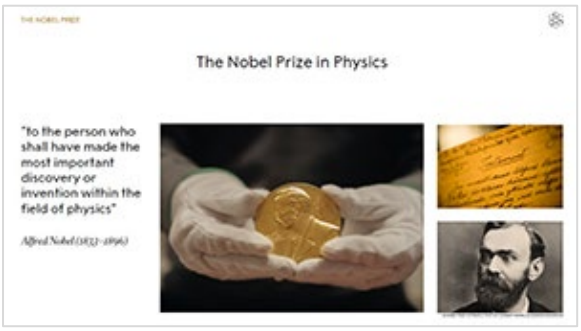
THE NOBEL PRIZE

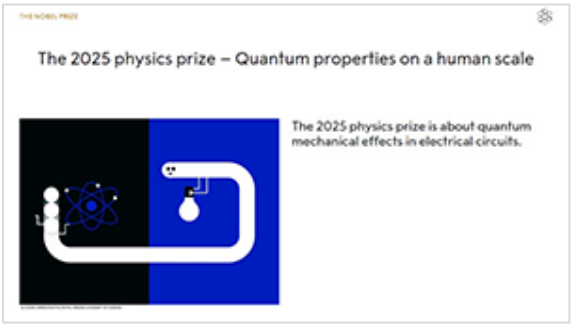
Speaker's manuscript – Physics prize 2025
Quantum properties on a human scale

The Nobel Prize in Physics



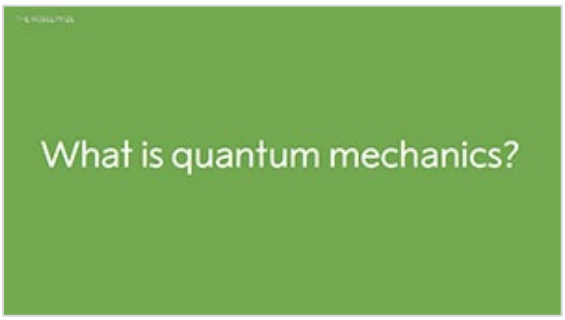
- The Nobel Prize was created by Alfred Nobel. He became very rich due to his invention of dynamite. Before his death in 1896, he wrote in his will that most of his wealth should be used as a prize to "those who, during the preceding year, shall have conferred the greatest benefit to humankind".
- According to the will, this prize is to be awarded in five categories: physics, chemistry, physiology or medicine, literature and peace.
- The Nobel Prize in Physics is awarded to "the person who shall have made the most important discovery or invention within the field of physics".

The 2025 physics prize – Quantum properties on a human scale



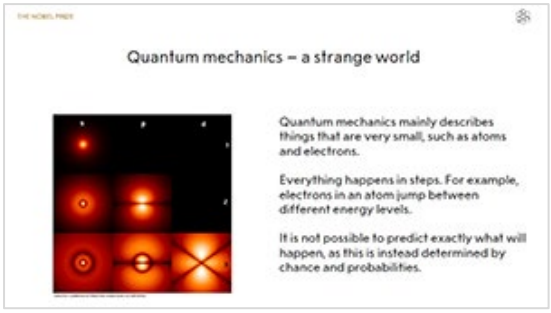
- The 2025 physics prize is about quantum mechanics. The Nobel Prize laureates are recognised for experiments that demonstrate quantum mechanical effects in electrical circuits.

What is quantum mechanics?



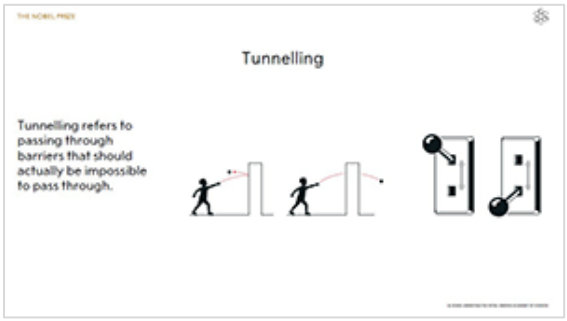
- Discuss this as a group for a moment: Has anyone heard of quantum mechanics? What is it?
- Don't worry if you have trouble answering this question. Quantum mechanics is difficult, not least because it often says things that don't agree with how we typically tend to view the world.

Quantum mechanics – a strange world



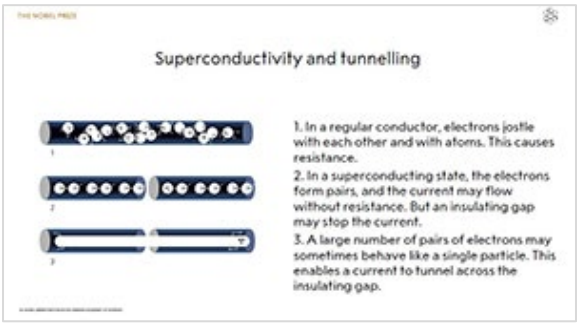
- Quantum mechanics is a theory that was developed about 100 years ago and which presented a completely new way of describing the world. This applies in particular to very small things. Here, we are at the level of atoms and particles. If quantum mechanics were to be applied on an everyday human scale, we would face an absurd world indeed. Yet, quantum mechanics still controls things in the world around us. For example, all the electronic devices we use every day are based on quantum mechanical effects among atoms and electrons. And the laureates' discoveries show that quantum mechanical effects may sometimes occur even on our scale of reality, such as in a computer chip that we can hold in our hands.
- Some of the principles of quantum mechanics include:
- Everything happens in steps. For example, the electrons in an atom jump between specific energy levels, which results in light being sent out in packages with certain energies. The image shows how an electron may be located at different levels around an atomic nucleus.
- Chance and probabilities determine things. For example, exactly when a radioactive atom will decay is determined by chance. But if we have many atoms, we are able to quite accurately say how long it will take before half of them have decayed.

Tunnelling



- One of the effects of quantum mechanics is tunnelling. This means that barriers that should actually be impossible to pass through may still sometimes be traversed.
- The left image shows how a ball in our everyday reality always bounces off a wall, but if quantum mechanics were to be applied on our everyday scale, it would sometimes go right through the wall.
- The right image shows a power switch. Do you see something strange? It should not be possible to move the levers. Figuratively speaking, however, the laureates' experiments show that the lever may suddenly end up in the opposite position.
- In other words, the laureates wanted to show that the quantum mechanical phenomenon of tunnelling can also be seen on the scale in which we perceive reality, for example in an electrical circuit.

Superconductivity and tunnelling



- We have now come to the laureates' experiments. Here, another phenomenon enters the picture – superconductivity.
- Superconductivity means that a current flows without encountering any resistance whatsoever. This only happens at very low temperatures, close to absolute zero at about minus 273 degrees Celsius or minus 460 degrees Fahrenheit.
- The upper image shows a regular conductor where the electrons are jostling with each other and with atoms. This causes resistance.
- The middle image shows a superconductive condition. The electrons form pairs and are able to flow without any resistance. But an insulating gap may stop the current.
- The bottom image shows how a large number of pairs of electrons may behave like a single particle. This enables a current to tunnel across the insulating gap. In their experiments, the laureates were able to show that this happens. (They also showed that the system had quantised energy levels, meaning that the energy in the circuit jumped between different levels.) What is new in their discovery is that quantum mechanical effects may manifest themselves on our scale: in an electrical circuit that we can see with our naked eyes and hold in our hands.

The 2025 Nobel Prize laureates in physics

- John Clarke, Michel Devoret and John Martinis together made the discoveries that resulted in the physics prize 2025. The experiments were carried out in Berkeley, California during 1984–1985.
- In an interview in connection with the announcement of the Nobel Prize, John Clarke talked about the importance of the collaboration between the three laureates.
- John Clarke was born in the United Kingdom but carried out research at the University of California, Berkeley, in the 1980s. His research group was joined by Michel Devoret, a Frenchman who had recently completed his doctoral studies in Paris. The group also included the American John Martinis, who was still engaged in his doctoral studies when these experiments were carried out.

What could these discoveries lead to?

- These discoveries have played, and will play, an important role in research by offering a better understanding of how quantum mechanical systems behave.
- In the future, these discoveries may also have an impact on the development of quantum computers, which will be much more powerful than current computers, quantum sensors, which may result in more sensitive measuring instruments, and quantum encryption technologies, which may offer more secure ways of storing and transmitting data.
- Now, let us watch a short video that tells us a little bit more about the discoveries made by the laureates and why they confer the greatest benefit to humankind.