PERIODIC BEHAVIOR AND VORTEX PATTERNS IN NON-CIRCULAR QUANTUM DOTS

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We use the spin-density-functional theory to study the effects of an external magnetic field on two-dimensional quantum dots with a non-circular hard-wall confining potential [1]. The increasing magnetic field leads to spin-polarization and formation of a highly inhomogeneous maximum-density droplet (MDD). The onset of the MDD can be predicted from the number of flux quanta which only depends on the area of the dot and is thus independent of the geometry.

In the post-MDD regime, we find oscillating behavior in the electron density with increasing magnetic field, indicating periodic changes in the polarized ground state. The periodicity is apparent in the total magnetization, where local maxima correspond to the formation of current vortices in the quantum dot [2]. At high magnetic fields, the vortices form regular patterns in the quantum dot, following the geometry of the system (see Fig.1).

The nature of the structural changes can also be determined by following the expectation values for the angular momenta. In rectangular geometries, there are permanent corner modes, but the development of the center orbits is very sensitive to the shape of the dot. In a square, for example, the central Kohn-Sham orbitals are nearly symmetric, whereas a rectangle with a width to length ratio of 1:2 shows two different oscillative modes. We discuss the relation between these regular oscillations and the orbits found in the corresponding classical bouncing maps [3].

References:

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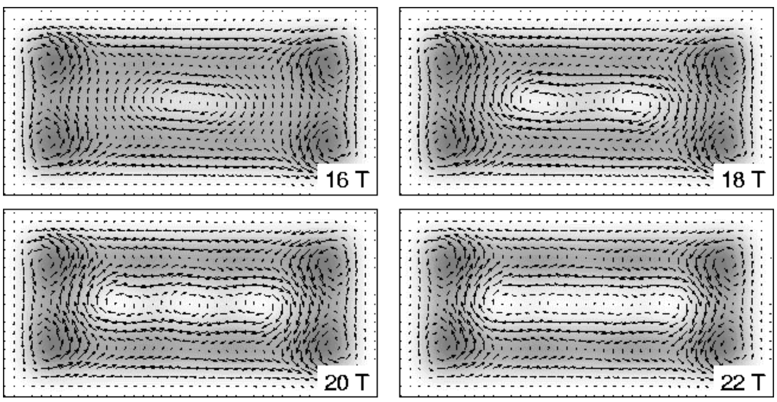

Figure 1. Electron and current densities of an eight-electron rectangular quantum dot at different magnetic fields. The increasing field leads to a formation of a vortex pattern.