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Dipolar Vortices and Dark Solitons in Quantum Ferrofluids[1] NICK PARKER, THOMAS BLAND, MATTHEW EDMONDS, NICK PROUKAKIS, Joint Quantum Centre (JQC) Durham-Newcastle, Newcastle University, UK, ANDREW MARTIN, School of Physics, University of Melbourne, Australia, DUNCAN O'DELL, Department of Physics and Astronomy, McMaster University, Canada —
The experimental achievement of Bose-condensed gases of atoms with large magnetic dipole moments has realized a quantum ferrofluid, which combines both superfluid and ferrofluid properties (for a review, see T. Lahaye *et al.*, Rep. Prog. Phys. 72, 126401 (2009)). Here the conventional isotropic and short-range atom-atom interactions become supplemented by long-range and anisotropic dipolar interactions, enriching the physical properties of the system. Here we discuss how the dipolar interactions modify quantized vortices, the fundamental nonlinear excitations of superfluids in two and three dimensions. As well as distorting the vortex profile, the dipolar interactions cause each vortex to approximate a macroscopic dipole; the vortex-vortex interaction then develops a novel anisotropic and long-range contribution (B. C. Mulkerin *et al.*, Phys. Rev. Lett. 111, 170402 (2013)). This is shown to significantly modify the two-vortex dynamics, and has implications for multi-vortex states. We also extend our analysis to dark solitons, the one-dimensional analogs of vortices, where dipolar interactions support unconventional dark soliton bound states (T. Bland *et al.*, Phys. Rev. A 92, 063601 (2015)).

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