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Development of an optical dipole force trap system towards search for an electron EDM using laser-cooled francium

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The electron permanent electric dipole moment (EDM) which violates time reversal symmetry is a sensitive tool for exploring the new physics beyond the Standard Model. In order to measure the value precisely, francium atom which has a large enhancement factor of about 900 for the electron EDM is a good candidate. To measure the electron EDM, it is important to have large interaction time between atoms and the applied electric field and it is also necessary to suppress spatial nonuniformity of electric and magnetic fields. The technique of cooling and trapping neutral atoms by laser lights is one of the best methods to achieve them. Therefore, we are planning an experiment to search for the electron EDM with francium atoms trapped in red-detuned optical dipole force trap (ODT).
We have already succeeded in optical dipole force trapping of rubidium atoms which have similar chemical properties to that of francium. However, the loading efficiency from magneto-optical trap (MOT) to ODT was only about 0.01 %. The temperature of the atomic cloud in MOT measured by time of flight method was about millikelvin. To overcome this issue, we plan to use polarization gradient cooling method to lower the temperature and employ a high-power fiber laser of 50 W for ODT. In this poster, we present the results of optimizing various parameters for increasing the atomic density in MOT and the current status of ODT development.

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