

# A Continuation Method for Solving Multi-Component Bose-Einstein Condensate

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We develop a continuation BSOR-Lanczos-Galerkin method for the computation of positive bound states of time-independent, coupled Gross-Pitaevskii equations (CGPEs) which describe a multi-component Bose-Einstein condensate (BEC). A discretization of the CGPEs leads to a nonlinear algebraic eigenvalue problem (NAEP). The solution curve with respect to some parameter of the NAEP is then followed by the proposed method. For a single-component BEC, we prove that there exists a unique global minimizer (the ground state) which is represented by an ordinary differential equation with the initial value. For a multi-component BEC, we prove that  $m$  identical ground/bound states will bifurcate into  $m$  different ground/bound states at a finite repulsive inter-component scattering length. Numerical results show that various positive bound states of a two/three-component BEC are solved efficiently and reliably by the continuation BSOR-Lanczos-Galerkin method.

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