From Vortex Rings to Hopfions in 3d Bose-Einstein Condensates

PANAYOTIS KEVREKIDIS, UMass, Amherst — In this talk we report a number of recent results on three-dimensional topological states. Motivated by our earlier work on vortices, we develop a two-fold approach for studying vortex rings. We analytically and numerically explore their emergence through an instability from planar or ring dark soliton states in the small amplitude/weak nonlinearity limit. We also analytically and numerically explore the opposite, particle based limit of large density/large nonlinearity in the Thomas-Fermi regime. We connect these two analytically tractable limits through detailed numerical computations revealing the spectral and nonlinear stability of such states. We also explore a series of other states, including so-called Hopfions, and dark-soliton-shells examining both their regimes of stability in 3d atomic BECs, as well as their mechanisms and manifestations of dynamical instabilities.

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