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Engineering of Quantum Entangled Dark Solitons on One-Dimensional Optical Lattices[1] R.V. MISHMASH, Physics Department, Colorado School of Mines, Golden, CO 80401 and Electron and Optical Physics Division, NIST, Gaithersburg, MD 20899, I. DANSHITA, C. W. CLARK, Electron and Optical Physics Division, NIST, Gaithersburg, MD 20899, L.D. CARR, Physics Department, Colorado School of Mines, Golden, CO 80401 and Electron and Optical Physics Division, NIST, Gaithersburg, MD 20899 — Using density and phase engineering techniques, we create quantum entangled dark solitons on a one-dimensional Bose-Hubbard lattice. This is accomplished numerically by employing a number-conserving time-evolving block decimation routine to simulate the Bose-Hubbard Hamiltonian. We show that when deep in the superfluid regime of the ground state phase diagram, solitons can be created with lifetimes on the order of tens of tunneling times. The soliton decay is purely due to quantum effects which we characterize with a complete set of quantum measures that include quantum depletion, von Neumann and generalized quantum entropies, and number fluctuations. Comparisons are made to the Bogoliubov theory which predicts quantum depletion into an anomalous mode that fills in the soliton. Our full quantum treatment allows us to go beyond the Bogoliubov approximation and explicitly calculate the time dependence of the distribution of the system's natural orbitals as well as their exact spatial form.

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