Topological stabilization of an attractive Bose-Einstein condensate

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Abstract:

We show, via mapping on a quantum fluid of light, that non-trivial topology dynamically stabilises a two-dimensional attractive Bose-Einstein condensate, altering its dynamics and delaying the collapse.

The stability of Bose-Einstein condensates depends strongly on the geometry and on the interactions between its constituents: while in the presence of repulsive interactions, condensates are long-lived, in the presence of attractive interactions, condensate collapse rapidly. On the other hand topologically defects are protected during the system evolution, therefore long-lived.

Here, we show that the hydrodynamic flow induced by a topological defect competes with the attractive interactions, modifying the dynamics and delaying the collapse of the condensate.

Experimentally, we map the condensate on a quantum fluid of light realized with a hot vapour of neutral atoms and imprint a multi-charge vortex at the center of the condensate. By controlling the interaction strength and the topological charge we investigate the geometry of the condensate up to its fragmentation and the early onset of a solitonic regime.

The full process is explained by the theoretical investigation of the mode of the Bogoliubov excitation spectrum.

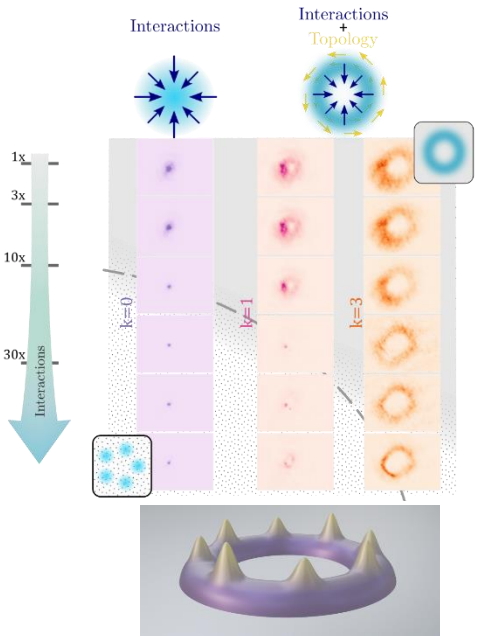

Fig. 1: Schematic representation of the collapse and fragmentation of the condensate.

References

[1] D. Capecchi, A. Gianfrate, P. Comaron, M. De Giorgi, D. Ballarini, F. Dalfovo, D. Trypogeorgos, D. Sanvitto[1], " Dynamical stabilisation of an attractive Bose-Einstein condensate using topological defects", in preparation.