ARTIFICIAL FEW-ELECTRON SINGLE AND MOLECULAR QUANTUM DOTS IN LOW MAGNETIC FIELDS: ELECTRONIC SPECTRA, SPIN CONFIGURATIONS, AND HEISENBERG CLUSTERS

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Exact-diagonalization (EXD) studies for few-electron (N) anisotropic quantum dots and quantum-dot molecules − covering a broad range of strength of inter-electron repulsion, confinement anisotropies (for single dots), and interdot separation (double dots) − will be presented for zero and low magnetic fields [1-3]. As a function of the magnetic field, the energy spectra exhibit a low-energy band consisting of a group of M states, with the number M being a consequence of the conservation of the total spin and the ensuing spin degeneracies for N electrons. The energies of the M states cross at a single value of the magnetic field, and with increasing Coulomb repulsion they tend to become degenerate, with a well defined energy gap separating them from the higher-in-energy excited states. The appearance of the low-energy band is a consequence of electron localization and formation of a Wigner molecule [4]. Using spin-resolved pair-correlation distributions, a method for mapping the complicated EXD many-body wave functions onto simpler spin functions associated with a system of N localized spins is introduced. Detailed interpretation of the EXD spin functions and EXD spectra associated with the low-energy band via an N-site Heisenberg cluster (with B-dependent exchange integrals) is demonstrated. Such analogies to Heisenberg clusters are promising for enabling future spintronics applications of artificial dots. Aspects of spin entanglement, referring to the well known N-qubit Dicke states, will also be discussed.

[**1**] C. Ellenberger, T. Ihn, C. Yannouleas, U. Landman, K. Ensslin, D.C. Driscoll, and A.C. Gossard, Phys. Rev. Lett. **96**, 126806 (2006).
[**2**] Yuesong Li, C. Yannouleas, and U. Landman, Phys. Rev. B **76**, 245310 (2007).
[**3**] Ying Li, C. Yannouleas, and U. Landman, arXiv:0902.0839v1 (2009).
[**4**] For a review of earlier literature in this area, see C. Yannouleas and U. Landman, Rep. Prog. Phys. **70**, 2067 (2007).