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EDM experiments with Nuclear Probes

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Searches for violations of the fundamental discrete symmetries parity (P), time reversal (T) and charge conjugation (C) are of outmost importance for the model building in physics and looking beyond the Standard Model of the electroweak interactions (SM). Permanent electric dipole moments (EDMs) are particularly sensitive probes to look for minute violations with a robust discovery potential. The EDMs are strongly suppressed in the SM to a level far below the experimentally reachable sensitivity. However, different experiments have provides limits to possible extensions to the SM.
The effects of symmetry violations are strongly enhanced in heavy atomic systems. This permits to derive stringent limits from precision atomic physics experiment. The sensitivity of a particular experimental approach depends on several parameters. Such are: i) possible intrinsic enhancement factors due to atomic and nuclear structure [1] which are particularly large for short lived elements around the nuclear charge 86-88 (Rn, Fr, Ra) which exhibit nuclear deformations [2]; ii) the number of available particles for the experiment which are available e.g. at the ISOLDE facility for the production of heavy elements [3]; and iii) the experimental procedure. The experimental work toward an EDM measurement with heavy nuclear probes [3] and the prospects for a sensitive EDM search at ISOLDE will be discussed. Furthermore, atomic parity violation (APV) is enhanced in the same type of heavy nuclei. A measurement of the weak mixing angle with a five-fold improvement over existing experimental results is reachable with a single trapped radium ion [4].
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[2] L.P. Gaffney et al. Nature 497, 199 (2013)
[3] L. Willmann et al., "Searches for permanent electric dipole moments in Radium Isotopes", CERN-INTC-2010-049 / INTC-I-115 (2010).
[4] M. Nunez Portela et al., Applied Physics B, DOI: 10.1007/s00340-013-5603-2 (2013).

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