Towards generation of dense ensemble of Strontium - 88 for studying cooperativity and related phenomena such as superradiance, subradiance and Anderson localisation

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Since the advent of laser cooling and trapping of atoms, the ultracold atomic physics platform has been a promising platform for discovering new phenomena and testing physical theories. There are ongoing efforts to build quantum technologies, such as quantum computers, quantum sensors, and quantum memories, using ultracold atoms. In our work, we attempt to generate ultracold dense ensemble of bosonic Strontium - 88, the most abundant isotope of Strontium. Sr - 88 isotope has small negative scattering length, which suppresses the three-body recombination rate, which is advantageous for achieving dense ensemble. Alongside Sr - 88 does not have hyperfine splitting, which makes it easier to manipulate and less prone to loss due to scattering. We are developing a novel technique to generate a dense medium. We aim to achieve the spatial density in the order 10^{15} atoms/cm^3 to carry out study of cooperative effects in the 32 MHz broad dipole allowed $^1S_0 \longrightarrow {}^1P_1$ blue transition. At this density, cooperativity can be observed as the atoms are closely placed spatially than the excitation wavelength. Cooperativity is phenomena which emerges from the collective excitation of the atoms. Theoretically, when atoms coherently emit radiation in-phase the emission scales quadratically with the number of atoms in the ensemble, and decays faster, termed as superradiance. Contrary, in-case of subradiance atoms oscillate anti-phase emitting lesser intense and delayed emission. In the dense sample, we intend to verify these phenomena experimentally. Investigating Anderson localization is another phenomenon we aim to study in the dense-sample testing. Including the possibility of localization and confining excitation and their application in the development of quantum memories.

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