

Crystals of fractional charges in correlated quasi-helical quantum dots

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In spin-orbit coupled quantum dots, the presence of a magnetic field transverse to the spin-orbit field is responsible of the opening of a gap at the degeneracy point of the spin-polarized subbands. For not too strong fields, two quasi-helical modes emerge with electrons having opposite spin counter-propagating in the system. Such a system is very sensitive to the effects of electron-electron interactions. In particular, when the Fermi level is tuned to special resonance values, described by a odd-denominator filling factor ν (namely, the ratio between the Fermi and the spin-orbit wavevectors), the system is instabile towards the formation of *fractional* phases, characterized by low-energy excitations with fractional charge νe where e is the electron charge.

What happens to ground-state properties, such as the electron density of a quasi-helical quantum dot, when a fractional phase occurs? This is a nontrivial question, since it can be expected that such a peculiar state may exhibit unusual features, which would compete with the conventional Friedel and Wigner oscillations. Indeed, in any finite-size system density oscillations can be expected, with Friedel and Wigner contributions giving rise to $N/2$ and N peaks in the density (for an even number N of electrons) respectively.

In this work we show that when the fractional phase is stabilized, the electron density is characterized by $N/\nu > N$ peaks. This number of peaks, larger than the number of electrons, is interpreted as the manifestation of a Wigner crystal of equally-spaced fractionally-charged lumps, each pean corresponding to a charge νe . This suggests that fractional properties of this phase are not only evident in the low-energy excitation spectrum but may be as well detected in the ground state.