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Extraction of Proton Electric Form Factor and Radius from Low- Q^2 Data

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This study calculates the energy decay rates (r) for both up and down quarks and the electric form factors (G_E) of the proton using low four-momentum transfer (Q^2) data from the PRad and MaMi electron-proton scattering experiments. The extracted decay rates for u and d quarks were nearly identical with $r \approx 3.94$, demonstrating a consistent exponential decay behavior across increasing Q^2 . Moreover, analysis of the electric form factor confirmed that the calculated values closely match with PRad and MaMi data at low Q^2 , validating the model in this region. However, increasing residuals and deviations from both MaMi data and the standard dipole form factor assumption at higher Q^2 indicate the model's limitations. The results underscore the sensitivity of both decay rates and G_E to the momentum transfer range and the need for a refined theoretical framework that incorporates higher-order QED corrections and spin-spin interactions. The extracted average proton charge radius is $0.8291 \pm 0.0019(stat) \pm 0.0004(std) fm$, aligns closely with PRad results, supporting evidence for a smaller proton radius.

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