Instability of Counter-rotating Vortices in miscible two-component Bose-Einstein condensates

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We theoretically study instability and nonlinear dynamics of multi-quantum vortices in trapped two-component Bose–Einstein condensates. We consider that each condensate has a multi-quantum vortex at the center; the two vortices have same amplitude of winding number with opposite sign. These counter-rotating multi-quantum vortices are expected to split into some vortices as multi-quantum vortices in a single-component BEC. However, we find that the vortices show novel splitting and nucleation of vortices by numerically solving the Gross–Pitaevskii equations. These dynamics are predicted by two kinds of linear analysis. One is numerically solving the Bogoliubov-de Gennes equation. The other is a local density approximation with the dispersion relation of the Bogoliubov excitations in countersuperflow, two counter-propagating uniform miscible superfluids. The countersuperflow is dynamically unstable when the relative velocity exceeds a critical value[1,2]. The instability of the counter-rotating vortices has a deep connection with the instability of countersuperflow.

1. H. Takeuchi, S. Ishino, and M. Tsubota, Phys. Rev. Lett. **105**, 205301 (2010).
2. S. Ishino, M. Tsubota, and H. Takeuchi, Phys. Rev. A. **83**, 063602 (2011).

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