Contribution ID: **70** Type: **Poster**

Vortex lattice nucleation in dipolar Bose-Einstein condensates

Wednesday, 13 September 2023 22:40 (20 minutes)

Degenerate quantum gases with strong permanent dipole moments are a robust platform for studying anisotropic and long-ranged phenomena in strongly correlated quantum systems [1]. When subjected to a rotating magnetic field, the resulting precession of the dipole moments of a magnetic dipolar Bose-Einstein condensate (dBEC) imparts angular momentum to the system. Due to the superfluidity of an interacting BEC, this has the consequence of quantum vortices forming in a hitherto vorticity-free fluid. Our work [2] focusses on theoretically tracking the evolution of a dBEC as the magnetic field rotation frequency is slowly accelerated from zero until the vortices have formed, and then observing the relaxation of the system to its final state at a fixed rotation frequency. We find that the dBEC closely follows pre-existing semi-analytical predictions [3] until the onset of vorticity, and that the vortex-filled states are characterised by background density striping and tilting. After sufficiently long hold durations, the vortices relax into an Abrikosov lattice with the lattice and background dBEC density profile approaching our predictions of the expected ground state, see figure below. These theoretical findings provide a complementary perspective on the recent realisation of vortices in dBECs via direct dipole rotation [4].

References

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Session Classification: Poster Session III

Track Classification: Superfluidity and Supersolidity