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Search for permanent EDM using Fr atoms

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The existence of the permanent Electric Dipole Moment (EDM) implies the time reversal symmetry violation. This violation directly means CP violation by the CPT theorem, and it would be expected to explain the observed matter-antimatter asymmetry. The electron EDM, which is the possible signal of the T-violation predicted by the Standard Model (SM) is too small to be measured with current experimental technique and the larger EDM would indicate a new physics beyond SM. This tiny EDM for the electron can be enhanced by the relativistic effects in the heavy atoms such as francium (Fr).

In this report, we will see the overview of the experiment of the search for EDM using two isotopes of Fr developed at RIKEN. One is ^{210}Fr , produced by a nuclear fusion-evaporation reaction between gold target and oxygen beam supplied from AVF cyclotron, and the other is ^{221}Fr , produced from the alpha decay of ^{225}Ac , which can be used as the generator for ^{221}Fr , and has a long lifetime ~ 10 days. Both isotopes have large enhancement factor of 895 compared with electron EDM, which can be calculated very precisely with the relativistic coupled cluster theory. The ^{221}Fr nucleus has, on the other hand, a large octupole deformation effect and can become the candidate to search for the nuclear EDM.

We conducted the high intensity surface ionizer to produce the Fr ions, the neutralizer which is used to recombine the electron to the Fr ion, and the Magneto-optical trap (MOT) for the Fr cooling and trapping. All the experimental apparatus were successfully developed and operated, and also the development of the new experimental apparatus to produce the high intensity ^{225}Ac source, and laser cooling for ^{221}Fr is now in progress. The present status and expected sensitivity for the EDM with the trapped cold Fr atoms will be discussed.

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