Contribution ID: **48** Type: **Poster**

On Demand Formation of Topological Defects in Ferromagnetic Spinor Bose Einstein Condensates

Wednesday 4 September 2024 17:00 (2 hours)

Spinor Bose-Einstein condensates (sBECs) are quantum superfluids with a spin degree of freedom arising from interactions between atoms in different magnetic sublevels $m_F = +1, 0, -1$. These novel ultracold atomic systems can exhibit ferromagnetic order and offer enhanced opportunities for exploring phenomena beyond those accessible in scalar BEC's, such as new classes of topological defects. The polar core vortex (PCV) is an example of a unique defect occurring in a transversely magnetized, ferromagnetic sBECs. PCVs exhibits opposing spin circulation in the $m_F = \pm 1$ components and an unmagnetized vortex core populated by atoms in the $m_F = 0$ state. This results in a defect with a topologically protected winding of the transverse magnetization and a flat density profile. The first experimental observation of a PCV was achieved by Sadler et al [1] in 2006, where the vortex sporadically formed following a magnetic field quench. Due to the non-deterministic nature of creating PCV's, further experimental study of their properties and dynamics has been limited, thus leaving a wide range of PCV applications left to be explored. In this presentation, I report on the apparatus developed to realize the first on-demand creation of PCVs in a uniform 2D ^{87}Rb sBEC. We also demonstrate our fine experimental control of density and spin profiles via the use of DMDs that lead our investigations into PCV dynamics, PCV driven turbulence and tests of ultracold spintronic devices

References

[1] L. E. Sadler, J. M. Higbie, S Leslie, M. Vengalattore, D. Stamper-Kurn, Spontaneous symmetry breaking in a quenched ferromagnetic spinor Bose-Einstein condensate, Nature 443 (2006) 312.

Short bio (50 words) or link to website

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Relevant publications (optional)

Career stage

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Session Classification: Posters II

Track Classification: FINESS