Department of Physics and Astronomy Colloquium

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Date: April 6, 2016
Time: 3:30 p.m. (**Refreshments** in ***Rm. 103*** @ **3:15 p.m.**)
Place: Rm. 103, Thirkield Hall, Howard University
Host: Dr. Thomas Searles

Spin Orbit Coupling in Ultra Cold Atomic Gases of spin-1 Bosons

Abstract: Motivated by the recent advances in ultra cold atoms [1], we will discuss the physics of spin-1 bosons in the presence of a spin orbit coupling. We will first consider the effects of spin-1 bosons and the role of spin orbit coupling in the continuum [2]. We will then introduce an optical lattice, which naturally creates strong correlations that drive charge and spin density wave superfluid phases. Ramping up the lattice depth leads to the spin-1 Bose-Hubbard model [3]. This provides a controlled setting to study the direct interplay of spin orbit coupling and strong correlations. In addition to the conventional spin-full Mott and superfluid phases contained in the spin-1 Bose-Hubbard model, due to the spin orbit coupling we find new lattice symmetry breaking phases [4]. For weak interactions, the interplay between the lattice momentum and the spin-orbit wave-vector induces a phase transition from a uniform superfluid to a phase where bosons simultaneously condense at the center and edge of the Brillouin zone. This state is characterized by spin density wave order, which arises from the spin-1 nature of the system. Interactions suppress this spin density wave order, and for sufficiently strong interactions the system becomes a Mott insulator. Inside the Mott lobes with an odd-integer filling we derive the effective low energy magnetic Hamiltonian. Focusing on the quasi-one-dimensional limit we solve the strongly coupled magnetic model via its classical limit and using the density matrix renormalization group.

[1] V. Galitski and I. B. Spielman, Nature 494, 49 (2013).
[2] Stefan S. Natu, Xiaopeng Li, and William S. Cole, Phys. Rev A 91 023608 (2015).
[3] Stefan. S. Natu, J. H. Pixley, and S. Das Sarma, Phys. Rev. A 91 043620 (2015).
[4] J. H. Pixley, Stefan S. Natu, I. B. Spielman, and S. Das Sarma Phys. Rev. B 93, 081101 (2016).