



The physical world: quantum

Einstein and Bohr

Presenter – Caption: Robert Llewellyn:

Countless things we take for granted in our everyday lives wouldn't be here if it wasn't for quantum mechanics. It's the theory that predicts how the world behaves at an atomic level, and it gave birth to a second industrial revolution with the invention of modern electronic devices.

The quantum theory caused another revolution, and we're all used to nature being certain, dependable, predictable, but the tiny quantum world just isn't like that. What happens inside an atom is just plain weird; it puzzles everyone. The journey to understand quantum theory is the story of a battle between two of the greatest physicists in the 20th century.

In the 1920's and '30's, Einstein fought a battle of ideas with someone you may not have heard of who was born in this street in Copenhagen: Niels Bohr. He's so famous; they even put him on the money.

Caption: Paul Davies - Visiting Professor - Imperial College London:

Niels Bohr was one of the giants of 20th century physics and so we had these two hugely influential figures, Bohr and Einstein at loggerheads, friendly loggerheads, but fundamentally disagreeing about quantum mechanics.

Caption: Abraham Pais - Rockefeller University:

They were very fond of each other, they respected each other highly, but as soon as it came on quantum the sparks would fly.

Caption: David Papineau King's College London:

Einstein felt that certain aspects of quantum mechanics, the rules presented by quantum mechanics, didn't really make philosophical sense, the world being presented by quantum mechanics was too ugly to be true.

V/O:

For centuries scientists believed that nature was predictable, if only we knew enough about the way the world worked, we'd be able to say exactly what would happen in the future. It seemed obvious that nature was deterministic – one thing determined another – but quantum mechanics shattered that certainty. It upset people then, and it still does now.

Caption: Neil Johnson - University Of Oxford:

It was a complete shock to hear that quantum mechanics had this weirdness beyond the straightforward weirdness that we'd been told about on the course, and I can quite understand why Einstein spent most of his life doubting it.

Presenter:

Albert Einstein was an early pioneer of quantum theory, and he showed that light exists as tiny quantum particles called photon. Einstein went on to be famous for a relativity theory: $E = mc^2$, and all that, but who was Niels Bohr?

Caption: Finn Aaserud - Niels Bohr Institute:

Niels Bohr was born in Copenhagen in 1885. He was the son of a prominent professor at the university. Bohr's contribution to quantum mechanics from the outset was his formulation of a model of the atom, and particularly the hydrogen atom, and that was essentially the work that he received a Nobel prize for, almost ten years later in 1922. Although his ideas tend to be misunderstood at times, he's an icon I think of this century in Denmark, perhaps the most well known Dane within Denmark.

Abraham Pais - Rockefeller University:

Bohr was not just a father figure to me personally, which he was, but he was a father figure to a generation of physicists. His Institute was the Mecca, the most important centre of physics in the 1920's and 1930's. Practically everybody of my generation, the younger generation, two generations, they all came to Copenhagen, and they worked together.

Paul Davies, Visiting Professor - Imperial College London:

It must have been truly wonderful that so many new areas of investigation were opening up, that you could pick almost any topic and apply the new sciences of quantum mechanics and relativity to them, and get almost instant results.

Abraham Pais - Rockefeller University:

It was as if you had hit on a field of gold, you just grabbed something up and there were nuggets of gold in your hands. There were problems that could be solved, that never could be solved before, with the new theory, and people went year after year. In other words it was a time in which you could make a great name much more easily than in later years.