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The search for electric dipole moment of charged particles using storage rings

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One of the main problems of modern particle physics is the inability of the Standard Model (SM) of Particle Physics to explain the matter-antimatter asymmetry in the Universe. The pursuit of physics beyond the SM is required and one way to achieve it is to strive for the highest precision in the search for electric dipole moments. Permanent electric dipole moments (EDMs) of particles violate both time reversal and parity invariance and, through the CPT-theorem they also violate the combined CP symmetry. Therefore, EDM measurements of fundamental particles are capable to probe new sources of CP-violation, and finding an EDM would be a convincing indicator for physics beyond the Standard Model.

Up to now, EDM searches focused on neutral systems (neutrons, atoms, molecules). Storage rings, however, make it possible to measure EDMs of charged particles by observing the effect of the EDM on the spin motion in the ring [1], [2], [3]. The direct search for proton and deuteron EDMs bears the potential to reach sensitivity beyond 10^{-29} e cm. The Cooler Synchrotron COSY at the Forschungszentrum Jülich provides polarized protons and deuterons with momenta up to 3.7 GeV/s, which is an ideal testing ground and starting point for such an experimental program. The JEDI collaboration is currently aiming at the first direct (precursor) measurement of the deuteron EDM in COSY. Beyond that, the technical design of the prototype EDM storage ring is the next milestone of the JEDI research program.

The talk will present the JEDI program for the measurement of proton and deuteron EDMs, and discuss the various technical developments, and show recent results.

References

[1] F. Abusaif *et al.*, arXiv: 1912.07881,
[2] F. Rathmann *et al.*, Phys. Rev. Accel. Beams **23**, 024601 (2020),
[3] A. Saleev *et al.*, Phys. Rev. Accel. Beams **20**, 072801 (2017).

Collaboration

JEDI (Jülich Electric Dipole moment Investigations)

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