Scientists discover new method of observing interactions in nanoscale systems

Scientists have used new optical technologies to observe interactions in nanoscale systems that Heisenberg's uncertainty principle usually would prohibit, according to a study published Jan. 17 in the journal *Nature*.

Researchers conducted experiments with high-powered lasers and quantum dots —artificial atoms that could be the building blocks of nanoscale devices for quantum communication and computing — to learn more about physics at the nanoscale.

One common phenomenon in physics is the Fano effect, which occurs when a discrete quantum state – an atom or a molecule – interacts with a continuum state of the vacuum or the host material surrounding it. The Fano effect changes the way an atom or molecule absorbs light or radiation, said Sasha Govorov, an Ohio University theoretical physicist who is co-author on the paper.

In experiments on nanoscale systems, Heisenberg's uncertainty principle sometimes blocks scientists from observing the Fano effect, Govorov explained. The interaction of the nanoscale system and its continuum state surroundings can't be detected.

But in a new high-resolution laser spectroscopy experiment led by M. Kroner and K. Karrai of the Center of NanoScience at the Ludwig-Maximilians University in Munich, Germany, scientists utilized a new method. They measured photons scattered from a single quantum dot while increasing the laser intensity to saturate the dot's optical absorption. This allowed them to observe very weak interactions, signaled by the appearance of the Fano effect, for the first time.

A theory for the new nonlinear method was developed by Govorov. "Our theory suggests that the nonlinear Fano effect and the method associated with it can be potentially applied to a variety of physical systems to reveal weak interactions," he said.

Scientists also can revisit older experiments on atoms by using modern tools such as highly coherent light sources that are strong enough to reveal such nonlinear Fano-effects, Karrai said. "We can explore new frontiers in quantum optics," he noted.

Source: Ohio University