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Transportation of a radioactive ion beam for precise laser-trapping experiments

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A radioactive francium (Fr) atom is known to enhance the effect of an atomic parity violation and an electric dipole moment, which means the violation of the time-reversal symmetry, due to its large nucleus. We are aiming at a discovery of the violation of fundamental symmetries by precision measurements of such observables using laser-trapped neutral Fr atoms.

Fr is produced through the nuclear fusion reaction between an oxygen beam and a gold target. The produced Fr is ionized at the surface of the gold target and is transported by electrostatic fields corresponding to a few keV. A problem was revealed that the purity of the produced ion beam was quite low because of impurities contained within the materials. The low-purity beam degrades the efficiency of the laser trapping. Therefore, a Wien filter was installed to purify the beam by mass separation. Accordingly, the purity was improved approximately 1000 times and it will lead to an improvement of the trapping efficiency. We report results obtained from the Wien filter experiment.

An imperceptible beam transportation has also been studied using stable rubidium isotopes to simulate a procedure from the production to the laser trapping of the radioactive element. Additionally, a newly-designed Fr ion source is developed to increase a production yield.