



Contribution ID: 76

Type: Talk

Results on exclusive $\pi^+\pi^-$ and $\rho(770)$ photoproduction and on collectivity in small systems obtained in ep collisions at HERA

Wednesday 8 September 2021 16:40 (18 minutes)

Exclusive photoproduction of $\rho(770)$ mesons is studied using the H1 detector at the ep collider HERA. A sample of about 900000 events is used to measure single- and double-differential cross sections for the reaction $\gamma p \rightarrow \pi^+\pi^- Y$. Reactions where the proton stays intact ($m_Y = m_p$) are statistically separated from those where the proton dissociates to a low-mass hadronic system ($m_p < m_Y < 10$ GeV). The double-differential cross sections are measured as a function of the invariant mass $0.5 < m_{\pi\pi} < 2.2$ GeV of the decay pions and the squared 4-momentum transfer at the proton vertex $|t| < 1.5$ GeV², in bins of the photon-proton energies $20 < W_{\gamma p} < 80$ GeV. Cross sections for $\rho(770)$ production are extracted as a function of t and $W_{\gamma p}$. The available energy range bridges the gap between fixed-target experiments and LHC central exclusive production. The Regge trajectory $\alpha(t)$ is extracted from these H1 data alone.

Measurements of two- and multi-particle angular correlations are presented in both ep deep-inelastic scattering at $\sqrt{s} = 319$ GeV and in photoproduction off protons at energies $W_{\gamma p} = 270$ GeV, as a function of charged-particle multiplicity. No long-range ridge structure is observed in the correlation functions. The second-order ($V_{2\uparrow}$) and third-order ($V_{3\uparrow}$) azimuthal anisotropy Fourier harmonics are extracted. Further, $C_2\{4\}$ signals are extracted from four-particle correlations for the first time in ep collisions and are found to be positive or consistent with 0. In summary, collective behavior has not been observed in collisions of protons with virtual or quasi-real photons at HERA energies.

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Session Classification: Hot and dense matter physics - QGP and heavy ion collisions

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