Observing a Photon no Longer a Seek-and-Destroy Mission

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A team of University of Queensland, Australia physicists has devised a sophisticated measurement system for single particles of light, or photons, enabling them to investigate fascinating behaviour in the quantum world.

In a world-first, the path of a single photon **can now be measured without destroying the photon** in the process.

One of the most surprising and unexpected aspects of quantum mechanics is the propensity for a photon to behave both like a particle and a wave.

The measurement developed at the Centre for Quantum Computer Technology within UQ's School of Physical Sciences has enabled these wave-like and particle-like properties of a single photon to be observed simultaneously.

The breakthrough innovation by Drs Geoff Pryde, Jeremy O'Brien, Andrew White, Stephen Bartlett and Associate Professor Tim Ralph was recently published in the American Physical Society's Physical Review Letters.

The quintessential experiment demonstrating the wave-like properties of light was English physicist Thomas Young's c.1801 experiment where light was shone on a pair of holes in a screen. Interference between the two possible paths gave rise to an interference pattern on a second screen behind the holes — a wave-like phenomenon.

The remarkable thing is that this wave-like behaviour persists even when the light is so dim that only a single photon is present in the apparatus at any given time.

"That is unless the experimenter observes a particle-like property by measuring which path the photon took — in that case the interference disappears," Dr O'Brien said.

In the UQ experiment, the researchers found that indeed the more particle-like the photon's behaviour was, the less wave-like behaviour was observed, and vice versa.

The experiment shows once and for all that light is essentially fickle — sometimes behaving as particles and at others, like waves.

To measure the path of single photon, the team observed a second photon which carried away information about the first after the two interacted.

The experiment involved shining a powerful ultra-violet laser in to a special crystal to produce the two photons; a circuit of optical fibres; lenses and other optical elements; and normal destructive single photon detectors.

The original news release can be found on the University of Queensland web-site.

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