e^+e^--pair production in π^-p reactions

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The cross section for the reaction $\pi^- p \to e^+e^-$ is computed, using vector-meson dominance and the amplitudes for the processes $\pi^- p \to \rho^0 n$ and $\pi^- p \to \omega n$, obtained in a coupled channel analysis of meson-nucleon scattering at energies near the threshold for vector-meson production [1]. These amplitudes are sensitive to the coupling of the vector mesons to baryon resonances below the vector meson production threshold. Data that directly reflect these amplitudes would provide very useful constraints on the dynamics of vector mesons propagation in nuclear matter and e^+e^- pair production in heavy-ion collisions. The $\pi^- p \to e^+e^- n$ reaction offers the possibility to experimentally test the pion induced vector meson production amplitudes below threshold. The interference of the two light vector mesons in the e^+e^- channel is sensitive to the magnitudes and the relative phase of the ρ^0 and ω production amplitudes (see Fig. 1). An experimental test of the N*Nρ^0 and N*Nω vertices through the $\pi^- p \to e^+e^- n$ reaction below the vector meson production threshold would be a most valuable constraint on the in-medium propagation of ρ^0- and ω-mesons.

We shall restrict our discussion to e^+e^- pairs of invariant masses ranging from 0.5 to 0.8 GeV. The exclusive measurement of the $e^+e^- n$ outgoing channel ensures that the e^+e^- pairs come from vector meson decays (pseudoscalar mesons decay into an e^+e^- pair and an additional photon). We note however that only s- and d-wave pion-nucleon resonances are at present included in the model of Ref. [1]. To be complete, the description of the $\pi^- p \to e^+e^- n$ reaction in the energy range discussed in this work ($1.2 < \sqrt{s} < 1.8$ GeV) should include also the effect of other partial waves.

The magnitude of the $\rho^0 - \omega$ interference in the $\pi^- p \to e^+e^- n$ is illustrated in Fig. 2, where we show the cross section for this reaction as function of the total center of mass energy. We have selected e^+e^- pairs of invariant mass m=0.55 GeV. This figure elucidates the role of baryon resonances with masses in the range of 1.5 to 1.6 GeV in generating strong interference effects.

Above the vector meson threshold, the $\rho^0 - \omega$ interference in the $\pi^- p \to e^+e^- n$ cross section is particularly interesting for e^+e^- pair invariant masses close to the ω mass. This effect is manifested in the invariant mass spectrum shown in Fig. 3 ($\sqrt{s}$=1.8 GeV). The model of Ref. [1] for the $\mathcal{M}_{\pi^- p \to \rho^0 n}$ and $\mathcal{M}_{\pi^- p \to \omega n}$ amplitudes predicts a constructive interference at this energy. This feature appears to be a very sensitive test of the model.

References

[1] M. Lutz, G. Wolf and B. Friman, Nucl. Phys. **A 661** (1999) 526*c* and Proc. of Hirschegg 2000.

[2] M. Lutz, B. Friman and M. Soyeur, in preparation.

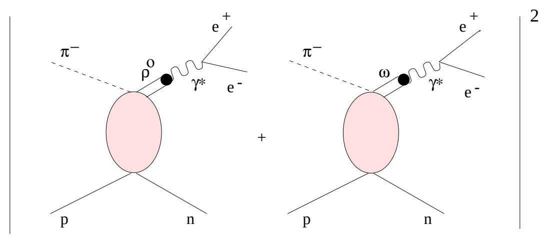

Figure 1: Squared amplitude for the $\pi^- p \to e^+e^- n$ reaction with intermediate ρ^0- and ω-mesons.

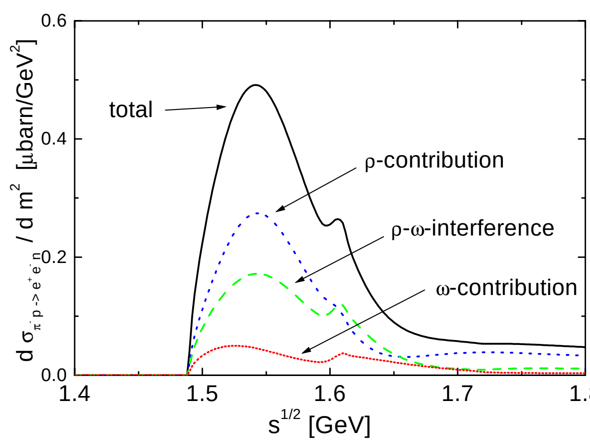

Figure 2: Differential cross section dσ/dm^2 for the $\pi^- p \to e^+e^- n$ reaction as function of $\sqrt{s}$ for a fixed e^+e^- pair invariant mass m=0.55 GeV.

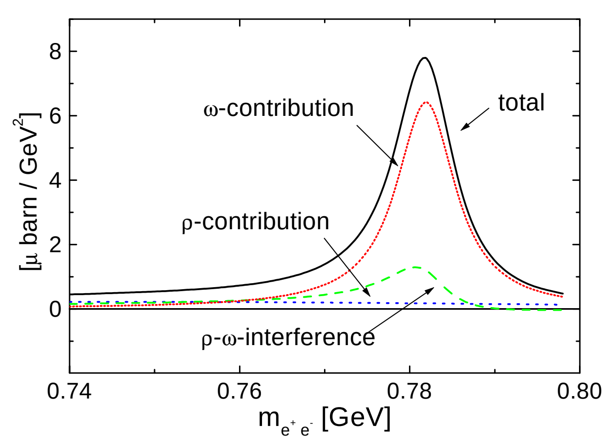

Figure 3: Differential cross section dσ/dm^2 as function of the e^+e^- pair invariant mass for a fixed total center of mass energy $\sqrt{s}$=1.8 GeV.