Can an oil bath solve the mysteries of the quantum world?

November 1 2013

For the past eight years, two French researchers have been bouncing droplets around a vibrating oil bath and observing their unique behaviour. What sounds like a high-school experiment has in fact provided the first ever evidence that the strange features of the quantum world can be reproduced on a macroscopic scale.

Now, many researchers are asking if the oil-bath experiments can provide insights into quantum mechanics and more specifically why particles can behave as waves and waves can behave as particles.

In this month's issue of *Physics World*, Jon Cartwright takes a closer look at some of the key experiments performed by the French pair but finds that not all quantum physicists are convinced that they will lead to a deeper understanding.

The French physicist Louis de Broglie was the first to describe wave–particle duality in 1926 but the phenomenon has since been very difficult to understand because no-one has ever observed something being both a particle and a wave in the everyday world.

That was until 2005, when Yves Couder and Emmanuel Fort found that when droplets of oil were released onto the surface of a vibrating oil bath, they started to bounce up and down instead of becoming immersed in the liquid, creating a series of waves beneath them. By adjusting the amplitude of the vibrations, they could make the droplets land on the crest of the waves and bounce around the bath.

These wave-droplets – or "walkers" as the researchers called them – appeared to be the first evidence of wave–particle duality on a macroscopic scale. The waves could not exist without the droplets and the droplets could not move without the waves.

In the years after the initial experiments, Couder and Fort used the oil bath to perform several of the classic experiments in quantum mechanics – including Young's double-slit experiment – and found that the walkers exhibited many similarities to the entities used in the original experiments.

One area where the walkers' analogy with quantum mechanics fails, however, is entanglement – the weirdest quantum phenomenon of all that describes how the physical state of two particles can be intricately linked no matter how far apart in the universe they are.

For this to happen, a wave must occupy a very high number of dimensions so particles can affect one another over large distances, faster than the speed of light. However, in a walker system the waves will always occupy just two dimensions, given by the length and width of the oil tank.

"If one thinks of [entanglement] as central to quantum theory, it cannot possibly be reproduced in the [walker] system," Tim Maudlin of New York University told Physics World.

Indeed, the magazine contacted a number of physicists and philosophers with a background in quantum foundations, and found that most were sceptical that the walker systems could shed light on the mysteries of the quantum world.

On whether Couder and Fort's work can inspire physicists to find a theory deeper than quantum mechanics, Cartwright concludes: "It may

be too soon to tell, but one point does seem clear: every time they look, the researchers find more ways in which walkers exhibit supposedly quantum behaviour."

Provided by Institute of Physics

Citation: Can an oil bath solve the mysteries of the quantum world? (2013, November 1) retrieved 20 September 2024 from
https://phys.org/news/2013-11-oil-mysteries-quantum-world.html