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Search for T-odd mechanisms beyond the Standard Model with a transversely polarized electron target?

Within the Standard Model, transverse single spin asymmetries in electron elastic scatterings arise only from multi-photon exchanges. Experiments at MIT-Bates, MAMI, JLab, where transversely polarized electron beams scatter off both hydrogen and nuclei targets, show surprising discrepancies from theoretical calculations based on unitary and optical theorem. Comparing with the unitary calculation, one may attribute the discrepancy to heavier intermediate states in two-photon exchanges (TPE) which are not included in the calculation. On the other hand, it requires the virtual photon to have large energy to excite high-energy/heavy states, one would expect contributions due to these intermediate states are small. From this point of view, the discrepancy is puzzling.

Another possible origin of these discrepancies could be T-odd mechanisms beyond the Standard Model, such as a novel T-violating interaction or an unanticipated two-boson exchange involving one virtual photon and one unknown T-conserving boson. However, the hadronic/nuclear uncertainties (such as possible intermediate states in TPE) in the theoretical calculations hamper us from investigating new physics via the transverse single spin asymmetry. In view of this, we propose to measure the transverse spin asymmetry in proton-electron (pe⃗) scattering instead of electron-proton (e⃗ p) scattering using an unpolarized proton beam and polarized electrons in a polarized hydrogen gas target, which is planned at the hadronic accelerator HIAF, currently under construction at IMP, CAS. In pe scatterings, the effective energy (or Q2) is 2~3 orders smaller than in ep scattering, only elastic intermediate state (i.e., proton) will be involved in two-photon exchanges. As a result, theory based on unitarity can provide calculations with little theoretical uncertainties. In experiments with polarized electron beams, asymmetries are usually very small due to relativistic effects. In scatterings between an unpolarized proton beam and a polarized electron target, no such effects present, as a result, the asymmetry will be larger by 4 orders, compared with e⃗ p experiments with electron beams of 1~2 GeV. Consequently, systematical errors in the experiment will be reduced significantly. Given the above advantages, the transversely polarized pe⃗ scattering could be an attractive approach to search for new physics.

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