Progress in Optical Dipole Trap Towards Photo-Association Spectroscopy

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The experimental setup based on a single-beam optical dipole trap (ODT) for cold Hg atoms enables the investigation of new hadron-hadron interactions [1] through photo-association(PA) spectra [2] near dissociation limit. Mercury atoms forming Hg_2, one of the heaviest two-atom molecules, are well-suited for this experiment. The Hg-Hg Van der Waals interaction is well characterized [3] and significantly weaker than in Sr_2 or Yb_2, reducing interatomic effects enhanced sensitivity to explore new physics beyond the Standard Model at nanometer scale.

For the first time, we have achieved Hg ODT, which represents the least polarizable atoms trapped to date, with temperatures reaching the microkelvin range. The ODT significantly enhances the atomic cloud density which is crucial for PA experiment. Experimental results, including the loading dynamics of the ODT, measurements of trap lifetime, determination of trap frequencies, overall performance of the trapping system, and the experimental scheme for PA experiments will be presented.

The experiment will be carried out using the dual-species experimental setup [5]. PA resonances can also be regarded as optical Feshbach resonances, which serve as a powerful tool for controlling atomic interactions [6]. The Hg_2 molecules will also be employed to investigate the potential for the realization of an optical molecular clock [7, 8].

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