# Diffusion and ballistic expansion of a two-dimensional quantum vortex bundle

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Quantum vortices are topological defects which are observable experimentally in superfluid $^4$He and $^3$He and in atomic Bose-Einstein condensates. In a two-dimensional system the sign of the winding number of the phase field around a vortex core determines if they are clockwise or anticlockwise. Vortices with winding numbers $\pm 1$ are stable, interact with each other and produce sound waves in the background fluid.

By using the Gross-Pitaevskii equation we numerically simulate a two-dimensional turbulent vortex bundle characterized by a superposition of $N$ vortices (both clockwise and anti-clockwise) which are initially confined in a circular region of radius $R$. The initial vortex coordinates are uniformly distributed with minimum distance $d$.

We study the evolution of the system, sampling over random initial conditions. We use a numerical algorithm to track the trajectories of the vortices. We estimate the diffusion time scale of the vortex configuration, and how it is affected by frequent ballistic expulsions of vortex dipoles from the bundle.