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Search for Time-Reversal Invariance Violation in Nuclei

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The important advantage to the search for Time-Reversal invariance violation (TRIV) in neutron nuclei interactions is the possibility of an enhancement of T-violating observables by many orders of magnitude due to the complex nuclear structure (see, i.e. paper [1] and references therein). Moreover, the variety of nuclear systems to measure T-violating parameters provides assurance that a possible "accidental" cancelation of T-violating effects due to unknown structural factors related to the strong interactions in the particular system would be avoided. Taking into account that different models of the CP-violation may contribute differently to a particular T/CP-observable, which may have unknown theoretical uncertainties, TRIV nuclear effects could be considered valuable complementary experiments to electric dipole moment (EDM) measurements.

The comparison of the ratio of TRIV to parity violating (PV) coupling constants λ with the constrains on the coupling constants from the EDM experiments gives us the opportunity to estimate the possible sensitivity of TRIV effects to the value of TRIV nucleon coupling constant, which we call a "*discovery potential*" for neutron scattering experiments [2], since it shows a possible factor for improving the current limits of the EDM experiments. Then, taking the DDH "best value" [3] of $h_\pi^1 \sim 4.6 \cdot 10^{-7}$, nuclear enhancement factors, and assuming that the parameter λ could be measured with an accuracy of 10^{-5} on the complex nuclei, one shows that the existing limits on the TRIV coupling constants could be improved by two orders of magnitude, assuming that the π-meson exchange contribution is dominant for PV effects. However, there is an indication [4] that the PV coupling constant h_π^1 is much smaller than the "best value" of the DDH. Should it be confirmed by the $\vec{n} + p \to d + \gamma$ experiment, the estimate for the sensitivity of λ to the TRIV coupling constant may be increased up to two orders of magnitude. This might increase the relative values of TRIV effects by two orders of magnitude, and as a consequence, the discovery potential of the TRIV experiments could be about 10^4.

As a result we show that the TRIV effects in neutron transmission through a nuclei target are very unique TRIV observables being free from FSI, and are of the same quality as the EDM experiments. These TRIV effects are enhanced by about 10^6 due to the nuclear enhancement factor. In addition to this enhancement, the sensitivity to TRIV interactions in these effects might be structurally enhanced by about 10^2 if PV π-nucleon coupling constant is less than the "best value" DDH estimate. Therefore, these types of experiments with high intensity neutron sources have a discovery potential of about $10^2 - 10^4$ for the improvement of the current limits on the TRIV interaction obtained from the EDM experiments.

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