On Dialogue

ROUTLEDGE • GREAT MINDS •

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David Bohm was born in 1917 in Wilkins-Barre, Pennsylvania in the United States. Despite being raised in a Jewish family, he became an agnostic in his teenage years. Bohm graduated from Pennsylvania State College in 1939, and went to the California Institute of Technology before attending the University of California at Berkeley. It was here that he joined the theoretical physics group directed by Robert Oppenheimer, and from where he obtained his PhD in 1943. During his time at Berkeley, Bohm contributed significantly to the understanding of quantum mechanics and relativity theory, and discovered the phenomenon "Bohm diffusion."

During the Second World War, much of Berkeley's physics research went into the Manhattan Project with the aim of producing the first atomic bomb. Although Oppenheimer wanted Bohm to join him in working on this project, Bohm was not given the security clearance to do so because of his involvement in left-wing politics.

After the war, Bohm moved to Princeton University and became an assistant professor. It was here that he met and worked with Albert Einstein. In 1949, the House Committee on Un-American Activities led by Senator Joseph McCarthy requested testimony from Bohm because of his links to suspected Communists. Bohm refused to give evidence against his colleagues and was arrested. Eventually he was acquitted, but he had already been suspended from Princeton. Following this, Bohm became a professor of Physics at the University of São Paulo, Brazil, upon the recommendation of Einstein and Oppenheimer.

In 1955, Bohm moved to Israel, and worked for two years at the Technion in Haifa, where he married Saral Woolfson. Bohm relocated to the United Kingdom in 1957, and started working as a research fellow at the University of Bristol. He followed his first publication, *Quantum Theory* (1951), with *Causality and Chance in Modern Physics* (1957) and *The Special Theory of Relativity* (1965). In 1959, Bohm and Yakhir Aharonov discovered the "Aharonov–Bohm effect," which showed that magnetic vector potential

could have quantum effects. Bohm became Professor of Theoretical Physics at Birkbeck College, University of London, in 1961.

In his later years Bohm became interested in human communication, social problems and creativity, resulting in his posthumous books *On Dialogue* (1996) and *On Creativity* (1998). Known as "Bohm dialogue," his ideas concerning interpersonal and group communication have been influential within management theory. Bohm argued that "free space" and equal status were vital prerequisites of communication and appreciation of personal beliefs.

Bohm was elected Fellow of the Royal Society in 1990. His final work, *The Undivided Universe* (published posthumously in 1993), was the result of a lengthy collaboration with Basil Hiley.

In 1992, Bohm suffered a fatal heart attack in the back of a London taxi. He was 74. He is now regarded as one of the most important quantum physicists of the twentieth century.

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David
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Foreword to the Routledge Great Minds Edition

> The collective thought is more powerful than the individual thought.
>
> David Bohm

I first stumbled across the name of David Bohm while trying to teach myself special relativity as a teenager. I had tried out many other textbooks, but Bohm's clicked with me: just the right amount of mathematical detail and plenty of space devoted to conceptual issues. In particular, Bohm focused far more than any other authors I'd read on the notions of the observer's perspective as a guide to invariant structure; of representation and the idea that theories provide a conceptual map of the world; and of perception and its relation to physics (including a detailed appendix devoted to this topic). There was something very concrete, visual, and physically intuitive about the way Bohm presented the theory and its implications, going to great pains to link the physics to the world of experience (and, importantly, highlighting where and why there were disconnections). This was one of a small handful of books that

ignited my passion for the *philosophical foundations* of physics, rather than simply physics *per se*.

In the same book Bohm describes how in using a map a user must locate and orient themselves by identifying a point and a direction that will serve to represent them. Each point and directed line corresponds to a different perspective on the world. But one can easily transform between these perspectives, coming to see what the other perspectives will be like. By abstracting out the invariant aspects, with respect to these transformations, one can gain an understanding of the terrain. Bohm considers this process in the context of *communication* between a pair of map users with differing points of view of the same terrain. Given the processes of transformation and abstraction just mentioned, there will be no question about which view gives the right view and which gives the wrong view: they can each simply consult their maps and figure out why each has their own perspective, how to transform between the two, and how to extract the invariant structure common to both.

As I learned about quantum mechanics, a little after relativity, I discovered that Bohm was embroiled in a strange kind of conflict of perspectives of his own, involving the nature and interpretation of quantum theory. Bohm was one of the first to offer an alternative to the "orthodox" interpretation of quantum theory (namely, the Copenhagen interpretation, primarily associated with Niels Bohr and Werner Heisenberg). That an *interpretation* of something should be held with such conviction and doggedness I always found rather strange. My first career path was leading me into a life as a concert pianist, and in that context *diversity* of interpretation is the very lifeblood of the discipline. The various interpretations of a piece of music are themselves like different maps, each of which gives a different perspective on the underlying musical reality, no one of which is the correct, objectively true version. The notion of "one true map" seemed obviously senseless to me. Yet in offering an

alternative perspective on quantum mechanics, Bohm was viewed by the community either as not doing very much at all (since his approach was, for all practical purposes, empirically identical to orthodox quantum mechanics) or as committing something approaching heresy for questioning the one true interpretation. The Copenhagen interpretation tends not to give a picture of the underlying "quantum reality" so much as an account of how we gain knowledge about quantum systems (*epistemology* that is, rather than ontology). Inasmuch as it does link to the world, it provides a fundamentally indeterministic picture containing ineliminable uncertainty. Quantum mechanics is viewed as a black box that enables a practitioner to generate outputs (say, some outgoing particles) from inputs (say, a pair of particles thrown together) in a purely probabilistic manner. To ask what happens during the transition between inputs and outputs is forbidden. Bohm produced an ontological interpretation that did away with the irreducible indeterminism of the Copenhagen interpretation.

There are by now many and diverse interpretations of quantum mechanics up for grabs, but still these each tend to insist that they have the correct view corresponding to reality – sadly, this is no less true of many modern Bohmians! What they agree on (what they *have* to agree on to be taken seriously) is the existing structure of experimental outcomes. Explaining how the quantum algorithm does this, and what the world must be like to make it go, is the job of an interpretation. For most physicists interpretation is an amusing hobby, secondary to the real work of crunching out numbers to compare with experiment. Bohm was never satisfied with this approach, and neither was he happy with the common refrain that "nobody *understands* quantum mechanics." In developing his own approach to quantum theory he attempted to do justice to both the physical and the philosophical. This inseparability of philosophy and physics characterizes much, if not all, of his later work.