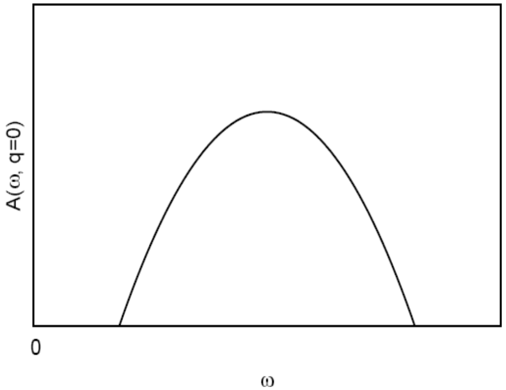
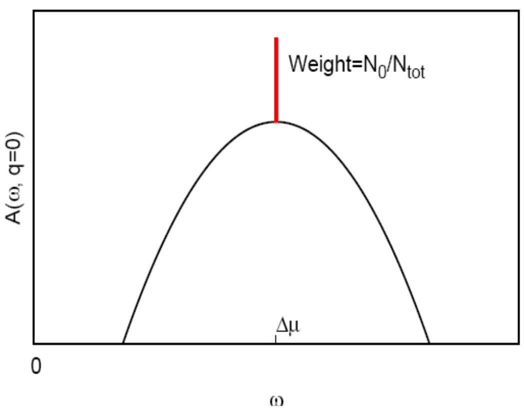
Supersymmetry Can Be Realized and Detected in Cold Atoms with Mixtures of Bosons and Fermions

PI: Kun Yang (NHMFL); Supported by NSF DMR-0704133

Supersymmetry is a concept usually associated with high energy physics. In a supersymmetric field theory or superstring theory, elementary particles come in pairs with identical properties but opposite statistics, i.e., one is a boson and the other is a fermion; they form the so-called superpartners. If supersymmetry is present in the fundamental theory of nature, it has far-reaching consequences, including the solution of cosmological constant problem and grand unification. On the other hand none of the superpartners of known elementary particles has been observed yet, indicating that supersymmetry (if present) must be broken in nature. In this work we demonstrate the possibility of realizing supersymmetry in trapped cold atom systems with mixtures of bosonic and fermionic atoms, where these atoms are superpartners of each other. We find supersymmetry is always broken in such systems, resulting in a fermionic collective mode called Goldstino. The Goldstino is visible in the fermion spectral function (see figures) as a sharp peak at the specific energy and momentum. This allows for direct demonstration of supersymmetry and its breaking in table-top atomic physics experiments, instead of huge billion $ accelerator labs.



Without Supersymmetry



With Supersymmetry

Y. Yue and K. Yang, Phys. Rev. Lett. **100**, 090404 (2008)**;**
featured in: http://physicsworld.com/cws/article/news/33425