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Colliding beam elastic pp and pd scattering to test T- and P-violation

To test T- and P-violation by proton EDM requires an electric storage ring (SR) with simultaneously counter-circulating, frozen-spin proton beams. The CPEDM feasibility study proposes a low-energy prototype ring with superimposed electric and magnetic bending storing frozen-spin 49.65 MeV (clock-wise) protons and pseudo-frozen spin 24.73 MeV (counter-clockwise) protons; *pd* combinations are also practical and interesting.

Such a SR in the collider mode can be used to search for beyond Standard Model semi-strong T-violation in elastic *pp* or *pd* scattering. Suggested by Lee & Wolfenstein, Prentki & Veltman and Okun, as a source of CP-violation, it still awaits the experimentum crucis.

Initial spin states are guaranteed by phase-lock technique developed by JEDI; a comparison of polarization effects in the direct and time-reversed reactions requires matching polarimetry of final-state particles. The notable exception is T-violation in collisions of vector polarized protons and tensor polarized deuterons.

Full final state polarimetry stops the scattered particles in azimuthally symmetric full acceptance tracking chambers of the polarimeter, totaling 3π sr. This high-efficiency polarimetry is feasible only because the scattered particles are soft enough to be stopped in the polarimeter, making collider experiments much superior to fixed target experiments.

Besides a comparison of the analyzing powers to final-state single-particle polarizations, an access to T-violation in double-spin observables will be possible. With a *pp* luminosity of 0.6 $\mathrm{mb}^{-1}\mathrm{s}^{-1}$, producing 10^8 elastic scatters per year, the time-reversal violation upper limits, currently at the level of a few 1%, could be lowered by more than one order in magnitude.

Primary frontier topic

Rare Processes and Precision Measurements Frontier

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