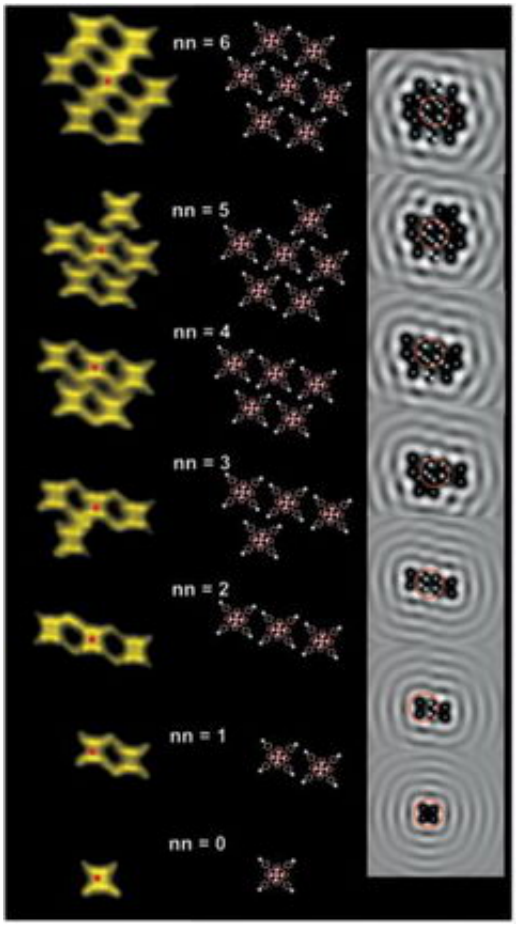
Physicists manipulate temperature of Kondo effect

January 31 2007

Physicists at Ohio University have learned how to manipulate the temperature of the Kondo effect, which they observed for the first time in a two-dimensional molecular layer.

In a recent issue of the journal *Physical Review Letters*, the scientists reported that they were able to manipulate and tune the Kondo effect by removing one molecule at a time from a small molecular assembly.



The researchers created a hexagonal unit of molecules by manipulating the nearest neighbor molecules. Credit: Saw-Wai Hla

The most important and useful property of molecules in nanotechnology is their ability to self-assemble and form molecular layers, said lead author Saw-Wai Hla, an associate professor of physics and astronomy at Ohio University. Many molecules, each having specific properties useful for nanodevices, can spontaneously assemble on substrates.

“This process is critical for the ‘bottom up’ approach in nanotechnology,” Hla said. “The manipulation of the Kondo effect inside the molecular layer is significant and may have an impact on the development of nanoscale molecular memory devices and for quantum computation.”

In the recent experiment, porphyrin molecules with a magnetic cobalt atom caged at each molecule's center were self-assembled on a copper crystal surface. The researchers used a custom built low-temperature scanning tunneling microscope to create a hexagonal unit of molecules by manipulating the nearest neighbor molecules.

The scanning tunneling microscope tip was used to detect the Kondo effect above the center molecule at — 450 F. The scientists found that reducing the number of molecules surrounding the hexagonal unit increased the Kondo temperature. When the center molecule is surrounded by six molecules, it has little chance to interact with outside electrons.

When the neighboring molecules are removed one at a time, however, the center unit can interact with surrounding free electrons from the copper surface. This changes the Kondo temperature, which is an indicator of how strong the magnetic atom inside the molecule is interacting with the free electrons.

"We are currently storing data at the level of millions, but if molecular memory devices could be developed using this phenomenon, then we could be storing data at the level of billions in the future," Hla said.

Source: Ohio University