Scale and conformal invariance in mesoscopic quantum gases

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I will give an introduction to non-relativistic scale and conformal symmetries and how they should manifest in few-body ensembles of fermionic quantum gases. I will begin by discussing how conformal symmetries impose strong constraints on the excitation spectrum of atoms in a harmonic trap, which splits into a set of so-called primary states and their centre-of-mass and breathing mode excitations. This structure, moreover, is not just an abstract mathematical construct, and I will show that it can be explicitly verified in degenerate perturbation theory for weakly interacting mesoscopic 2D Fermi gases. In particular, it is also present for rotating Fermi gases, for which the centre-of-mass excitations describe the cyclotron and guiding-centre motion of the total particle cloud (such excitations are illustrated in the figure). I will also discuss how the conformal symmetry is manifest in the many-body wave function, where it dictates the form of a hyperradial component, which can be demonstrated using Monte Carlo sampling of few-body wave functions. Weakly interacting 2D Fermi gases thus constitute a system where fundamental symmetries like the non-relativistic conformal symmetry can be revealed using very elementary methods. These results should be experimentally testable in current experiments on mesoscopic Fermi gases.

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