Abstract Submitted
for the MAR09 Meeting of
The American Physical Society

Variational Ground State of the One Dimensional Bose-Hubbard Modelel J.D. MANCINI, Kingsborough College of CUNY, V. FESSATIDIS, Fordham University, S.P. BOWEN, Chicago State University, R.K. MURAWSKI, Drew University — Recently Eichenberger and Baeriswyl [PRB **76**, 180504R, (2007)] have introduced a novel variational ansatz to study the two dimensional Hubbard model. Their scheme involves choosing a trial ket which consists of an exponential operator constructed from the Hamiltonian which then operates on a mean field ground state $|\psi_0\rangle$. In this study, we wish to extend this ansatz by combining it with a second ansatz in which a variational basis is constructed by systematically taking derivatives with respect to a (set) of variational parameters. The model we will study is the one dimensional Bose-Hubbard Hamiltonian which is used to investigate the properties of interacting bosonic atoms in a one-dimensional optical lattice. The Hamiltonian is given by

$$H_{\rm bh} = -J \sum_{l=1}^{M} (a_l^\dagger a_{l+1} + {\rm h.c.}) + \frac{U}{2} \sum_{l=1}^{M} n_l \left(n_l - 1\right),$$

where a_l ($a_l^\dagger$) creates a boson at the lowest level localized on the l-th site, J is the hopping energy and $U > 0$ is the onsite repulsion. Our results are then compared with other approximation methods such as Hartree-Fock-Bogoliubov theories and the variational Bijl-Dingle-Jastrow method.

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Date submitted: 15 Nov 2008

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