Electron Localization in Strongly Correlated Quantum Dots

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Two-dimensional quantum dots are highly tunable systems that allow the study of the physics of strongly correlated electrons[1]. As the electronic density decreases, interactions become stronger and electrons localize at their classical positions, as in Wigner crystallization that occurs in an infinite two-dimensional system. In this work, we study circular N-electron quantum dots. We use variational and diffusion Monte Carlo techniques to investigate ground state properties of quantum dots in the strongly localized regime using liquid-like (delocalized Hartree orbitals) and solid-like (localized gaussian orbitals) trial wave functions. The recently developed energy optimization methods[2–5] allow us to efficiently vary a large number of parameters in both the Jastrow and the determinantal parts of the wave function, including the positions of the floating gaussians and thereby the symmetry of the ordered phase. We also propose[5] a simple yet accurate way to recover the conservation of angular momentum in localized gaussian-based trial wave functions that significantly improves the fixed-node energy.

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