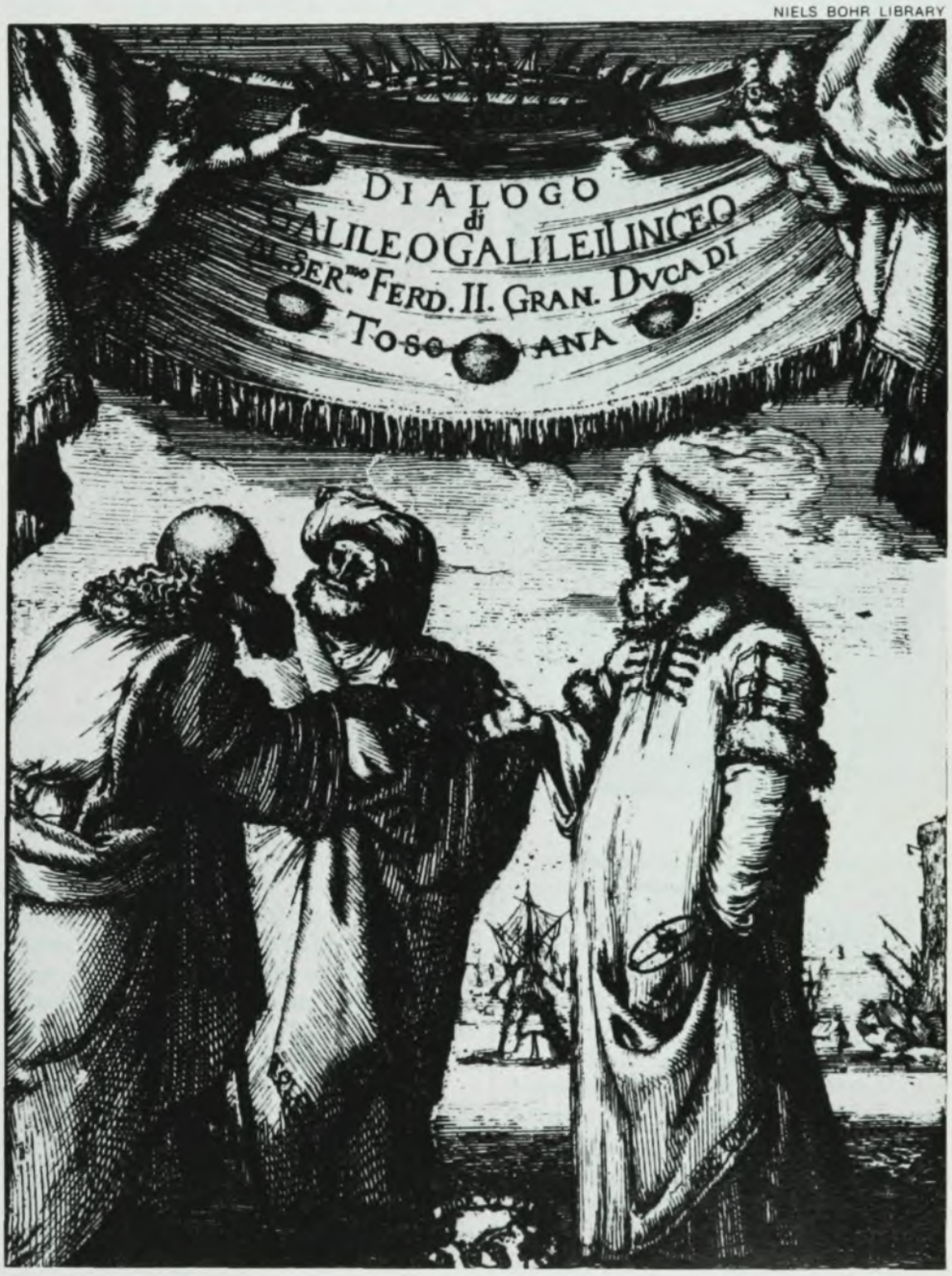

Aristotle and Ptolemy (left) argue against Copernicus (right) and his heliocentric system in this engraving from Galileo's *Dialogo, Massimi Sistemi* (1632). J. M. Jauch resurrects this dialogue plan in *Are Quanta Real?* to present the controversy raging between determinists and those who adhere to the statistical point of view in quantum mechanics.

The problem of the nature of physical reality has for long engaged the attention of philosophers and scientists. Since the conviction of what is "real" depends to a large extent on the taste and prejudices of the thinker examining the problem, it is unlikely that a concensus will ever be reached. To some, physical reality means the existence of a "real" world independent of the existence of human observers; it is the task of science to "discover" this world by the analysis of our sense impressions and our mental reflections based on them. To others this view appears to be arbitrary and wholly unnecessary for the satisfaction of human needs; they prefer to consider reality as simply the totality of human experience, which science is supposed to try to describe and understand in terms of suitable theories.

The construction of physical theories itself continues to be the subject of detailed investigation, some of it so profound as to be practically incomprehensible even to working scientists, not to mention the educated layman. Broadly speaking, the most successful theories may be divided into two classes: the deterministic and the statistical. The prime example of the former is, of course, classical mechanics, built up in the 17th and 18th centuries by masters like Galileo, Newton, Huygens, Euler and Lagrange. Here the laws derived from the theory provide a precise prediction of the state of a dynamical system at all times once the state is prescribed at a given instant. A statistical theory, on the other hand, uses probability considerations to calculate *averages* of quantities descriptive of the system and foregoes determinism. Statistical mechanics is a good example of such a theory, and it has been remarkably successful in describing the behavior of complicated systems. It must be confessed, however, that in the eyes of the adherents of deterministic theories the use of statistics is largely a matter of analytical convenience and not a matter of logical necessity. They tend to feel that if we had sufficient command of mathematics we could make all physics deterministic, in the sense, say, of celestial mechanics.

The epistemological situation in physics has changed considerably with the advent of quantum theory. In the viewpoint of the so-called "Copenhagen" interpretation of quantum mechanics the predictions of this theory, even for a single system, are of necessity statistical, dictating the abandon-

ment of strict determinism. Considerable controversy has been aroused by this view. Authorities like Niels Bohr, Max Born and Werner Heisenberg have (along with most physicists who use quantum mechanics in their researches) ranged themselves on the statistical side, whereas equally great celebrities like Albert Einstein, Erwin Schrödinger and Louis de Broglie have defended the deterministic viewpoint. This controversy is the theme of *Are Quanta Real?* whose author, Josef M. Jauch, a well-known authority on quantum mechanics, is Professor and Director of the Institute of Theoretical Physics at the University of Geneva in Switzerland.

The author has chosen an ingenious and felicitous way of handling his theme. He has resurrected Galileo's famous dialogue plan used in the great works *Dialogues Concerning Two New Sciences* (1638) and *Dialogue Concerning the Two Chief World Systems —Ptolemaic and Copernican* (1632). So we once more have the pleasure of listening to Salviati, Sagredo and Simplicio, this time, after a lapse of nearly three and a half centuries, arguing about the reality of quanta. As before, Salviati represents largely the author of the book, while Sagredo is the eager questioner with an open mind. Simplicio comes off somewhat better than his illustrious 17th-century predecessor, for though a sceptic he is by no means ignorant and indeed has a thorough grasp of quantum mechanics, though he does defend the deterministic point of view and does it well. But so far as the reviewer can make out, the "virtue" that triumphs at the end of the fourth day of discussions is the statistical interpretation, which is argued by the author rather persuasively. The reader of the book will, of course, wish to judge for himself and he will certainly be challenged by this clever, thoughtful and entertaining presentation of the problem.

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Ernst Mach: His Life, Work and Influence

John T. Blackmore
414 pp. U. of California Press, Berkeley, 1972. $16.95

The history of 19th- and 20th-century philosophy of science has for too long remained unwritten. Although it is indisputable that many scientists of the time were influenced in one way or another by contemporary philosophy, until recently we have had no intensive studies of the lives and influence of such important groups as the German positivists. Ernst Mach was among the most well known philosophers, at least among scientists, of the late 19th century. Though he thought of himself as a physicist, much of his writing centered on what he believed to be the proper foundations and methods of science, and many scientists of the time, including Max Planck, Ludwig Boltzmann, Wilhelm von Ostwald and Albert Einstein, were influenced by or engaged in polemics with Mach. There is a very definite need for a book detailing Mach's life, his philosophical and scientific work, and his influence.

John Blackmore, who teaches the history of ideas at Harvey Mudd College in California, wrote his dissertation on Mach, and this book is a revision of it, a revision that involved cutting the doctorate in half. Perhaps this drastic editing is the source of the book's failings, for Blackmore's work is most inadequate. Blackmore tells us in his preface that he wanted to produce a true biography, to show and explain Mach's philosophical and scientific ideas, and to emphasize his influence on 20th-century science and philosophy of science. This is a large task, which requires a perceptive look into the man's life and into how his work was affected by his personal affairs. The author needs as well the ability to separate the various aspects of his subject's philosophical career, to tell us what they were and how they came to be. He must have a keen sense of the history of the time and how science developed in it to be able to show his readers where his subject's work fits in and what influence it had.

Unfortunately Blackmore's *Ernst Mach* fails to fulfill the promises of its preface and proves inadequate either as an historical account or as an explanation of the issues involved. His treatment of Mach's personal life and the effect it had on his philosophy illustrates the inadequacies in Blackmore's appreciation of the ways in which incidents in a man's life can affect his work, for he gives us no real analysis of Mach's growing-up or a sense of the gradual, historical development of his thought. He merely lists events and asks us to believe that the elderly Mach correctly interpreted the effects certain of his youthful experiences had on him.

In spite of Blackmore's inadequacies as a biographer we might hope for a clear explanation of Mach's philosophy, at least in its mature form if not as it developed over time (the latter we surely do not get). Here again,