Abstract Submitted
for the DAMOP20 Meeting of
The American Physical Society

Simulating a Josephson charge qubit with coupled Bose–Einstein condensates[1] ELISHA HABER, MAITREYI JAYASEELAN, JOSEPH D. MURPHREE, ZEKAI CHEN, NICHOLAS P. BIGELOW, University of Rochester — A Bose–Einstein condensate (BEC) is attractive for simulating the superconducting Josephson junction (SJJ), which is the basis for superconducting qubits. The SJJ comprises two superconducting plates, which are separated by a thin barrier that allows Cooper pairs to tunnel between the plates. To realize a Bosonic Josephson junction, we use two BECs that are coupled together in a double-well. We model this setup with the two-mode Bose–Hubbard Hamiltonian, where the parameters are set so that fluctuations in the atom number difference are suppressed (number squeezing). The system will thus be analogous to an SJJ charge qubit. We present an experimental protocol to realize a BEC charge qubit analog using an ultracold cloud of ^{87}Rb atoms confined in a planar, red-detuned optical dipole trap. The ground and excited state wavefunctions are calculated variationally, and a spectral method is used to numerically simulate the dynamics of the system when the potential is varied in time. Similar to the charge qubit, the BEC analog has a ground state corresponding to both wells having the same number of atoms, and a first excited state of one atom having tunneled between the wells. Any superposition of these states can be reached by controlling the barrier position.

[1]This work was supported by the National Science Foundation Grant No. PHY-1708008 and NASA/JPL RSA Grant No. 1616833

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Date submitted: 19 Mar 2020 Electronic form version 1.4