Observation of vortices in dipolar quantum gases

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Due to anisotropic long-range interactions, degenerate ultra-cold dipolar gases of Erbium and Dysprosium exhibit supersolidity [1,2], an exotic phase of matter both density-modulated and phase coherent. It is theorized that these supersolids maintain their phase coherence due to a superfluid background. While density modulation can be directly observed and phase coherence emerges from self-interference, the superfluid nature of the system in terms of irrotational flow has yet to be shown unambiguously. Quantized vortices, a defining feature of superfluidity, is an unequivocal probe of irrotational flow which can be used to prove the existence of the superfluid background in the supersolid phase. Here we study, both experimentally and theoretically, the creation of vortices in both the unmodulated BEC phase [3] and the modulated supersolid phase of Dy-164 [4].

References

[1] Long-lived and transient supersolid behaviors in dipolar quantum gases, L. Chomaz et al., Phys. Rev. X, 9, 021012 (2019)
[2] Two-dimensional supersolidity in a dipolar quantum gas, M. A. Norcia et al., Nature 596, 357-361 (2021)
[3] Observation of vortices and vortex stripes in a dipolar condensate, L. Klaus et al., Nature Physics 18, 1453–1458 (2022)
[4] Manuscript in preparation

Figures

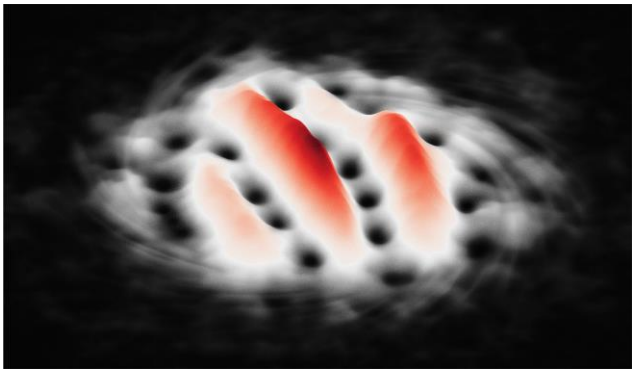

Figure 1: Simulation of a rotating dipolar quantum gas featuring quantized vortices [3]