

HEISENBERG: explorer of the imagination

Fritjof Capra pays tribute to one of the architects of modern holistic science

Werner Heisenberg, who died 40 years ago, was one of the founders of quantum theory and will be remembered, along with Albert Einstein and Niels Bohr, as one of the giants of modern physics. He played a leading role in the dramatic change of concepts and ideas that occurred in physics during the first three decades of the 20th century. These concepts brought about a profound change in our worldview: from the mechanistic worldview of Descartes and Newton to a holistic and ecological view.

At the very core of this change of paradigm lies a fundamental change of metaphor from seeing the world as a machine to understanding it as a network. As Heisenberg put it in his classic *Physics and Philosophy*, “The world thus appears as a complicated tissue of events, in which connections of different kinds alternate or overlap or combine and thereby determine the texture of the whole.”

The new view of reality was by no means easy to accept for physicists at the beginning of the 20th century. The exploration of the atomic and subatomic world brought them into contact with a strange and unexpected reality. In their struggle to grasp this new reality, scientists became painfully aware that their basic concepts, their language, and their whole way of thinking were inadequate to describe atomic phenomena. Their problems were not merely intellectual, but amounted to an intense emotional and even existential crisis, as vividly described by Heisenberg in his book. I remember reading *Physics and Philosophy* as a young student in the late 1950s, soon after it was published. It had a tremendous

influence on my thinking and determined the trajectory of my entire career as a scientist and writer.

At the beginning of the 20th century, physicists, for the first time, probed deep into the atomic world, into a realm of Nature far removed from their everyday environment, and in doing so they transcended the limits of sensory imagination. They found, to their great surprise and dismay, that they could no longer rely with absolute certainty on logic and

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common sense; that ordinary language was often completely inadequate to describe the newly discovered phenomena. Atomic physics forced scientists to think about Nature in new categories. It was Heisenberg’s great achievement to recognise this clearly and to build a new conceptual foundation in terms of these categories.

Heisenberg became involved in atomic physics at the age of 20 when he was a student at the University of Munich. In 1922, his teacher Arnold Sommerfeld invited him to attend a series of lectures given by Niels Bohr in Göttingen. The topic of the lectures was Bohr’s new atomic theory, which