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Studies of Cold strontium atoms in an optical cavity

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Today's ultra-precise and accurate atomic clocks continue to make important contributions to fundamental physics as well as applied technology. Atomic clocks have imposed significant limits on the drift of fundamental constants, such as the fine structure constant and the ratio of electron to proton mass and may have the potential to enhance the sensitivity of gravitational wave detectors, or put general theory of relativity to the ultimate test. To further improve atomic clocks we propose alternative strategies on how to perform laser frequency stabilization by exploiting cavity QED with atoms having ultra-narrow optical transitions. Recently we have constructed a cavity QED system where cold 88-atrontium atoms are coupled to a single mode of the optical cavity. The atoms are interrogated on the 7.6 kHz narrow intercombination line 1S0 −3P1 of strontium. Since the sample temperature is typically of a few mK it provides an interesting domain where the Doppler energy scale is several orders of magnitude larger compared to the narrow linewidth of the optical transition. This opens for non-linear phenomena where the cavity-atom system becomes sensitive to velocity dependent multi-photon scattering events the so-called Dopplerons that affect the cavity field transmission and phase. We have studied the cavity atom system and will discuss how this system may improve on future atomic clocks. We will also discuss the prospects of superradiant laser sources involving narrow optical transitions in thermal sample of atoms.

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