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Model Independence of the γZ Box in Parity-Violating ep Scattering

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The γZ box correction plays a key role in precision studies of electron–proton scattering, where it impacts the determination of the weak mixing angle. Earlier calculations often relied on simplifying assumptions such as forward-scattering limits or helicity independence, which limit their applicability to real experimental conditions.

We present a new calculation that retains the full kinematic and spin dependence of the scattering amplitude, providing a more accurate description at finite momentum transfer and low energies. The results show that the correction depends strongly on the scattering conditions, highlighting the need for refined treatments. This framework improves the reliability of theoretical inputs for experiments such as P2, thereby strengthening tests of the Standard Model and searches for new physics.

Authors: DUCH, Balma (IFAE); Prof. SPIESBERGER, Hubert; Prof. MASJUAN, Pere (IFAE)

Presenter: DUCH, Balma (IFAE)

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