TOTAL CROSS SECTION FOR INTERACTION BETWEEN PROTONS AND 8.3-BeV *NEUTRONS*

L. OZHDYANI, V. S. PANTUYEV, M. N. KHACHATURYAN, and I. V. CHUVILO

Joint Institute for Nuclear Research

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The total neutron-proton interaction cross section was measured for a mean effective neutron energy $8.3\,^{+1.2}_{-1.3}$ BeV (in the l.s.) under good geometry ($\theta/2 = 0.228°$). The total cross section was found to equal 41.2 ± 2.6 mb.

THE total cross section for the interaction between neutrons and protons was measured at the proton synchrotron of the Joint Institute for Nuclear Research by the attenuation of a neutron beam under conditions of good geometry ($\theta/2 = 0.228°$).

We used in the experiment a neutron beam produced in a beryllium target 10 cm thick inside the vacuum chamber of the accelerator and taken out at 0° relative to the direction of the proton beam in the proton synchrotron. The beam was collimated by a steel collimator 250 cm long with an aperture diameter of 5 cm, located 18.5 m from the target. The angular divergence of the collimated beam was no greater than 0.07°. The resultant beam of neutral particles consisted mainly of neutrons and also γ quanta produced in the decay of π^0 mesons and a small mixture of K_2^0 mesons. To remove γ quanta from the beam, we placed two lead filters 6.2 cm thick in front of the collimator. Charged particles produced as a result of the interaction of neutrons and γ quanta with the walls of the accelerator vacuum chamber and the with the lead in the filters were removed with the aid of a magnetic field of intensity up to 18 000 Oe over a length of 130 cm.

The geometry of the experiment and the value of the magnetic field were so chosen that charged particles of the highest possible momentum were deflected by an angle exceeding the angle subtended by the neutron detector. Figure 1 shows a diagram of the detector. To increase the efficiency of recording high-energy neutrons in the neutron detector, we used a Cerenkov counter containing lead glass. The neutron detector consisted of a scintillation counter operating in anticoincidence with an aluminum converter 10 cm thick, three coincidence scintillation counters operating in coincidence, and a lead-glass Cerenkov counter whose dimensions were equivalent to ~20 radiation units or to two nuclear mean free paths. The calculated efficiency of the detector was ~1% with a satisfactory energy resolution. We recorded only those neutrons whose energy loss in the Cerenkov counter exceeded a certain threshold energy. We calibrated the energy threshold of the neutron detector by varying the energy of the accelerated protons in the synchrotron. Pulses from the Cerenkov counter were amplitude analyzed with the aid of a 12-channel amplitude analyzer.

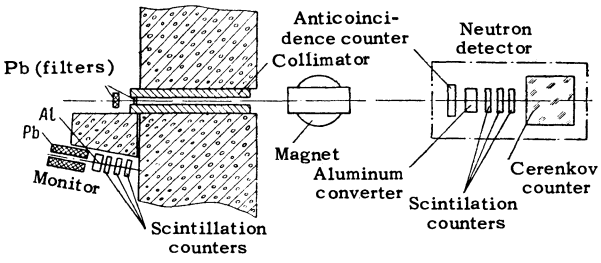

FIG. 1. Diagram of neutron detector and geometry of the experiment.

As a monitor, we used a telescope consisting of three scintillation counters and an aluminum converter located behind a lead collimator 100 cm long 17.0 m from the target in the accelerator. The axis of the monitor channel was set at 3° relative to the direction of the accelerated protons.

In the measurements, we used polyethylene targets 48.53 and 23.66 g/cm^2 thick and carbon targets 41.56 and 20.32 g/cm^2 thick.

From the measurements, the total neutron-proton cross section at an effective neutron energy of $8.3\,^{+1.2}_{-1.3}$ BeV was found to be 41.2 ± 2.6 mb.

This cross section is greater than the value 33.6 ± 1.6 mb measured for an effective neutron energy of 4.5 BeV.[1] This means that in the energy interval 4.5 — 8.5 MeV there is a tendency for the total np cross section to increase (see Fig. 2).

At present, we are continuing the measurements of the total cross sections for the interaction of neutrons with protons and heavier nuclei.

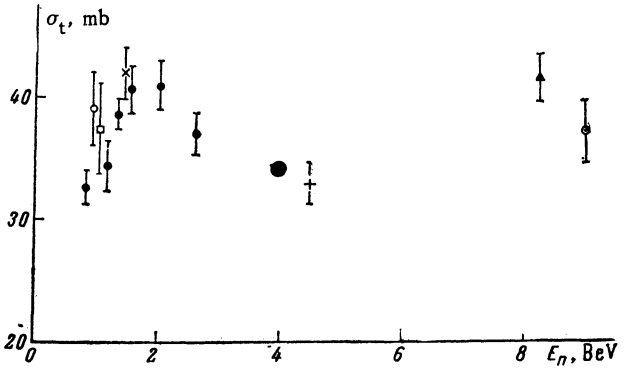

FIG. 2. Total neutron-proton cross sections: ×—data of[1]; ●—data of[2]; o—data of[3]; □—data of[4]; +—data of[5]; ⊙—data of[6] (the value shown apparently does not include a correction for the screening of the neutron by the proton in the deuteron); ▲—data of this work.

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