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Measurement of Electric Dipole Moments in Storage Rings

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The existence of permanent electric dipole moments (EDMs)
of elementary particles violates
two fundamental symmetries, time reversal, $\mathcal{T}$,
and parity $\mathcal{P}$.
Assuming that the combined symmetry transformation $\mathcal{CPT}$,
where $\mathcal{C}$ is the charge conjugation,
is conserved by all interactions, $\mathcal{T}$ violation is equivalent
to $\mathcal{CP}$ violation.

$\mathcal{CP}$ violation is of particular interest since it is required to
explain the dominance of matter over anti–matter in our universe.
The Standard Model (SM) predictions are several orders of magnitude
too small to account for this dominance.
Additional $\mathcal{CP}$ violating interactions are needed.
These could show up in permanent
electric dipole moments of elementary particles.

Up to now, EDM searches focused on neutral particles,
for example neutron, atoms and molecules, because charged particles are accelerated
in large electric fields and therefore cannot be kept in small volumes.
Storage rings with diameters $>$10m have to be operated to allow for charged particle EDM measurements.
Such EDM storage ring projects for proton, deuteron and light nuc\-lei are
pursued at Brookhaven National Laboratory and at
Forschungszentrum J\"ulich with the ultimate
goal to reach a sensitivity of $10^{-29} e$·cm.

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