Dynamics of Massive Vortices on a Planar Annulus

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Quantum vortices are indeed one of the striking effects arising in rotating superfluids. These quantized topological excitations are generally thought as funnel-like holes around which a quantum fluid exhibits a swirling flow: within this picture, vortex cores are empty regions where the superfluid density goes to zero.

In many real systems, however, vortices are not empty. Atoms of a different species or excitations resulting from thermal or quantum fluctuations can fill the holes in the superfluid, providing vortices with an effective inertial mass.

In this talk I will discuss the dynamics of massive vortices on a planar superfluid film with ring geometry [1], also motivated by the recent easy experimental reach of annular trapping potentials. Here, two-dimensional point vortices in the majority component ψ_a (light blue region in the figure) host the atoms of the minority component ψ_b (brown dot), thus playing the role of massive cores [2].

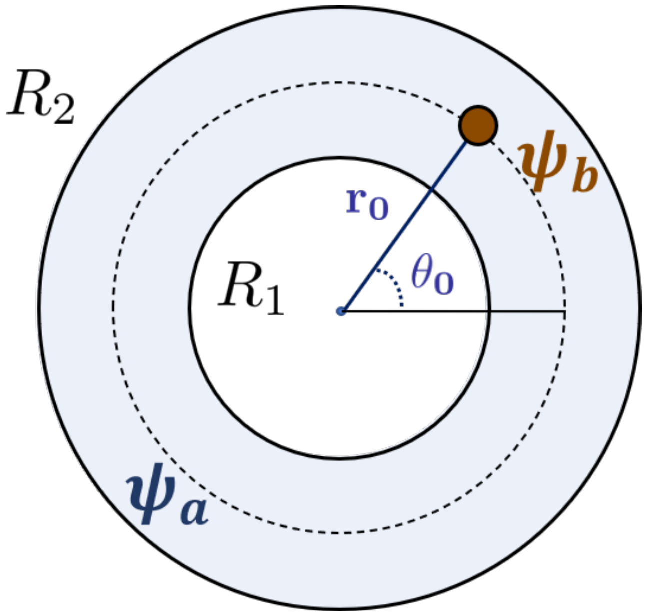

Figure 1: Schematic representation of a single vortex inside a planar annulus with radii R_1

The presence of a finite mass alters dramatically the vortex dynamics, since the particles trapped in the vortex core experience an effective gauge field provided by the surrounding superfluid component. This leads to a density-dependent effective magnetic field that is responsible for a modification of the precession frequency (compared to their massless counterparts) and the onset of a cyclotron motion, which for large mass eventually becomes unstable.

We also present the results for the dynamics of a symmetric necklace of N massive vortices inside the annulus, whose massless configuration has seen recent experimental realizations [3,4].

References

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