D correlation measurement in the beta decay of trapped and polarized ions

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In this talk we discuss the potentials of a new technique of optical orientation of radioactive ions trapped in an open Paul trap, permitting to reach a very high degree of polarization, for β decay experiments.

More precisely, laser polarization of the alkali-earth ions $^{23}Mg^{+}$ and $^{39}Ca^{+}$ in a Paul trap and detection of the emitted electron and recoil ion shall enable the measurement of the so-called *D* correlation. *D* is a triple correlation of the form $\langle \mathbf{J} \rangle (\mathbf{p}_e \times \mathbf{p}_\nu)$ with $\mathbf{p}_e$ and $\mathbf{p}_\nu$ being respectively the momenta of the electron and the neutrino, and **J** the nuclear spin. The *D* correlation violates Time reversal. While such violation is predicted to occur in the Standard Model via the quark mixing mechanism, experimental constraints are 5 to 10 orders of magnitude lower. There is a large window in which *D*, *R* correlations and neutron EDM searches can contribute to the search for other sources of CP violation at a much higher level, which could explain for example the large matter-antimatter asymmetry observed in the Universe. The best constraints so far on *D* arise from the neutron decay and are of the order of 2×10^{-4} on coupling constants of interactions violating T. Lower constraints have been obtained from hyperon, Kaon, and nuclear decays. The latter were derived from the decay of ^{19}Ne yielding a constraint of 6×10^{-4}, limited by statistics. With the expected rates from the upgraded SPIRAL facility at GANIL, an experiment aiming at *D*-correlation measurement with an unprecedented sensitivity of the below 10^{-4} can be conceived. It is envisaged to perform a proof-of-principle of the laser polarization method using the laser systems of IGISOL at JYFL, together with an optimized trapping setup inspired by the one of LPCTrap used at GANIL for the measurement of the β-ν angular correlation.