Development of a Laser Frequency Stabilization and an Optical Transmission System for the Francium Electric Dipole Moment Search

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The search for electric dipole moment (EDM) of an elementary particle is primarily sensitive to new physics beyond the Standard Model. If the elementary particle has a finite EDM, it implies CP violation. While the Standard Model predicts very small values of the EDM, several theoretical models beyond the Standard Model, such as the supersymmetric model, predict much larger values, which are expected to be observable with modern experimental techniques. In paramagnetic atoms, it has been theoretically shown that the EDM of the inner electrons is enhanced by the electric field inside the atom. We proceed with an experiment to laser cool francium (Fr) atoms, the heaviest alkali element, toward an electron EDM search because the electron EDM is enhanced by 799, and the laser cooling technique elongates an interaction time of Fr with the external electric field up to 1 sec. We developed a laser frequency stabilization and transmission system for magneto-optical trapping (MOT) of Fr. Since Fr does not have stable isotopes, we generate Fr by fusion reaction using a beam supplied from RIKEN AVF cyclotron. We placed the laser sauces in a room away from the radioisotope experimental area where the vacuum chamber for MOT was located to avoid radiation damage for the laser systems. The laser beams were transmitted using 400 m long polarization maintaining fibers. The laser optical frequencies were stabilized using a wavelength meter (HighFinesse, WS8-2) in the vicinity of the trapping transition (corresponding to a resonance wavelength of 718 nm with a natural linewidth of 7.6 MHz) and the repumping transition (817 nm with 5.4 MHz) in ^{210}Fr, respectively. In this talk, we will report the details of frequency stabilization and optical transmission system.