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Stability of Ring Dark Solitons in Bose-Einstein Condensates
MARK EDWARDS, Georgia Southern University, LINCOLN CARR, Colorado School of Mines, CHARLES W. CLARK, NIST — Bose-Einstein condensates confined in a cylindrical "can" potential (Prince Albert potential) admit vortex-like solutions of the time-independent Gross-Pitaevskii (GP) equation that consist of a number of nodal rings concentric with the vortex line. The radius of the can must coincide with one of the nodal rings in order that the state be a stationary solution of the GP equation. If a phase imprint consisting of a single jump at one of the intermediate nodal rings is applied, a ring-shaped dark soliton is created which exhibits oscillatory radial motion. We have studied the stability of this time-dependent state by performing a partial-wave analysis of the solution of the time- dependent GP equation and deriving the coupled time-dependent equations of motion for the partial waves and by performing a Bogoliubov analysis. We have used these equations to study the effects of a ring phase imprint that is not concentric with the vortex line and the rate of diffusion of a single ring soliton when partial waves of neighboring winding number are seeded with a small amount of population. We also show the connection with the Bogoliubov analysis.

Mark Edwards
Georgia Southern University

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