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Generalized Hasimoto Transform, Binormal Flow and Quantized Vortices[1] SCOTT A. STRONG, LINCOLN D. CARR, Colorado School of Mines —
A quantized vortex is a topological object central to the study of quantum liquids. Current models of vortex dynamics are motivated by the nonlinear Schrödingier equation and porting techniques from classical vortices. Self induction of classical vorticity ideally localized to a space curve asserts that a curved vortex filament propagates at a speed proportional to its curvature, $|\mathbf{v}| \propto \kappa$, in the binormal direction of the Frenet frame, $\hat{\mathbf{b}}$. Interestingly, this autonomous dynamic can be mapped into the space of solutions to a cubic focusing nonlinear Schrödinger equation, $i\psi_t + \psi_{ss} + \frac{1}{2}|\psi|^2\psi = 0$, where ψ is a plane-wave defined by curvature and torsion of the vortex filament, $\psi = \kappa \exp[i \int ds \tau]$. Using these two results, one can define a vortex configuration, within superfluid helium or a Bose-Einstein condensate, and prescribe a binormal evolution. In general, however, binormal flow depends nonlinearly on local curvature and maps to a class of nonlinear integro-differential Schrödinger equations. In this talk we discuss how system size affects higher-order nonlinearity and filament geometry which is applicable to theoretical and numerical investigations of vortex dominated quantum hydrodynamics.

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