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Progress on generalized parton distributions and gravitational form factors

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Masses and spins of hadrons are fundamental quantities in physics; however, their origins are not understood yet and their investigations are major purposes of building electron-ion colliders in 2030's. Both of them can be investigated by generalized parton distributions (GPDs). The t-channel or spacelike (s-channel or timelike) GPDs are studied by deeply virtual Compton scattering (two-photon processes) at charged-lepton accelerator facilities (e^+e^- collider facilities) such as the JLab, CERN-AMBER, and EICs (KEKB). Here, the s-channel GPDs are generally called generalized distribution amplitudes (GDAs) and they could be also called timelike GPDs because they contain timelike form factors. I discuss experimental prospects mainly at the e^+e^- collider KEKB, the hadron-accelerator facility J-PARC, and the Long-Baseline Neutrino Facility (LBNF) at Fermilab. It is possible to extract the s-channel GPDs and gravitational form factors of hadrons by the two-photon processes $\gamma^* + \gamma \to h + \bar{h}$, where h is a hadron. Actually, there was the first report on the determination of the gravitational form factors and radii (mass and mechanical radii were 0.32-0.39 fm and 0.82-0.88 fm for π^0) from actual experimental measurements in Ref.[1]. At J-PARC, the GPDs will be investigated by the exclusive Drell-Yan process $\pi^- p \to \mu^+\mu^- B$ [2], where the baryon B could be a nucleon or Δ. In future, other processes could be investigated for the GPDs. For example, the $2 \to 3$ reaction processes $NN \to N\pi B$ could be used for probing the GPDs in the ERBL (Efremov-Radyushkin-Brodsky-Lepage) region. In addition, the neutrino facility Fermilab-LBNF, possibly also the nuSTORM at CERN, can be used for the GPD measurement by the single-pion production processes $\nu + N \to \ell^- + N' + \pi$ and $\bar{\nu} + N \to \ell^+ + N' + \pi$ [3].

References

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