SMALL IS DIFFERENT: FERMIONIC AND BOSONIC MOLECULES IN QUANTUM DOTS AND TRAPS

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Electrons confined in two-dimensional quantum dots and trapped atoms can form structures with crystalline characteristics. These many body states originate from strong correlations between the constituent particles, and they are called electron (or boson) molecules. Such states allow investigations of fundamental many body phenomena and they are of significance because of the potential use of such systems for the implementation of qubits in quantum computers.

We discuss first two-electron quantum dots (2eQD), that are the simplest man-made structures allowing study of the effect of electron-electron interaction including exchange and correlation. We present recent experimental measurements of the spectrum of a 2eQD. The magnetic field dependent excited state spectrum found experimentally can be described well through exact diagonalization of the hamiltonian, and it can be discussed within a generalized Heitler-London approach. The calculations suggest that correlations are significant at low magnetic fields leading to spatial separation of the electrons – that is, formation of an electron molecule [1

In the second part of the talk we show that a finite system of repelling bosonic atoms in a trap, can develop crystalline features for sufficiently strong inter-atomic repulsion [2]. Furthermore, in rotating traps such crystalline structures, called rotating boson molecules (RBM), made of localized bosons forming polygonal-ring-like arrangements, develop even for weak inter-particle repulsion. For small numbers of neutral bosons, the RBM ground-state energies are found to be always lower than those of the corresponding mean-field (Gross-Pitaevskii, GP) solutions, in particular in the regime of GP vortex formation [3].

1. C. Ellenberger, T. Ihn, C. Yannouleas, U. Landman, K. Ensslin, D. Driscoll, and A.C.Gossard, Phys. Rev. Lett. 96**,** 126806 (2006).
2. I. Romanovsky, C. Yannouleas, U. Landman, Phys. Rev. Lett. 93, 230405 (2004);
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