

$\pi N \rightarrow \omega N$ in a Coupled-Channel Approach

G. Penner and U. Mosel
University of Giessen

For pion-induced dilepton production at HADES an understanding of the elementary reactions on the nucleon is mandatory. Here, because of vector meson dominance, the vector meson production plays a special role.

With this aim in mind we developed in [1] a unitary coupled-channel effective Lagrangian model that already incorporated the final states γN , πN , $2\pi N$, ηN , and $K\Lambda$ and was used for a simultaneous analysis of all available experimental data on photon- and pion-induced reactions on the nucleon. In an extension of the model to higher c.m. energies, i.e. up to center of mass energies of $\sqrt{s} = 2$ GeV for the investigation of higher and so called hidden nucleon resonances, the consideration of other final states becomes unavoidable and hence the model is extended to also include $K\Sigma$ and especially ωN . However, the ωN channel resisted up to now a theoretical description in line with experiment. Especially the inclusion of nucleon Born contributions overestimated the data at energies above 1.77 GeV and only either the neglect of these diagrams or very soft formfactors led to a rough description of the experimental data. Our analysis differs from previous investigations on $\pi N \rightarrow \omega N$ since a larger energy region is considered, which means there are more restrictions from experiment. Furthermore, due to rescattering being of great importance (s. fig. 1), the reaction process is influenced by all other channels and vice versa. This leads to strong constraints in the choice of ωN contributions and it is therefore possible to extract them more reliably. The calculation presented

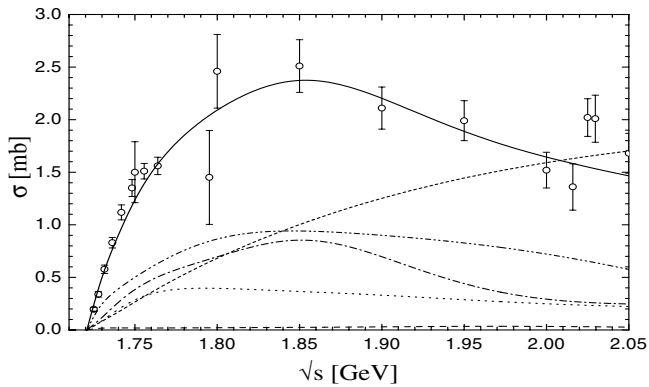


Figure 1: $\pi^- p \rightarrow \omega n$ total cross section. The contributions of various partial waves are given by $J^P = \frac{1}{2}^- (S_{11})$: dashed, $\frac{1}{2}^+ (P_{11})$: dotted, $\frac{3}{2}^+ (P_{13})$: dash-dot, $\frac{3}{2}^- (D_{13})$: dash-dot-dot (in brackets the πN notation is given). The sum of all partial waves is given by the solid line, short dashed is the same coupling set, but ignoring rescattering.

here lead to an overall χ^2 of 3.08 per degree of freedom by comparison to a total of 2360 data points in the channels $\pi N \rightarrow \pi N$, $2\pi N$, ηN , $K\Lambda$, $K\Sigma$, ωN , where for the last one alone the χ^2 resulted in 2.53. There were claims in the literature that the threshold data of $\pi N \rightarrow \omega N$ [2]

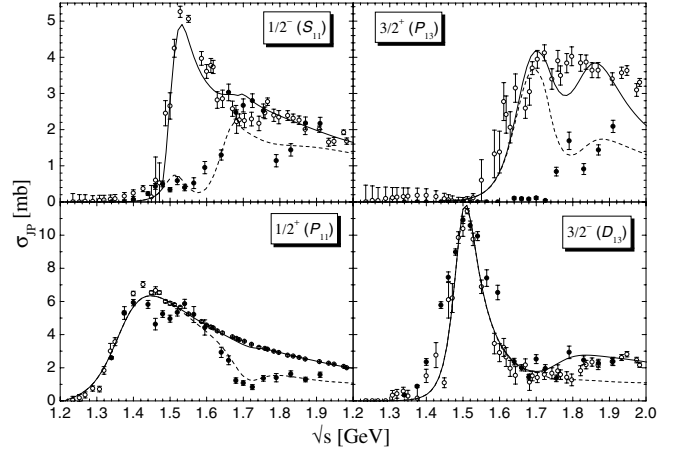


Figure 2: $\pi N \rightarrow \pi N$ inelastic (\circ as extracted from SM00 [4], calculation: solid line) and $\pi N \rightarrow 2\pi N$ partial-wave cross sections (\bullet as extracted by [5], calculation: dashed line), both for $I = \frac{1}{2}$.

(as presented in fig. 1) – being an important input of our calculations – were incorrectly extracted from the experimental count rates. However, as we show in [3], these data points were indeed correctly deduced.

The total ωN cross section (cf. fig. 1) is dominantly composed of two partial waves contributing with approximately the same magnitude $J^P = \frac{3}{2}^- (D_{13})$ and $\frac{3}{2}^+ (P_{13})$, and also a smaller $\frac{1}{2}^+ (P_{11})$ contribution, while the $\frac{1}{2}^- (S_{11})$ partial wave is almost negligible (in brackets the πN notation is given). The main contributions in these partial waves stem from the $D_{13}(1950)$, the $P_{13}(1720)$, the nucleon, and the $P_{11}(1710)$. The $D_{13}(1950)$ is especially interesting, since it is only listed in the PDG at 2.08 GeV, but was already found as an important contribution in πN and $K\Lambda$ channels (cf. [1]) at around 1.95 GeV. In our calculation it turns out to be an important production mechanism as well, in particular at threshold. Since the data in all other channels (including πN inelasticities and $2\pi N$ partial wave cross sections in the isospin $\frac{1}{2}$ partial waves, s. fig. 2) are also very well described in the ωN threshold region ($1.72 \text{ GeV} < \sqrt{s} < 1.76 \text{ GeV}$), our partial wave decomposition of $\pi N \rightarrow \omega N$ is on safe grounds.

References

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