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A Search for the Electric Dipole Moment of the Neutron

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The experimental search for a neutron electric dipole moment could reveal new sources of time-reversal (T) and charge-conservation-and-parity (CP) violation and challenge proposed extensions to the Standard Model. The goal of the present experiment is to improve the measurement sensitivity of the neutron EDM by two orders of magnitude.

The physics goals of this experiment remain timely and of unquestioned importance. There is ample reason to expect a nonzero value for the neutron EDM: many theories predict EDM values within the six orders-of-magnitude window between the current limit and the value allowed by the Standard Model. The results of this experiment could make a significant complementary contribution to the search for new physics at the Large Hadron Collider (LHC).

The experiment is based on the magnetic-resonance technique of rotating a magnetic dipole in a magnetic field. Polarized neutrons and polarized 3He atoms are confined in a bath of superfluid 4He at a temperature of 450 mK. When placed in an external magnetic field, both the neutron and 3He magnetic dipoles precess in the plane perpendicular to the magnetic field. The neutron EDM is determined from the difference in the precession frequencies of the neutrons and the 3He atoms when a strong electric field is applied either parallel or anti-parallel to the magnetic field. The 3He serves as a volume comagnetometer to minimize magnetic-field systematic effects. Due to shielding effects, 3He should have a negligible electric dipole moment.

Improvements over previous experiments arise from an increased electric field due to the excellent dielectric properties of superfluid 4He, an increase in the total number of ultracold neutrons (UCNs) stored, and an increased measurement time due to the longer storage of UCN in the cryogenic container.

I will review the present status of the construction of the nEDM experiment and outline its role within the context of the international efforts to measure electric dipole moments.

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