Numerical methods for computing the ground state of spin-1 Bose-Einstein condensates in uniform magnetic field

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(Dated: August 25, 2008)

In this article, we propose efficient and accurate numerical methods for computing the ground state solution of spin-1 Bose-Einstein condensates subject to uniform magnetic field. The key idea in designing the numerical method is based on the normalized gradient flow with the introduction of the third normalization condition, together with the two physical constraints on the conservation of total mass and conservation of total magnetization. Different treatments to the Zeeman energy terms are found to yield different numerical accuracies and stabilities. Numerical comparisons between different numerical schemes will be made in this paper and the best scheme will be identified. The numerical scheme will then be applied to compute the condensate ground state in a harmonic plus optical lattice potential and the effect of the periodic potential, in particular to the relative population of each hyperfine component, will be investigated through the comparisons to the condensate ground state in a pure harmonic trap.

PACS numbers: 03.75.Hh, 03.75.Lm, 03.75.Mn, 67.40.Db