ELASTIC BACKWARD SCATTERING OF NEGATIVE PIONS BY NEUTRONS IN THE 1.4 - 4.0 BeV/c MOMENTUM INTERVAL

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We have investigated the elastic backward-scattering reaction

$$\pi^- + n \to \pi^- + n \tag{1}$$

in the 1.38 - 4.05 BeV/c momentum range. Reaction (1) was investigated with an installation capable of registering with high efficiency inelastic evens of the type $\pi^- + n \to \pi^- + n + k\pi^{\pm 0}$. A diagram of the installation is shown in Fig. 1. The π^--meson beam was separated by means of of telescope counters C_1, C_2, C_3, C_4, C_5, and C_6, and had $\Delta p/p \lesssim 5\%$. The event was registered in a cylindrical spark chamber, inside of which a target (D_2O or H_2O) was placed. A high-voltage pulse was produced across the chamber by coincidences between signals from counters C_1, C_2, C_3, C_4, C_5, and C_6 with any of the lateral counters C_7, C_8, C_9, or C_{10} in the absence of a signal in the anticoincidence counters A_1 or A_2. The forward-scattered neutrons were registered by a neutron counter n, the efficiency of which to 2-BeV/c neutrons was found experimentally to be 0.64 ± ± 0.17. Theoretical value of this efficiency is 70%. The signal from the neutron counter was registered with an oscillograph and used to monitor the events selected by photography in the spark chamber. Part of the spark-chamber electrodes was made of lead (total lead thickness 4 radiation units). In addition, a layer of lead 1 radiation unit thick was placed between the target and the anticoincidence counter A_1. Thus, the apparatus registered the gamma quanta from π^0 decays with high efficiency, and the admixture of inelastic events in the cases selected by us did not exceed 2%.

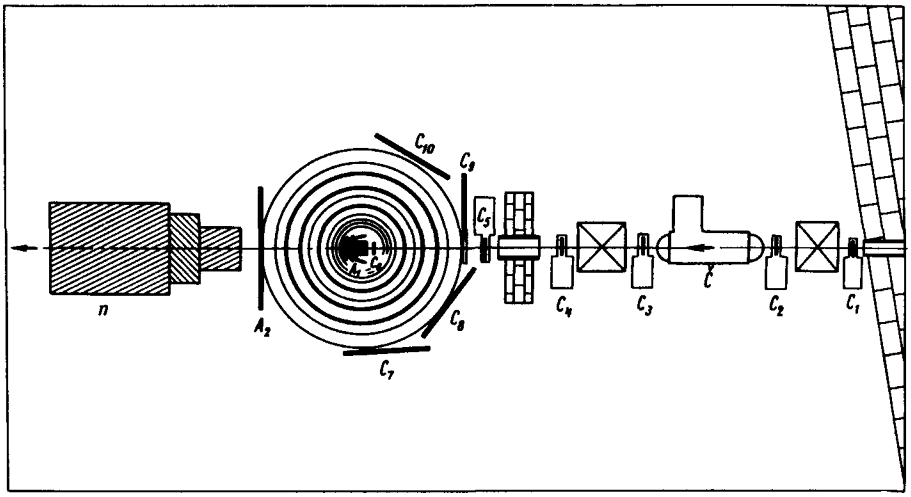

Fig. 1. Diagram of the installation of gas Cerenkov counter Č for the separation of the π^+ beam.

We selected 1700 cases of reaction (1) with pion scattering angle > 90° (lab. system). For these cases we measured the three-dimensional angles (the angles were measured accurate to 1° in the horizontal plane and 5° in the vertical). The events produced on free neutrons were separated by means of a D_2O - H_2O subtraction procedure. To obtain the absolute cross sections,

p, BeV/c	R = $\bar{\sigma}_{H_2O}/\bar{\sigma}_{D_2O}$	$\bar{\sigma}_n = \bar{\sigma}_{D_2O} - \bar{\sigma}_{H_2O}$ mb/sr[1)]	$\langle\bar{\sigma}_n\rangle = \sigma_{D_2O}(1-\bar{R})$ mb/sr[1)]	σ, mb/sr[2)]
1.20				350±20
1.38	0.53±0.09	443±105	487±60	
1.55	0.55±0,12	465±165	470±85	550±44
1.72	0.38±0.09	394±80	323±46	
1.88			226±38	415±83
2.0	0.47±0.07	163±33		
2.12			91±13	
2.56		69±21	89±15	
2.7				128±33
3.0	0,57±0,12	75±21	78±11	
3.3		41±14	49±10	
3.5				47±20
4.05		23±9	27±8	
4.5				22±7

1) Total uncertainty in the cross sections is 25%.

2) A. I. Alikhanov et al., Proc. Conf. on High-energy Physics, Dubna, 1964 (work done on C^{12}).

we introduced appropriate corrections for the interaction of the primary pion and the neutron in the surrounding medium, for the efficiency of the electronic circuitry, for the beam composition, and for the screening of the nucleons in the deuterium (Glauber's correction). The over-all uncertainty in the values of the cross sections, due to these corrections, amounts to 25%. The table lists the cross sections $\bar{\sigma}_n = \bar{\sigma}_{D_2O} - \bar{\sigma}_{H_2O}$, averaged over the c.m.s. angle interval 160 - 180°, as functions of the energy. The indicated errors are statistical. In addition to the cross section $\bar{\sigma}_n$, we measured the cross section for the neutron of the O^{16} nucleus. The table lists the values of R = $= \bar{\sigma}_{H_2O}/\bar{\sigma}_{D_2O}$ for different energies. These quantities are close to one another. A χ^2 test for compatibility with one value yields a probability $P(\chi^2) = 80\%$. If we assume that R does not depend on the energy, then we can carry out the subtraction in the following manner: $\langle\bar{\sigma}_n\rangle = \bar{\sigma}_{D_2O}(1 - \bar{R})$, where $\bar{R} = 0.49 \pm 0.41$ 1). The values of $\langle\bar{\sigma}_n\rangle$ are listed in the table with their statistical errors.

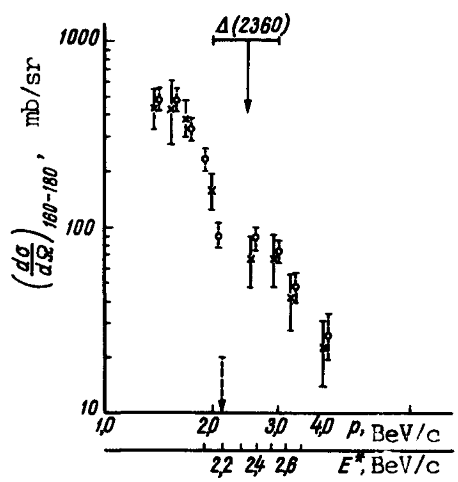

Fig. 2 Cross section for elastic π-n backward scattering vs. the π⁻ momentum.

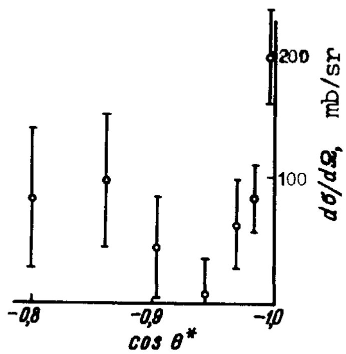

Fig. 3. Differential cross section for elastic π⁻ backward scattering.

Figure 2 shows $\bar{\sigma}_n$ and $\langle\sigma_n\rangle$ vs. the pion momentum. Attention is called to the irregularity in the momentum region 2 - 3 BeV/c. It is possible that this singularity is a manifestation of the $\Delta(2360)$ resonance (its position and width are indicated in the figure).

Figure 3 shows the angular distribution of elastic $\pi^- n$ backward scattering at an average pion momentum 2.8 BeV/c (the cross sections were obtained by a difference method and were averaged in the 2.1 - 3 BeV/c momentum interval). A peak is seen in the region of $\cos\theta^* = -1$. The slope of the peak relative to the momentum transfer is $(d/du)\ln(d\sigma/d\Omega) = (18^{+21}_{-7})$ BeV^{-2}.

Figure 2 shows the upper limit (with 90% confidence) of the cross section for the elastic backward scattering reaction $\pi^+ + n \to \pi^+ + n$, obtained by us in a short exposure.

[1] From the value of R we found that the average number of neutrons of the oxygen nucleus, which participate effectively in reaction (1), is $\bar{n} = 1.6 \pm 0.4$.

USE OF THE PINCH EFFECT FOR OPTICAL LASER PUMPING

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The authors have shown earlier [1,2] that a self-compressed strong-current discharge (pinch) is a powerful source of radiation in the ultraviolet and the visible regions (2000 - 6000 Å). The characteristics of this radiation (form of the spectrum, intensity, etc.) are determined by the discharge conditions (working gas, current density, discharge-chamber construction, etc.). Depending on the experimental conditions, we can obtain both discrete and continuous radiation of varying power.

In this paper we describe experiments on the use of the radiation from a straight pinch for optical pumping of Nd^{3+}-glass and ruby lasers. The experiments were carried out at currents up to 300 kA, with a rise rate of ~ 3×10^{11} A/sec and a discharge period ~ 4 μsec. The energy source was a specially constructed low-inductance capacitor bank rated 30 μF at 9 kV working voltage. The current switching was by means of ring-type vacuum discharge unit with eight igniting electrodes. The parasitic inductance of the resonant circuit (the self-inductance of the capacitor bank, the discharge unit, and the leads) was reduced to 6 nanohenry.

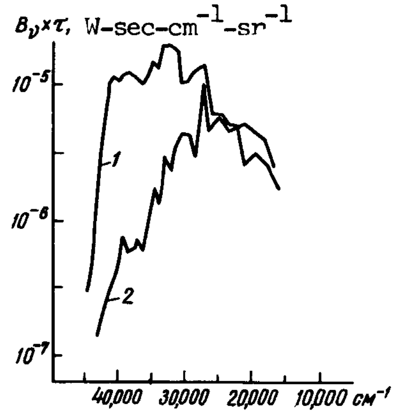

Fig. 1. Distribution of spectral brightness: 1 - spectrum from end of chamber, 2 - spectrum from the side.

Under the given experimental conditions (current density 20 kA/cm^2) the light yield was ~ 12%. With 1.2 kJ electric energy delivered by the bank, the optical radiation energy was ~ 150 J, of which 50 - 70 J was in the 4000 - 6000 Å region and 80 - 100 J in the 2000 -