Condensed Matter Seminar

Molecular states of electrons in emission spectra of quantum dots

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Correlation between particles in finite quantum systems leads to a complex behavior and novel states of matter. One remarkable example of such a correlated system is expected to occur in an electron gas confined in a quantum dot (QD), where at vanishing electron density the Coulomb interaction between electrons rigidly fixes their relative positions like those of the nuclei in a molecule. Unlike real molecules, however, which have sizes and properties fixed by their chemical constituents, the size, shape and electronic density of such confined electronic structures, referred to as Wigner molecules (WM), can be varied experimentally using various combinations of semiconductor materials, types of nanostructures, numbers of electrons, electrostatic potentials and magnetic fields. Thus these WMs present a novel and compelling field for fundamental and applied research. Here we present the results of an experimental study of correlated states of electrons in self-organized QDs using high-spatial-resolution low-temperature near-field scanning optical microscopy (NSOM). Using emission spectra of single dots we observed crossover from a Fermi liquid to WM behavior at a critical density of $5x10^{10}$ cm^{-2}. A magnetic-field-induced molecular-droplet transition has been observed in the Fermi liquid regime. Preliminary results on electrostatic control of the electron population and on NSOM imaging of the emission states in these QD are discussed.

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