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Elastic scattering of 179.3 MeV antiprotons by deuterium

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The angular distribution for elastic scattering of 179.3 MeV antiprotons by deuterium has been measured. The data should provide further constraints on the elementary p̄-n amplitudes.

Recent accurate measurements of low-energy antiproton elastic scattering by nuclei ranging from ^{12}C to ^{208}Pb have made it possible to determine unambiguously the main features of the p̄-nucleus interactions.[1,2] In addition, in order to get more information on the p̄-n elementary amplitudes, which cannot be studied directly, we have compared the 178.4 MeV p̄ elastic scattering by ^{16}O to that by ^{18}O, for which the relative weight of the p̄-p and p̄-n amplitudes is different. A possible cause of the differences observed in the relative behavior of the experimental data versus Kerman-McManus-Thaler-type calculations for the oxygen isotopes was the uncertainty in the elementary p̄-n amplitudes.[3]

Another and more direct way to probe the p̄-n amplitudes consists of analyzing the data for elastic scattering of antiprotons by deuterium. Such a procedure has been used by Ming Ma and Smith,[4] who determined the p̄-nucleon amplitudes from a Glauber analysis of p̄-deuterium elastic scattering data at higher energies (from 1.6 GeV/c to 2 GeV/c), unfortunately without discrimination between protons and neutrons. They showed, in particular, the strong dependence of the shape of calculated angular distributions, around the first minimum and the second maximum, on the value of the ratio of the real to imaginary parts of the elementary p̄-nucleon amplitudes. As the only existing data for p-D elastic scattering at low energy (170 MeV) are strongly contaminated by nonelastic processes[5] we have measured the elastic scattering of 179.3 MeV p̄ by deuterium. We had two goals: (i) to provide data for probing the p̄-n amplitudes, and (ii) to

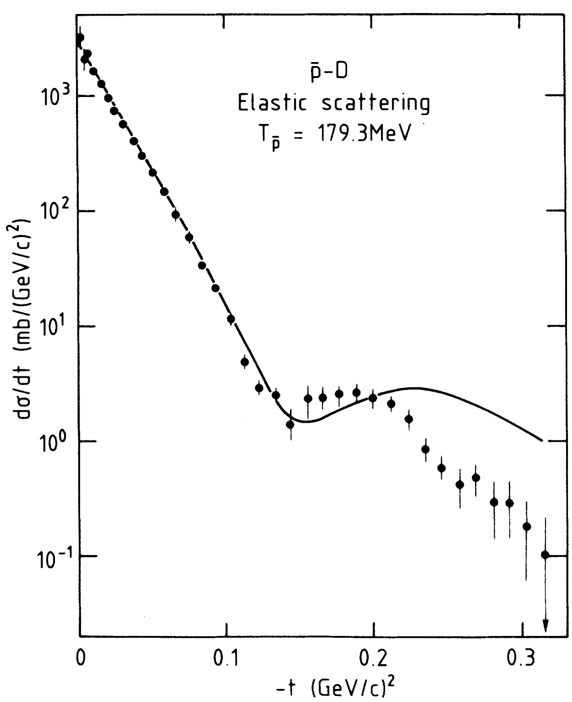

FIG. 1. Differential cross section for 179.3 MeV p̄ elastic scattering by deuterium. The experimental data (filled circles) are compared to Glauber calculation by Mahalanabis (see Ref. 6). The p̄-nucleon amplitudes have the classical Gaussian parametrization with $\sigma_p = 142$ mb, $\alpha_p = 0.21$, $\beta_p = 21.8$ (GeV/c)^2, $\sigma_n = 140$ mb, $\alpha_n = 0.135$, and $\beta_n^2 = 21.6$ (GeV/c)^2.

complete one systematic study of the p̄-nucleus interaction.

We have used the 612 MeV/*c* antiproton beam from LEAR to bombard a 1 g/cm^2 CD_2 target. The scattered antiprotons were detected by means of the SPES II magnetic spectrometer facility. More detailed information about the experimental setup may be found in Ref. 6. The angular distribution has been measured from 5° to 63.3° in the laboratory in angular bins of 1.67°. At each angle we have also measured under the same conditions the antiproton scattering by a 0.75 g/cm^2 carbon target in order to subtract the carbon contaminations below the D_2 elastic peak. This subtraction has been taken into account in the displayed errors bars. The absolute normalization uncertainty is 10%.

Data are shown in Fig. 1 together with the results of a Glauber calculation by Mahalanabis.[7] The calculation reproduces fairly well the experimental data up to $-t=0.14$ $(GeV/c)^2$. At large angles the discrepancy between the calculation and the experiment may be attributed to the form of the amplitudes used, but also to the doubtful validity of the Glauber theory at large momentum transfers. Bendiscioli *et al.*[8] have analyzed our data for ^{12}C, ^{40}Ca, and ^{208}Pb, adjusting the p̄-n amplitude parameters in order to fit the data by a Glauber calculation. Their analysis resulted in a parameter set for the p̄-n elementary amplitude almost independently of the target nucleus. Such an analysis should be extended to include our p̄-D data. On the other hand, a similar analysis, using only the existing p̄-D data, including ours, would provide information on the energy dependence of the p̄-n elementary amplitude.

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