

EDM Experiments at Storage Rings

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According to our present understanding, the early Universe contained the same amount of matter and antimatter and, if the Universe had behaved symmetrically as it developed, every particle would have been annihilated by one of its antiparticles. One of the great mysteries in the natural sciences is therefore why matter dominates over antimatter in the visible Universe. The breaking of the combined charge conjugation and parity symmetries (CP-violation, CPV) in the Standard Model of particle physics (SM) is insufficient to explain this and further sources of CPV must be sought. These could manifest themselves in electric dipole moments (EDMs) of elementary particles, which occur when the centroids of positive and negative charges are mutually and permanently displaced. An EDM observation would also be an indication for physics beyond the SM.

No EDM has been observed so far; after its discovery, investigations on different systems will be required to pin down CPV sources. In this respect the idea to search for EDMs of charged hadrons (i.p. proton and deuteron) in a new class of precision storage rings has recently been put forward. In addition such searches bear the potential to reach sensitivities of 10^{-29} e cm.

The EDM measurement principle, the time development of the polarization vector subject to a perpendicular electric field, is simple, but the smallness of the effect makes this an enormously challenging project. A stepwise approach, from R&D for key-technologies towards the holy grail of a double-beam precision storage ring with counter-rotating beams, is needed. The ongoing research of the JEDI Collaboration at the cooler synchrotron COSY of Forschungszentrum Jülich (Germany) provides invaluable information: recent experimental milestones will be presented and discussed.

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