Scattering of photons and vector mesons off nucleons[G]

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To leading order in the baryon density, the properties of vector mesons in nuclear matter are determined by the vector-meson nucleon scattering amplitudes. Since these amplitudes are not directly constrained by data, there are presently large theoretical ambiguities in predictions of the vector-meson spectral densities in nuclear matter. We address this problem by implementing the constraints from data on pion- and photon-nucleon reactions in a systematic way [1]. The framework for this calculation is a coupled-channel approach for meson-baryon and photon-baryon scattering, including the $\gamma N, \pi N$, ρN, ωN, $\pi\Delta$, ηN, $K\Lambda$ and $K\Sigma$ channels where the interaction kernel is approximated by quasi-local 4-point interaction vertices. Nucleon and isobar resonances are generated dynamically. In such a scheme the amplitudes for experimentally non-accessible processes like ρN and ωN scattering are constrained by the data on elastic πN scattering and inelastic reactions like the pion- and photon-induced production of vector mesons. Here we report on the role of the photo-induced reactions in the determination of the vector meson-nucleon scattering amplitudes.

The description of photon-induced reactions is based on an assumption of the vector-meson dominance type which directly relates the electromagnetic quasi-local 4-point interaction vertices to the corresponding vertices involving the ρ and ω fields. Given the model for the hadronic reactions, this allows us to compute a wealth of data on photo-induced reactions with a minimal extension of the model. This is particularly useful, since we find that the available data sets on hadronic reactions does not uniquely determine hadronic model parameters. Furthermore, the generalized vector-meson dominance assumption provides a constraint on the otherwise undetermined relative phases of amplitudes involving ρ_0 and ω mesons. This phase is needed e.g. in calculations of e^+e^- pair production off nucleons [2] and of inelastic electron-nucleon scattering.

We obtain a reasonable description of the $\gamma p \to \pi N$ multipole amplitudes, the πN elastic scattering data as well as the photo- and pion-induced production reactions. In Fig. 1 the d-wave electric $E_{2-}(D_{13})$ and magnetic $M_{2-}(D_{13})$ multipole amplitudes are shown as illustrative examples. We emphasize that an improved description of the latter multipole amplitudes is expected once ρN and ωN states with subleading angular momentum characteristics are considered. For a detailed discussion of our results we refer the reader to [1]. We note that in our model, which accounts only for s-wave vector-meson nucleon interactions, the cross section is expected to fall short in channels where the long-ranged one-pion interaction can contribute and leads to important strength in non-s-wave-like ρN or ωN states. This is the case e.g. in the reaction $\gamma p \to \omega p$ shown in Fig. 2. The main effect of the inclusion of photo-induced reactions is a stabilization of the solution in the $S11$ channel and a fairly strong suppression of the ρ-meson coupling to the $N(1520)$ resonance compared to previous analyses [5].

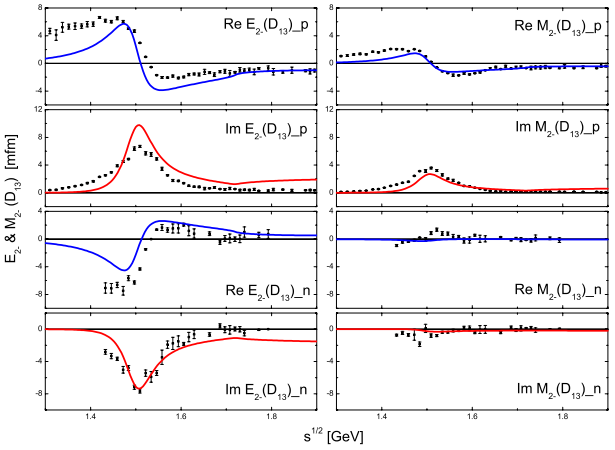

Figure 1: The $E_{2-}(D_{13})_{p,n}$ and $M_{2-}(D_{13})_{p,n}$ multipole amplitudes for photo-induced pion production compared to the SM00 solution of Arndt *et al.* [3].

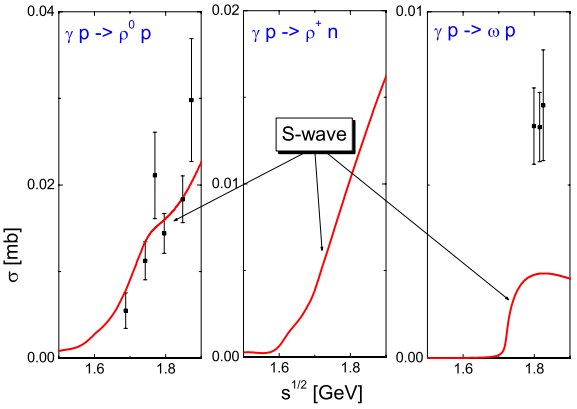

Figure 2: Photo-induced vector-meson production cross section. Data from [4]

References

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