Vortices in self-bound dipolar droplets

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Quantized vortices have been observed in a variety of superfluid systems, from $^4$He to Bose-Einstein condensates and ultracold Fermi gases along the BEC-BCS crossover. In this work we study the stability of singly quantized vortex lines in dilute dipolar self-bound droplets. These droplets are quantum objects fully stabilized by the interplay of short range and long range interactions in the dipolar quantum gas and a trap is not needed for the droplet to keep its shape and size. We first discuss the energetic stability region of dipolar vortex excitations within a variational ansatz in the generalized nonlocal Gross-Pitaevskii functional that includes quantum fluctuation corrections. We find a wide region where an absolute minimum corresponding to a vortex state exists. We then show via large scale dynamical simulations that such vortices are subject to fragmentation into two droplets with equal particle number when the splitting energy, defined as the energy difference of the droplet with vortex and two non-overlapping ground state droplets, is positive. When the splitting energy is negative droplets hosting a vortex do not fragment but develop Kelvin waves, leading eventually to a bending of the vortex line. We conclude with some experimental considerations for the observation of such states and suggest possible extensions of this work.