Abstract Submitted
for the DAMOP14 Meeting of
The American Physical Society

Experimental investigation of collective atomic effects in cavity QED with application to atomic clocks[1] BJARKE T.R. CHRISTENSEN, MARTIN R. HENRIKSEN, Niels Bohr Institute, University of Copenhagen, PHILIP G. WESTERGAARD, Danish Fundamental Metrology, JUN YE, JILA, National Institute of Standards and Technology and University of Colorado, JAN W. THOMSEN, Niels Bohr Institute, University of Copenhagen — Atoms placed in an optical cavity can experience cooperative effects where the atomic dipoles synchronize and collectively acquire a macroscopic phase. This collective phase can significantly enhance the phase response of the system and open the possibility of using collective effects to improve the spectral purity of a clock laser. We demonstrate the first measurements of a collective phase behavior of ^{88}Sr atoms trapped inside an optical cavity and we investigate the input probe power and atom number dependence of this collective behavior. We trap about 3×10^8 atoms in a standard Magneto Optical Trap (MOT) inside a low finesse ($F = 85$) cavity and perform direct spectroscopy on the narrow optical $^1S_0 \rightarrow {}^3P_0$ transition ($\Gamma = 7.6$ kHz) at 689 nm. The phase response is measured by performing cavity enhanced FM spectroscopy using the so-called NICE-OHMS technique. In addition, we will present our latest results for optimizing the collective phase response, demonstration of superradiance at an optical frequency and investigation of the time evolution of the phase synchronization of the atoms.

[1]This work was supported by Carlsberg, DNRC and ESA.

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Date submitted: 31 Jan 2014 Electronic form version 1.4