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Laser frequency locking with 46 GHz offset by using an electro-optic modulator for magneto-optical trapping of francium atoms

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The investigation of fundamental symmetry violations can elucidate the new physics beyond the standard model. Laser cooled and trapped Fr atoms have particular advantages for the precise symmetry violation measurements. Fr isotopes have ground state hyperfine splitting of about 46 GHz. For achieving laser cooling and trapping of Fr atoms, the hyperfine splitting frequency has to be accurately measured. The frequency difference of 46.1 GHz (^{210}Fr) has to be bridged by two different lasers or has to be generated from a single laser by an electro-optic modulator (EOM). However, it is difficult to generate a frequency component with 46 GHz at the first sideband with an EOM in order to stabilize the frequency difference. In this work, we demonstrated the laser frequency locking with 46 GHz offsets between the trapping and re-pumping lights by generating a 10th order sideband using a fiber-based single-pass waveguide EOM. We successfully obtained the frequency locking error signal by performing delayed self-homodyne detection of the beat signal. Sweeping the trapped-light and re-pumping-light frequencies with keeping its frequency difference of 46 GHz was confirmed over 1 GHz by monitoring the Doppler absorption profile of iodine molecule. This technique enables us to search for a resonance frequency and magneto-optical trapping of Fr atoms. This can be applied for other radioactive as well as stable atoms with large hyperfine splitting.

Biography

Ken-ichi Harada has completed his PhD degree from Kumamoto University in Japan and joined the NTT Basic Research Laboratories. From 2010, he has been working at CYRIC, Tohoku University, as an Assistant Professor and then as a Lecturer. His research interests are in the fields of spectroscopy of atoms and molecules, laser cooling and trapping, fundamental symmetry violation studies, optical magnetometry, electro-optics devices and silicon photonic devices. He has published more than 33 papers in peer-reviewed journals.

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