# A new 'lens' for looking at quantum behavior

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(PhysOrg.com) -- In a paper published in *Physical Review Letters*, researchers Daniel Terno (Macquarie University, Australia) and Radu Ionicioiu (Institute of Quantum Computing, Canada) provide a new perspective on fundamental notions of quantum physics.

Terno and Radu proposed taking a new approach to understanding wave-particle duality - a cornerstone phenomenon of quantum mechanics.

At the heart of quantum theory is the idea that objects in the quantum world will sometimes behave like particles, and other times behave like waves. This ability to combine exclusive properties is called a quantum superposition and is a fundamental principle of quantum mechanics.

Duality has been the foundation of many ongoing debates in the physics

community, the most famous of which was between Albert Einstein and Niels Bohr. Ultimately the issue physicists face is that you can't observe both wave-like and particle-like properties with a single apparatus.

Terno and Ionicioiu have tried to tackle this issue by asking - what if when performing experiments, parts of the apparatus are absent and present at the same time. What the researchers propose is that you can select the property being tested (wave or particle) even after the test is performed.

Known as a delayed-choice experiment, the photon in this experiment shows a "morphing" between "particle" and "wave," supporting the conclusion that these properties are not inherent, but merely a reflection on how we "look" at it.

"Unlike the traditional approach, in this quantum-controlled experiment a single set-up is used to measure complementary behaviors, and they are revealed by matching the data about a photon with the data about the apparatus.  What we find is that behavior is in the eye of the observer, " Terno summarizes.

The intriguing results have caught the attention of science writers around the world, including French journalist Michael Schirber. Schirber recently wrote that this new thought experiment "demonstrates with logical precision the futility of trying to label the photon as a particle or a wave".

Terno says the thought experiment was designed for exactly this purpose, to look at an old question through a new lens. "We tried to shed some light by looking at the problem from a novel perspective," says Terno. "It was a perfect testing ground for our new tools. Once you get them, you'll start to apply them to more and more problems, and this is what we are going to do next."

Provided by Macquarie University