Working Group #1

Measurement of Electric Dipole Moments in Storage Rings

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Permanent Electric Dipole Moments (EDMs) of fundamental particles violate both time invariance and parity. Assuming the CPT theorem, the violation of time invariance implies CP violation. The CP violation of the Standard Model is orders of magnitude too small to be observed experimentally in EDMs in the foreseeable future. Since it is also too small to explain the observed excess of matter over antimattter in our universe, other mechanisms beyond the realm of the Standard Model must be at play. High precision measurements of EDMs therefore provide a valuable means to search for physics beyond the Standard Model such as supersymmetry, multi-Higgs models, for instance [1, 2].

EDM experiments with charged hadrons are proposed at storage rings where polarized particles are exposed to an electric field. If an electric dipole moment exists, the spin vector will experience a torque resulting in change of the original spin direction which can be determined using elastic scattering of the beam particles on a carbon target. Although the principle of the measurement is simple, the smallness of the expected effect makes this a challenging experiment requiring new developments in various experimental areas.

In the working group test measurements should be designed to measure important properties of a polarized particle beam [3, 4]. One is the spin coherence time: A particle ensemble with perfectly aligned spin vectors will decohere after a certain time. This time scale is described by the spin coherence time. Another important quantity is the the so called spin tune. As in an NMR experiment spin vectors precess in the magnetic field of the accelerator. The number of spin rotations per particle revolution is defined as the spin tune.

The objective of the working group is to design an experiment to determine the spin tune and the spin coherence time. Students should get acquainted with the spin motion in electro-magnetic fields described by the Thomas BMT equation. Furthermore, the relation of (spin dependent) cross sections and counting rates in a detector will be discussed. Students should understand how one can extract from the measured counting rates the desired quantities, the spin coherence time and the spin tune.

References

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[3] G. G. Ohlsen, Rept. Prog. Phys. **35** (1972) 717.

[4] V. Bargmann, L. Michel and V. L. Telegdi, Phys. Rev. Lett. **2** (1959) 435.