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Frequency stabilization of 221Fr D2-line laser using iodine spectrum

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Francium (Fr) is expected to exhibit the largest atomic electric dipole moment (EDM) among alkali atoms, making it an ideal candidate for probing physics beyond the standard model. In particular, 221Fr is of interest due to its potential for continuous extraction from 225Ac and its enhanced sensitivity to quark EDMs through nuclear octupole deformation. To achieve high-precision EDM measurements, laser cooling and quantum control are essential. For this purpose, a narrow-linewidth laser is required to operate a magneto-optical trap (MOT) for 221Fr. The MOT trap transition of 221Fr D2 line (417.399579(50) THz) lies only 0 – 0.2 GHz away from a peak in R(133) 3-10 lines of molecular iodine (Atlas line number 380) (Fig. 1). A CW-mode Ti:sapphire laser is successfully locked to this iodine absorption line for more than 10 hours, achieving a frequency fluctuation within 2 MHz (Fig. 2). This laser system will be used for MOT of 221Fr. In addition, we plan to implement offset-locking techniques to generate repumping and auxiliary beams necessary for full laser trapping and measurement.

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