CEBAF EXPERIMENT 93-031

Photoproduction of Vector Mesons at High t

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At low values of momentum transfer t, photoproduction of vector mesons occurs mainly through the photon coupling to intermediate vector meson states which diffractively scatter from the target. This corresponds to the Vector Meson Dominance Model (VDM), and the cross section depends only on the size of the meson and the target. At high t, hard processes are expected to take over and the production is thus more sensitive to quark and gluon exchange mechanisms.
ρ and ω production proceed mainly through valence quark rearrangement mechanisms and exhibit a s^{-8} behavior at large t. On the contrary, ϕ production proceeds mainly through two gluon exchange: to the extent that it is a pure s-$\overline{s}$ state, quark exchange is OZI suppressed if the strangeness content of the nucleon is small. If indeed ϕ production on the proton is dominated by two gluon exchange, it will be a unique way to study hidden color components in nuclei.

The aim of the proposed experiment is to measure the t dependence of the photoproduction of ρ, ω and ϕ mesons on the proton and helium-3 up to values of t around 5 GeV^2. Scarce data exist in this range for ρ and ω production. They have however been obtained with a bremsstrahlung photon beam and no complete identification of the final state has been achieved. No data exist for ϕ production for t > 1 GeV^2. At such high values of momentum transfer, hard processes are dominating and ϕ production is much supressed as compared to ρ and ω production. If the ϕ production proceeds via two gluon exchange, we expect a dip in the t dependence near t = -2.3 GeV^2. It arises from the interference of two amplitudes: in the first one both gluons couple to a single strange quark, in the second one gluon couples to s and the other one to $\overline{s}$.

This experiment will make use of the tagged photon beam in Hall B and of the CLAS to detect the recoiling proton and the ρ, ω and ϕ by their decay channels $\pi^+\pi^-$, $\pi^+\pi^-\pi^0$ and K^+K^- respectively. CLAS will be operated at its highest field to get the best reconstructed meson mass resolution, and we will trigger on two positive charged particles outbending. Pion-kaon separation is achieved using ToF information and kinematic correlations. The good tagger resolution always allows a clean background rejection. The polarization of the ϕ will be measured by analysing the angular distribution of the kaons and may give interesting information on the strange content of the proton. Data for the reaction $\gamma p \rightarrow K^-\Lambda$ and $K^+\Sigma$ at high t will be recorded in the same energy range. The experiment will be run at CEBAF nominal energy of 4 GeV, and will greatly benefit of any increase of CEBAF's energy.