Few-particle States in Coupled Electron-Hole Quantum Dots

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We perform an exact-diagonalization calculation of the ground- and excited-state properties of a bipolar quantum-dot molecule consisting of two vertically coupled quantum dots containing different kind of particles, i. e. electrons and holes, in equilibrium. This type of dots can be structured in electron-hole bilayers created in InAs/GaSb crossed gap systems or biased GaAs/GaAlAs heterostructures [3].

We consider two vertically aligned infinitesimally thin circular quantum dots placed into a strong perpendicular magnetic field. One of the dots contains electrons, and the other one an equal number of holes. Working in the limit of strong magnetic fields (in practice, $B > 3T$), we restrict the single-particle bases to the states in the lowest Landau level. The spin degree of freedom is also frozen out by the strongly polarizing magnetic field.

The relative importance of the intra-dot Coulomb interaction is tuned by changing the externally applied magnetic field, while the inter-dot distance sets the balance of intra-dot to inter-dot interactions. In these systems the Coulomb interactions are rather strong, with the ratio of the Coulomb interaction energy to the single-particle level spacing typically exceeding 10. Both regimes of weak and strong inter-dot coupling are investigated.

We demonstrate [4] how the coupling between dots containing particles of different charge-sign and different effective masses rearranges the approximate single-particle levels and brings about an intricate non-monotonous pattern of switching of the ground-state angular momentum with the increasing magnetic field, as well as a novel scheme of filling of the single-particle orbitals distinctly different from that observed in coupled electronic dots.

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[3] See e.g. T. P. Marlow *et al.*, Phys. Rev. Lett. **82**, 2362 (1999) and U. Sivan *et al.*, Phys. Rev. Lett. **68**, 1196 (1992).
[4] E. Anisimovas and F. M. Peeters, Phys. Rev. B **65**, 233302 (2002).