



## **The physical world: quantum**

### *The uncertainty principle*

#### **Presenter:**

As Niels Bohr became the most prominent champion of quantum theory, Einstein became its most famous doubter. Einstein didn't so much disagree with the theory, he thought it was incomplete; it was saying the wrong things about the true nature of reality. So what was quantum theory saying?

The theory states that there is an absolute limit to what we can know about what goes on in nature at the atomic level. It says the universe is run on chance, that nothing is certain, which means what exactly?

To give you an idea of the difference between the ordinary world and the quantum world, imagine that inside this tin is an ordinary glove. Now it's either left handed or right handed. The obvious way to find out is to have a look. All we've done is reveal what nature already knew, that was the nature that scientists and the rest of us were used to, but in the quantum world it isn't that easy.

Now imagine that inside our tin is a quantum glove which behaves in the same way as a subatomic quantum particle does. Before we open the tin there's an equal chance that the glove could be left or right handed. Quantum theory says not only don't we know which hand it is, but nature itself doesn't know.

In fact, in a way, the glove doesn't even really exist when the tin is closed; it's in some sort of ghostly state in between being left and right handed.

It's only when we open the tin and make a measurement that a choice is made and it becomes one or the other. In the quantum world it's not as simple as 'to be or not to be'. Until it's observed, nature hasn't made up its mind. Well you think this sounds odd, can't be true? Well you'd be in good company because Albert Einstein would have agreed with you. He couldn't accept that nature was uncertain. That's what he was getting at when he said "God does not play dice".