Elastic and Total Cross-Section Measurements by TOTEM: Past and Future

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The TOTEM experiment at the LHC has measured proton-proton elastic scattering in dedicated runs at \( \sqrt{s} = 2.76, 7, 8 \) and \( 13 \) TeV centre-of-mass LHC energies. The proton-proton total cross-section \( \sigma_{\text{tot}} \) has been derived for each energies using a luminosity independent method. TOTEM has excluded a purely exponential differential cross-section for elastic proton-proton scattering with significance greater than 7 \( \sigma \) in the \(|t|\) range from 0.027 to 0.2 GeV\(^2\) at \( \sqrt{s} = 8 \) TeV. The \( \rho \) parameter has been measured at \( \sqrt{s} = 8, 13 \) TeV via the Coulomb-nuclear interference, and at 13 TeV was found to be \( \rho = 0.1 \pm 0.01 \). The \( \rho \) measurement is a strong evidence of the existence of a 3-gluon bound state, predicted from theoretical models both in Regge-like and modern QCD framework.

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