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Modeling BEC's in Double Wells[1]

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We introduce a new method for the simulation of Bose-Einstein condensates in regimes where both mean field effects (Gross-Pitaevskii theory) and the fragmentation of states (Bose-Hubbard model) play significant roles. This procedure takes advantage of the differing time scales of spatial wave-function deformation and changes in Fock-space expansion coefficients via use of a novel basis. These 2,3D simulations are used to analyze two often cited experiments [1,2]. An experiment from the MIT cold atom group [1] is shown to reach tentative conclusions, not fully consistent with the present simulations. Namely, full fragmentation is not achieved. The time scale used for raising the potential barrier is also seen to result in substantial non-adiabaticity. This confuses analysis of number squeezing, as both result in degradation of interference patterns. Results of an experiment from the Heidelberg group [2], including both Josephson and self trapped dynamics, are modeled and extended to number entangled states.

[1] Y. Shin et al., PRL **93**, 050405 (2004)
[2] M. Albiez et al., PRL **95**, 010402 (2005).

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