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Phases of Ultra Cold Gases in the Fermi-Bose Hubbard Model DANIEL SCHIRMER, Colorado School of Mines, L.D. CARR COLLABORATION[1], CHARLES CLARK COLLABORATION[2] — The experimental realization of a BEC has stimulated the interest in theoretical models of zero-temperature quantum phase transitions. Ultra cold gases confined in optical lattices can demonstrate a wide range of different phases by varying controllable system parameters, such as optical lattice intensity, particle number, spin composition and the inter-atomic interaction. This project aims to unveil phases in a one dimensional system of fermions coupled to a bosonic molecular state, in the limit of an infinite number of lattice sites. This is accomplished by solving the Fermi-Bose Hubbard model using a numerical method developed by G. Vidal [G. Vidal, Phys. Rev. Lett. 91, 147902 (2003)], and implemented into a Mathematica package by J. E. Williams at NIST, which was used extensively in my research. This research focuses on calculating diagrams of the homogeneous system as functions of nearest neighbor hopping energies, onsite fermion chemical potential, onsite fermi-bose coupling strength, and a detuning factor, determining relative boson chemical potential. For most calculations, onsite interactions are not considered. Because ultra cold gases are possible to create, manipulate, and observe, they function as a future test bed for studies in solid-state physics and quantum computation. Theoretical tools such as phase diagrams are especially important to the development of these fields.

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