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Exploring Collective Physics in a Strontium Optical Lattice Clock

lundi 22 février 2016 16:00 (3 heures)

We investigate collective emission from coherently driven ultracold ^{88}Sr atoms. We perform two sets of experiments, using a strong and weak transition that are insensitive and sensitive, respectively, to atomic motion at one microKelvin. We observe highly directional forward emission with a peak intensity that is enhanced, for the strong transition, by 10^3 compared to that in the transverse direction. This is accompanied by substantial broadening of spectral lines. For the weak transition, the forward enhancement is substantially reduced due to motion. Meanwhile, a density-dependent frequency shift of the weak transition ($\sim$ 10% of the natural linewidth) is observed. In contrast, this shift is suppressed to $<$1% of the natural linewidth for the strong transition. Along the transverse direction, we observe strong polarization dependences of the fluorescence intensity and line broadening for both transitions. The measurements are reproduced with a theoretical model treating the atoms as coherent, interacting, radiating dipoles. In addition we will present our latest results on spin-orbit coupling (SOC) measurements where the SOC emerges naturally during the clock interrogation when atoms are allowed to tunnel and accumulate a phase set by the ratio of the "magic" lattice wavelength to the clock transition wavelength.

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