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Equatorial waves in rotating bubble-trapped superfluids

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As the Earth rotates, the Coriolis force causes various oceanic and atmospheric waves to be trapped along the equator, including Kelvin, Yanai, Rossby, and Poincaré modes. It has been demonstrated that the mathematical origin of these waves is related to the nontrivial topology of the underlying hydrodynamic equations. Inspired by recent observations of Bose-Einstein condensation (BEC) in bubble-shaped traps in microgravity ultracold quantum gas experiments, we demonstrate that equatorial modes are supported by a rapidly rotating condensate in a spherical geometry. Using a zero-temperature coarse-grained hydrodynamic framework, we reformulate the coupled oscillations of the superfluid and the Abrikosov vortex lattice resulting from rotation as a Schrödingerlike eigenvalue problem. The resulting non-Hermitian Hamiltonian is topologically nontrivial. We also solve the hydrodynamic equations for a spherical geometry and find that the rotating superfluid hosts Kelvin, Yanai, and Poincaré equatorial modes, but not the Rossby mode. Our predictions can be tested with state-of-the-art bubble-shaped trapped BEC experiments.

References

G. Li and D. K. Efimkin - Phys. Rev. A 107, 023319 (2023)

Short bio (50 words) or link to website

https://sites.google.com/a/monash.edu/dmitry-efimkin-research-group/publications?authuser=0

Relevant publications (optional)

1. Equatorial Waves in Rotating Bubble-Trapped Superfluids - G. Li and D. K. Efimkin - Phys. Rev. A 107, 023319 (2023)
2. Topological hybrid electron-hole Cooper pairing - A. Chansky and D.K. Efimkin - Phys. Rev. B 108, 075433 (2023)
3. Anomalous drag in electron-hole condensates with granulated order - H. Liu, A.H. MacDonald, and D.K. Efimkin - Phys. Rev. Lett. 127, 166801 (2021)

Career stage

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