Structure formation in immiscible two–species Bose–Einstein condensates in perturbed harmonic traps

ROBERT PATTINSON, NICK PARKER, NICK PROUKAKIS, Joint Quantum Centre Durham-Newcastle, School of Mathematics and Statistics, Newcastle University, Newcastle upon Tyne, United-Kingdom, I-KANG LIU, SHIH-CHUAN GOU, Department of Physics, National Changhua University of Education, Changhua, Taiwan, SIMON GARDINER, DANIEL MCCARRON, HUNG-WEN CHO, SIMON CORNISH, Joint Quantum Centre Durham-Newcastle, Department of Physics, Durham University, Durham, United-Kingdom, TOM BILLAM, Jack Dodd Centre for Quantum Technology, Department of Physics, University of Otago, Otago, New-Zealand — We investigate the mean–field equilibrium solutions for a trapped two–species $^{87}\text{Rb}-^{133}\text{Cs}$ immiscible Bose–Einstein condensate, and show that the density profiles observed in a recent Bose-Einstein experiment (D. J. McCarron et al. Phys. Rev. A 84, 011603 (2011)), which include ball and shell formations and axially/radially separated states, can be reproduced when accounting for weak linear perturbations. We also demonstrate the importance of the coupled growth of the two condensates by a simple finite temperature model which reveals such structures to be generally metastable in the presence of dissipation, with our findings confirmed by the more accurate Stochastic Projected Gross–Pitaevskii equation.

Robert Pattinson
Joint Quantum Centre Durham-Newcastle, School of Mathematics and Statistics, Newcastle University, Newcastle upon Tyne

Date submitted: 25 Jan 2013