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JEDI and beyond – the quest for EDMs of charged particles

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The detection of an electric dipole moment (EDM) of elementary particles can shed light on two nagging questions of contemporary particle physics and cosmology. These are the excess of matter over antimatter, which is related to the strength of the CP symmetry violation, and the composition of dark matter (DM), which comprises a large fraction of the energy content of the Universe. In order to measure the EDM of charged particles, storage rings equipped with polarimeters have been proposed. A non-zero EDM interacting with the electric field of the ring in the particle rest frame would lead to a torque rotating the particle´s spin, which is parallel to the EDM vector. The resulting change in beam polarisation is the observable allowing one to deduce the EDM value. Though simple in its principle, the method is very challenging, since the smallness of the sought effect requires unprecedented precision in the ring construction, operation and monitoring, and thus demands many new developments.

On the roadmap towards such storage-ring based EDM measurements, a stepwise approach has been adopted. Pioneering efforts of the JEDI collaboration, exploiting the existing COSY synchrotron of Forschungszentrum Jülich, have led to the first-ever measurement for the deuteron. Along with that, an attempt to search for oscillating EDMs as an indication for axions or axion-like particles – presumed DM-candidates - has been undertaken. The results of those experiments will be reported. Next steps will also be envisaged. They comprise development of the key technologies to construct a precursor, 100-m circumference ring with electrostatic deflectors as well as magnetic elements, featuring clockwise and counter-clockwise beams. The concept, once proven, would then be extended into a full-glory all-electric 500-m ring for highest EDM sensitivity.

Presenter: WROŃSKA, Aleksandra (Jagiellonian University)