Electrons 'in limbo' seen for first time

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Hrvoje Petek, University of Pittsburgh professor of physics and codirector of Pitt's Gertrude E. and John M. Petersen Institute of NanoScience and Engineering (PINSE), has published two papers in recent weeks that literally illuminate how electrons behave on various surfaces.

In the first paper, Petek and Miroslav Nyvlt of Charles University in Prague explored the properties of metals under intense light--a situation "where the classical physics of electron emission from metals emerges from its quantum roots," says Petek. They found that when light of a certain energy and intensity is shone onto a metal surface, a few electrons in the metal become stuck on the surface (that is, they are neither emitted from nor reabsorbed into the metal). As Petek puts it, the electrons are "in limbo."

These electrons undergo the process of "total internal reflection"--a process well known for light, but observed by Petek and Nyvlt for the first time in electrons.

These findings, published in the March 3 issue of *Physical Review Letters*, could lead to the ability to transmit electrons, without scattering, over larger distances than previously possible. For example, electrons on the surface of carbon nanotubes could be excited to make "very small and very fast" transistors, Petek says.

"We anticipate that these elusive electrons will provide exquisite probes for how photons and electrons interact with metal surfaces," he adds.

In Petek's second paper, published in the current issue of Science, he and Pitt Professor of Chemistry Kenneth Jordan, a PINSE researcher, make new progress toward extracting hydrogen from water using titanium dioxide as a catalyst.

In a May 2005 *Science* paper, Petek and Jordan presented their findings on the properties of water on the surface of titanium dioxide. In their current experiment, they used methanol instead of water, because they discovered that excited electrons last longer in methanol than in water, allowing chemical reactions to be observed.

This research shows how protons in methanol molecules move in such a way that they control the reabsorption of electrons into the titanium dioxide. Such motion, correlated between protons and electrons, is needed to convert light into chemical energy on solid surfaces, as well as by light-harvesting proteins.

The work for the PRL paper was performed at the Max Planck Institute of Microstructure Physics in Halle, Germany, where Petek was an Alexander von Humboldt Senior Scholar and Nyvlt was the group leader. Other authors on the paper are Francesco Bisio, now at the University of Genoa; Jirka Franta, now at Charles University; and Jurgen Kirschner, director of the Max Planck Institute.

Source: University of Pittsburgh