Researchers send 'heavy photons' over world-record distances

June 21 2005

Unsurpassed exciton distances, lifetimes may lead to new form of optical communication

When light hits a semiconductor material and is absorbed, its photons can become "excitons," sometimes referred to as "heavy photons" because they carry energy, like photons, but have mass, like electrons. Excitons typically exist for only a short time--trillionths of a second--and travel only a few microns before turning back into photons, which are then emitted from the material.

In the June 10 issue of the journal *Physical Review Letters*, scientists from the University of Pittsburgh and Bell Labs, the R&D arm of Lucent Technologies, report that they have designed and demonstrated a two-dimensional semiconductor structure in which excitons exist longer and travel farther than previously recorded. In their paper, titled "Long-Distance Diffusion of Excitons in Double Quantum Well Structures," David Snoke, senior author and associate professor of physics and astronomy at Pitt, and his colleagues report a system in which excitons move freely over distances of hundreds of microns. Their findings open up the possibility of new applications, such as excitonic circuits.

The researchers "stretched out" the excitons by pulling them apart with an electrical field. This extended the excitons' lifetimes by a million (up to 30 microseconds) and expanded the distances the excitons traveled (up to a millimeter). They were able to "see" the excitons by observing the emitted photons. The semiconductor structures designed in the experiment are of "world-record quality," said Snoke.

The ability to control excitons over long distances could lead to excitonic circuits in which photons are converted directly into excitons, which are then steered around a chip and converted back into photons again at a different location, such as an optical memory device, said Snoke. "It's another tool in our optics toolbox," he said.

"We're doing this with semiconductor circuits now designed for moving electrons," he added. "It's a completely new type of control over the system."

Other authors of the paper are Zoltan Voros and Ryan Balili, graduate students in Pitt's Department of Physics and Astronomy, and Loren Pfeiffer and Kenneth West of Bell Labs.

Source: University of Pittsburgh