Abstract Submitted
for the MAR10 Meeting of
The American Physical Society

Entanglement Entropy and Mutual Information in Bose-Einstein Condensates[1] KUN YANG, WENXIN DING, NHMFL & Florida State University
— We study the entanglement properties of free non-relativistic Bose gases. At zero temperature, we calculate the bipartite block entanglement entropy of the system, and find that it diverges logarithmically ($\frac{1}{2}\ln N$) with the particle number in the subsystem. For finite temperatures, we study the mutual information between the two blocks. We first analytically study an infinite-range hopping model, then numerically study a set of long-range hopping models in one-dimension that exhibit Bose-Einstein condensation. In both cases we find that a Bose-Einstein condensate, if present, makes a divergent contribution to the mutual information which is proportional to the logarithm of the number of particles in the condensate in the subsystem. Below T_C the prefactor of the logarithmic divergent term is $1/2$ for the infinite-range hopping model, and model dependent ($<1/2$) for the long-range hopping models.

[1]Phys. Rev. A 80, 012329 (2009)

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Date submitted: 17 Nov 2009 Electronic form version 1.4