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Vortices on rotating shell-shaped Bose-Einstein condensates

Monday 2 September 2024 10:20 (20 minutes)

The recent realisation of hollow-core bubbles of Bose-Einstein condensates on the Cold Atom Lab aboard the International Space Station has rendered this intriguing geometry accessible, motivating study into the behaviour of vortices on curved surfaces [1]. In shell geometries, superfluid vortex behaviour promises interesting responses to rotation as the continuity of the velocity field required across the closed-curved surface of the shell imposes additional restrictions on the condensate phase. We study the response of a bubble condensate to an externally imposed rotation, demonstrating that for small rotation rates, a familiar triangular Abrikosov lattice of vortices is formed, with two aligned vortex lattices appearing in each hemispherical shell. An elliptical deformation of the spherically symmetric condensate shape occurs at larger rotation rates due to the centrifugal force. As the driving rotation frequency is increased, a multi-charge vortex and its anti-vortex pair is formed at the poles, surrounded by singly charged vortices in the bulk condensate density. strong text

References

[1] R.A. Carollo et al. Nature 606 (2022) 281-286.

Short bio (50 words) or link to website

I am a Deborah Jin Research Fellow at the University of Queensland. Prior to this, I have held postdoctoral research positions at the Australian National University, Okinawa Institute of Science and Technology Graduate University, Japan and Newcastle University, UK.

Relevant publications (optional)

[1] A. C. White, Triangular vortex lattices and giant vortices in rotating bubble Bose-Einstein condensates, Phys. Rev. A 109 (2024) 013301. https://doi.org/10.1103/PhysRevA.109.013301
[2] T. Zhang et. al, Chaotic few-body vortex dynamics in rotating Bose-Einstein condensates, Phys. Rev. Fluids 4 (2019) 054701. https://doi.org/10.1103/PhysRevFluids.4.054701
[3] A. White, Y. Zhang and T. Busch, Odd-petal-number states and persistent flows in spin-orbit-coupled Bose-Einstein condensates, Phys. Rev. A 95 (2017) 041604(R). https://doi.org/10.1103/PhysRevA.95.041604

Career stage

Postdoc

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