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Noble gas EDM measurements and noble gas magnetometry

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Spin-polarized noble gases have several attractive features for EDM measurements: 1) several species can be polarized simultaneously by spin-exchange optical pumping; 2) they can be contained in cells; 3) spin relaxation times can be long - minutes to hours providing narrow linewidths and high precision; 4) large signal to noise results from spin-polarization of high densities; 5) multiple species can provide co-magnetometry that can monitor or mitigate systematic effects arising from magnetic field fluctuations.
For example, the spin-exchange pumped noble-gas maser has been used to measure the EDM's of 3He and 3Xe simultaneously with a sensitivity on the 129Xe EDM of about 3e-27 e-cm (Phys. Rev. Lett. 86, 22 (2001)). We have begun a program to improve this measurement with the goal of an order of magnitude improvement in sensitivity.
Octupole collectivity can strongly enhance the atomic EDM because the nuclear Schiff moment depends on collective effects and on the polarizability, which in turn depends on small splitting of opposite parity nuclear states that arise in octupole deformed systems. 221Rn and 223Rn are good candidates for enhanced EDMs; however there is currently a paucity of data on the nuclear structure of these isotopes. We have initiated studies of the nuclear structure and octupole collectivity, and we have also developed apparatus to collect and polarize radon isotopes at TRIUMF (Vancouver, Canada) in preparation for Radon-EDM measurements.
Noble gas species, specifically 129Xe, are also potentially ideal candidates for a co-magnetometer for ultracold neutron (UCN)-EDM experiments (replacing the 199Hg used in the most recent ILL measurement). 129Xe has a much smaller neutron-absorption cross section and may be cooled so that the trajectories are more similar to the UCN. We have developed a new two-photon magnetometry scheme that promises to provide precision magnetometry in a volume that contains spin-polarized 129Xe. The technique is currently being studied in an analogous two-electron system: 171Yb. When combined with an improved 129Xe EDM sensitivity, this provides an attractive comagnetometer for neutron-EDM measurements.

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