Vortices in dipolar condensates

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Bose-Einstein condensates comprised of atoms with a permanent dipole moment are now routinely producible in labs around the world, a journey that started with chromium, and moved to the more strongly dipolar lanthanide atoms erbium and dysprosium. The long-ranged anisotropic dipole-dipole interaction offers a fascinating new platform to study many-body quantum phenomena, with proposals to utilize ultracold dipolar matter for quantum simulation and metrology (L. Chomaz *et al.*, arXiv:2201.02672 (2022)). In this talk, I will review the intriguing predictions that dipolar interactions are touted to have on vortices in quantum matter, including anisotropic cores and interactions, that culminate in unique vortex lattice configurations such as stripe lattices. Recently, the first vortices in dipolar condensates were observed in an experiment (L. Klaus *et al.*, arXiv:2206.12265 (2022)), utilizing rotating magnetic fields as a unique method in order to stir the BEC and impart angular momentum. At low scattering lengths, when the system is relatively more dipolar, the transition to the vortex stripe phase is observed, where vortices tend to align along the magnetic field, as shown in the attached Figure.

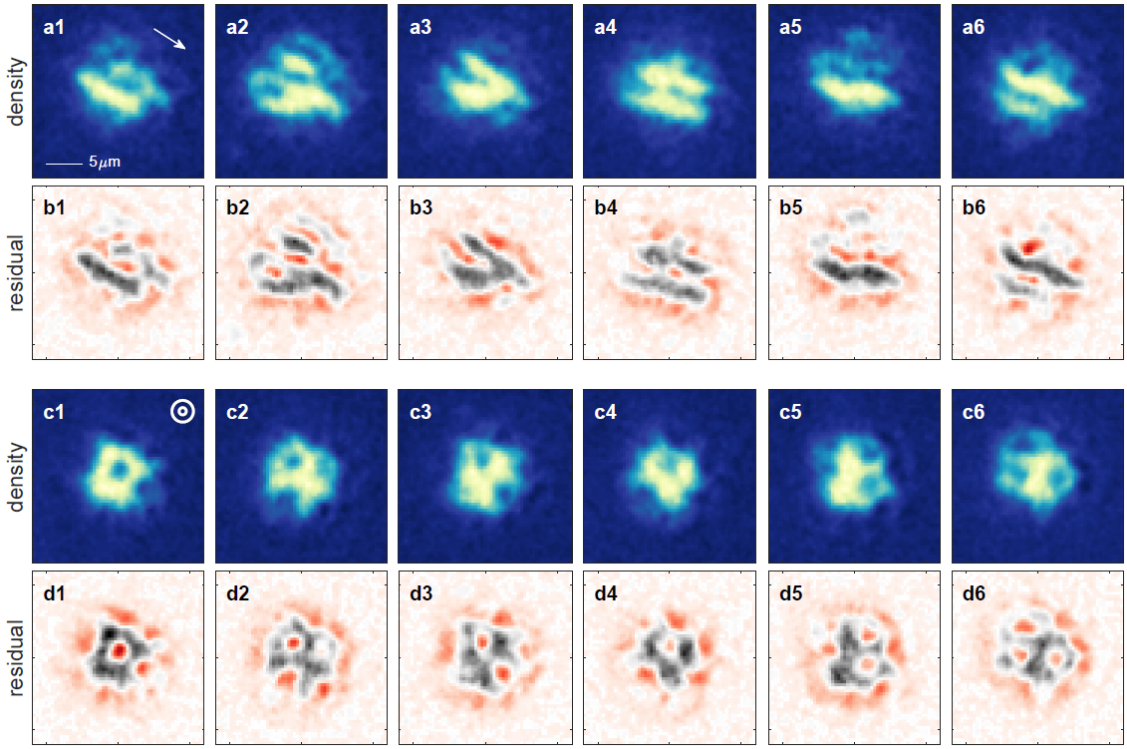

Figure: Vortices in a dysprosium Bose-Einstein condensate. a) images taken after 500ms of continuous stirring, vortices are stretched along the magnetic field direction (white arrow) and tend to organize themselves along stripes. Each column is a different experimental run. b) residual images obtained by subtracting the image a) from the average image (averaged over ∼100 runs) in order to highlight the vortex positions. c) and d) same as a) and b), but the magnetic field is tilted up over 100ms after stirring, and vortex cores and interactions become isotropic. See L. Klaus *et al.*, arXiv:2206.12265 (2022) for more details.