An improvement of continuation method in Rotating Bose-Einstein Condensates

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Abstract

We study the discrete nonlinear Schrödinger (DNLS) equations that model rotating Bose-Einstein Condensates (BEC) both analytically and numerically. Due to the difficulties associated with transformation invariant solutions, standard continuation methods may not properly follow the solution curves of the DNLS equations. We propose a quotient transformation invariant continuation method to circumvent this obstacle. We also analyze the bifurcation properties of the primal stalk solution curve corresponding to the DNLS equations for an isotropic trap. In numerical computation, the existence of a bistable region corresponding to the bound states with a 0- or 1-vortex is shown. This finding not only agrees with the physics of the experimental phenomena, but also explains why a 0- or 1-vortex may be observed within a certain region that has an angular velocity. Numerical evidence shows that trap potentials have little effect on the width of the bistable regions. In contrast, intra-component scattering length significantly affects the bistable region.