Scale Issues in High-Energy Diffractive Vector-Meson Production

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Recent measurements of diffractive vector-meson production with the general-purpose detectors H1 and ZEUS in electron-proton interactions with 300 GeV center-of-mass energy at the HERA accelerator complex have made possible many quantitative tests of the precepts of perturbative QCD (pQCD). The high flux of quasi-real photons from the 27.5 GeV electron beam has allowed high-statistics studies of vector-meson photoproduction to be compared to the deeply inelastic processes at high photon virtuality $Q^2 \gg \Lambda^2_{\mathrm{QCD}}$. Special-purpose electron detectors at small scattering angle have been used to identify a transition region $0.2 < Q^2 < 1$ GeV^2 where the pQCD prediction for the dominance of point-like configurations of $q\overline{q}$-pairs is verified. Data samples characterized by high momentum transfer to the 820 GeV initial-state proton, $1 < |t| < 8$ GeV^2, have now become available, and the results lend support to the idea that pQCD calculations should accurately describe the inelastic vector-meson production processes in high-$|t|$ photoproduction. Measurements of the energy dependence and the $|t|$-dependence of the elastic cross sections for ρ, ω, ϕ, and J/ψ production have provided tests of the proposal that the mass (or size) of the vector meson provides a third scale which can be used to study the transition to the domain of pQCD validity. A preliminary result on elastic Υ production has also been announced by the ZEUS collaboration. These issues of scale will be discussed in the context of topical phenomenological models, comparing the HERA results and those from fixed-target experiments at lower energy to the wealth of calculations available in the contemporary literature.