Simulation study for systematic uncertainty suppression in nEDM experiment assuming various surfaces roughness

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The neutron intrinsic electric dipole moment (nEDM) is sensitive to new physics beyond the standard model and could prove to be new source of CP violation. Several experiments are being planned worldwide for its high-precision measurement.

The nEDM can be measured as the ultracold neutron (UCN) spin precession in a storage bottle under homogeneous electric and magnetic fields. In those experiments, when UCNs are in certain ordered motion, systematic uncertainties due to the relativistic magnetic field connected with a longitudinal magnetic field gradient in the storage bottle become enhanced, and could comparable to the nEDM that we expect. They are associated to various complex factors such as the inhomogenity of magnetic field, a geometrical configuration of storage volume, and its surfaces roughness. Therefore, simulation study is essential to reduce them.

Non-specular reflection occurring at storage volume's sidewalls, which rough surfaces induce, can suppress the systematic uncertainties effectively. With micro-roughness model, formulated by Steyerl [1], we can implement it in simulation study.

Using Geant4UCN simulation framework incorporated into micro-roughness model, we simulated 100 sec UCNs storage in the cylindrical volume whose radius and height are 6cm and 10 cm, respectively, with surfaces roughness 0.7 nm, 1.4 nm, and 2.1 nm RMS; where the 10 kV/cm and 10 μ T electric magnetic fields are applied; UCNs rotate with 3m/sec from an initial point in order to represent UCNs certain ordered motion. Their simulation allow us to understand how effectively surfaces roughness suppress systematic uncertainties. We will report on the result obtained from the analysis of them.

References

[1] A.Steyerl, Z.Phys. **254**,169 (1972).