Researchers crack quantum physics puzzle

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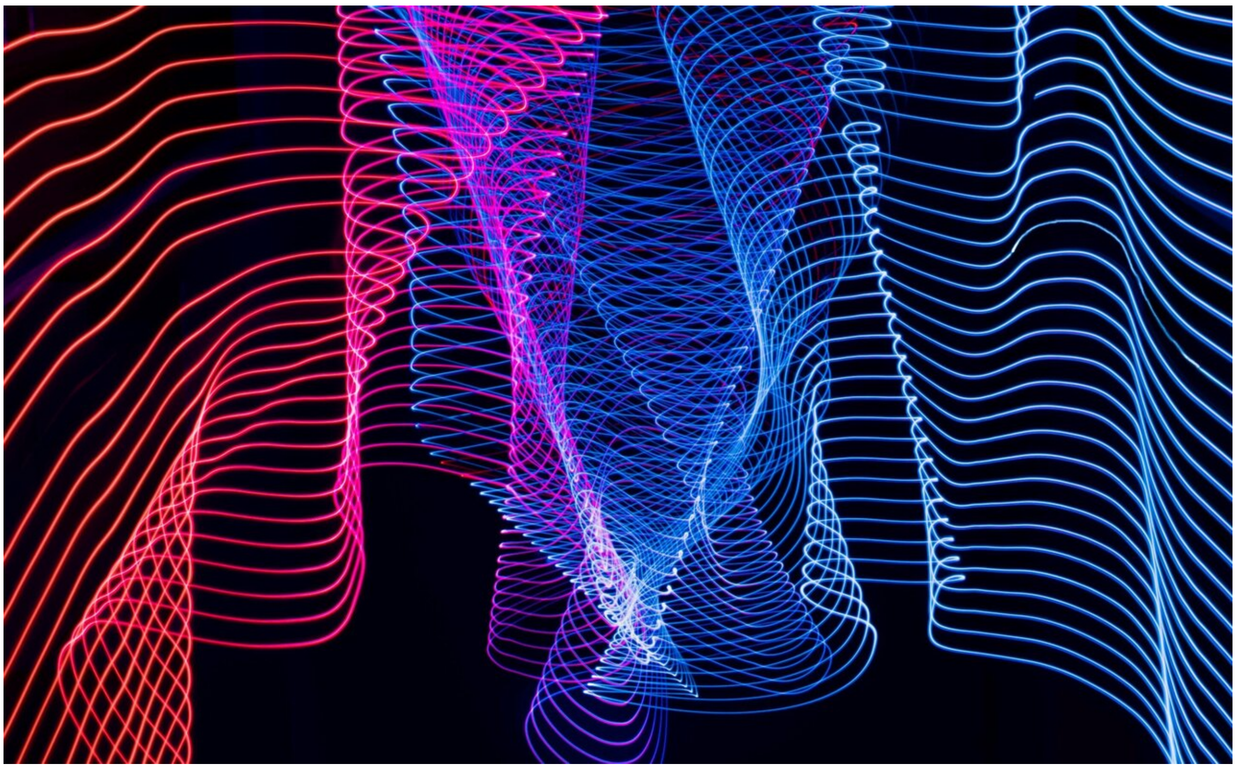

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Scientists have re-investigated a 60-year-old idea by an American physicist and provided new insights into the quantum world.

The research, which took seven years to complete, could lead to improved spectroscopic techniques, laser techniques, interferometric high-precision measurements and atomic beam applications.

Quantum physics is the study of matter at the atomic level. Atoms and electrons are so small, 1 billion placed side by side could fit within a centimeter. Because of the way atoms and electrons behave, scientists describe their behavior as waves.

Waves, unlike particles which travel in straight lines, can go around obstacles, but if there are enough random obstacles, the waves cannot get through because they interfere with each other and cancel out.

At low temperatures, matter, which is made up of atoms and particles, can be made to behave much like light; that is, light behaves the same way all waves do. In its interaction with matter, light can behave like it is composed of particles that don't go around objects, but instead travel in a straight line.

In the Quantum Information Lab at the University, researchers took this one step further and added an ultra-cold atom experiment to the mix. With the aid of high-tech lasers, they manipulated these ultra-cold atoms until they were so cold that their wave behavior became visible to the eye.

"We are talking a billionth of a degree above absolute zero (-273.15 degrees C), so that is pretty chilly. We have created customized patterns of obstacles to stop the waves, and when we take a picture, we can find out where these atoms are. This way, we can see what exactly is required to get our quantum-mechanical waves to reflect off obstacles, and why the waves do not get in," Dr. Hoogerland says.

"From this research emerges a deeper understanding of the quantum world, which in turn determines what happens in the world around us. Spin-offs from this research are improved spectroscopic techniques, laser techniques, interferometric high-precision measurements and atomic beam applications."

Working together, through the Dodd-Walls Center for Photonics and Quantum Technologies, with researchers at the University of Otago, the research team was finally able to match the results of the experiments with theoretical predictions, giving way to new insights, which could be used to create and test "designer materials" with customized properties.

More information: Donald H. White et al. Observation of two-dimensional Anderson localisation of ultracold atoms, *Nature Communications* (2020). [DOI: 10.1038/s41467-020-18652-w](https://dx.doi.org/10.1038/s41467-020-18652-w)

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