

Estimate of the backward elastic π^-d scattering cross section at 3.7 GeV/c

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We determine the upper bound of the backward elastic π^-d scattering cross section at an initial π^- -meson momentum 3.7 GeV/c, namely, $d\sigma\pi^-d/d\Omega_{180^\circ} \leq 3.7 \times 10^{-32}$ cm²/sr.

We attempted to measure the backward elastic π^-d scattering cross section at an initial π^- -meson momentum 3.7 GeV/c using a 1.5-meter spectrometer with an optical spark chamber in a magnetic field. A detailed description of the installation is given in^[1]. To study the π^-d scattering, a target of solid deuterium, 15 cm long, was placed inside the spark chamber. The events were registered in the case when the system of the scintillation counters isolated at least a positive particle emitted from the target forward, with a momentum larger than 700 MeV/c, and a backward particle. Among the selected 3609 two-prong events, we found not a single one corresponding to the kinematics of elastic πd scattering. This means that the upper bound of the differential cross section at $-0.9 \leq \cos\theta_{\text{cms}} \leq -1$ (at a confidence level 90%) is

$$\frac{d\sigma\pi^-d}{d\Omega_{180^\circ}} \leq 3.7 \cdot 10^{-32} \text{ cm}^2/\text{sr}.$$

The obtained limiting value of the cross section is much smaller than the previously known values of $d\sigma^{\pi d}/d\Omega_{180^\circ}$ at initial π^- -meson momenta $P_{\pi^-} \geq 1$ GeV/c,^[2,3] and indicates that the exponent in the energy dependence of the cross section for backward elastic πd scattering

$$d\sigma^{\pi d}/d\Omega_{180^\circ} \sim P_{\pi^-}^n \quad (1)$$

is $n \geq 3$. Apparently, the energy behavior of $d\sigma^{\pi d}/d\Omega_{180^\circ}$ can be described by a relation of the type (1) with $n \sim 4.8$ in the entire range of experimental data,^[2-4] start-

ing with $P_{\pi^-} \geq 250$ MeV/c, with the exception of the resonant irregularities. The hypothesis of exchange of two baryon Regge trajectories leads to a value $n = 3-5$.^[5]

The cross section for backward πd scattering, roughly speaking, is smaller by two orders of magnitude than the cross section for elastic pd scattering at the same momentum of the incident particles. This relation can be easily understood qualitatively within the framework of the concept of baryon exchange in the u channel, for in the case of pd scattering there is exchange of one baryon, and in the case of πd scattering two baryons are exchanged. The latter is less probable. At an initial momentum 1.3 GeV/c, we know the cross section for backward elastic $p\text{He}^3$,^[6] where exchange of two baryons in the u channel can also be proposed. The cross section $d\sigma^{p\text{He}^3}/d\Omega_{170^\circ}$ is close to the cross section $d\sigma^{\pi d}/d\Omega_{180^\circ}$ at the corresponding momentum.

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