order-of-magnitude values. This consideration is especially important in the calculations of spectra which are very sensitive to assumptions about the form of the matrix element. Thus, one can expect the value $\sigma^+ = 1.0$ mbn following from calculations from statistical weights to be, apparently, closer to experiment than the value $\sigma^+ = 0.33$ mbn obtained by integration of the calculated spectrum.†

In our opinion there are, at present, no reasons to assert that the cross section for production of strange particles in p-p collisions is significantly less than the cross section for production of strange particles in π-N collisions at equivalent energies in the c.m.s. (see references 7 — 9). The very small value of the cross section observed in the work of Cool et al.[9] would appear to result from inadequate statistics.

*In reference 7, $\sigma^+ = 0.2$ mbn was obtained. The difference comes from the fact that we took into account a series of additional factors: the resonance interaction of pions and nucleons in states with angular momentum and isotopic spin $P = T = 3/2$, the difference in statistical weights of the reactions.

†An annalogous situation occurs in π-N collisions for energies equal in the c.m.s. ($E_{lab} \lesssim 2$ Bev).

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Translated by G. E. Brown
173

INTERPRETATION OF THE MAXIMUM IN THE TOTAL CROSS SECTION FOR PROTON-PROTON SCATTERING IN THE 1 Bev REGION

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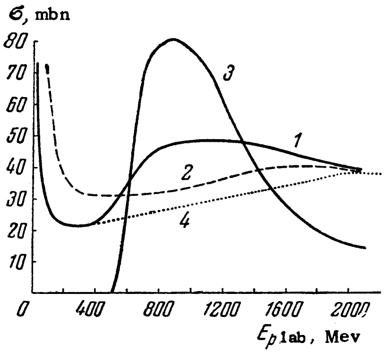
In the last few years, several articles[1-4] have employed the resonance interaction between the π meson and nucleon ("isobar") in the 200 Mev region; this follows from the presence of the maximum in the total cross section for scattering of π^+ and π mesons on protons in this energy range.[5]

We shall show that the maximum in proton-proton scattering near 1 Bev can be explained as coming from the excitation of one of the nucleons to an "isobaric" level. For this, we use methods proposed by Takeda.[7] Assuming charge independence for the total proton-proton and proton-neutron cross sections, we have

$$\sigma(pp) = P\left\{\frac{2}{3}\sigma_{1/2} + \frac{1}{3}\sigma_{3/2}\right\},$$
$$\sigma(pn) = P\left\{\frac{5}{6}\sigma_{1/2} + \frac{1}{6}\sigma_{3/2}\right\}, \qquad (1)$$

where $\sigma_{1/2}$ and $\sigma_{3/2}$ are the cross sections for the meson-nucleon resonance systems with isotopic spin $T = 1/2$ and $T = 3/2$; P is the probability of the one-meson state of the π-meson cloud surrounding the nucleon core. According to experiment, in the 1 Bev region, $\sigma(p, p) > \sigma(p, n)$. This inequality can be satisfied if $\sigma_{3/2} > \sigma_{1/2}$. Consequently, the resonance in the meson-nucleon system occurs in the $T = 3/2$ state.



1 — total p — p scattering cross section. 2 — total p — n scattering cross section, according to the experimental data of Chen and Shapiro.[6] 3 — resonance value of $P\sigma_{3/2}$, obtained from Eq. (1). 4 — approximate non-resonance part of $P\sigma_{3/2}$.

From Eq. (1), we can find the experimental value of $P\sigma_{3/2}$. Using Eq. (1) and the Breit-Wigner resonance formula for the meson-nucleon system in the $T = 3/2$ state:

$$P\sigma_{3/2} = 2\pi P \lambda\!\!\!^{-2} (2J+1) \frac{(\Gamma/2)^2}{(\varepsilon - \varepsilon_0)^2 + (\Gamma/2)^2}, \qquad (2)$$

(where $\lambda\!\!\!^{-} = 2.4 \times 10^{-13}$ is the wave length of the π meson in the center-of-mass system, J is the total angular momentum), we obtain $J = 3/2$, $P = 0.1$, $\Gamma = 82$ Mev, $\epsilon_0 = 110$ Mev, in satisfactory agreement with the parameters of the isobar.[5]*

*Some of the difference of ε_0 from the corresponding resonance energy in reference 5 may arise from the fact that we did not consider the velocity of the virtual π mesons in the meson clouds surrounding the nucleon cores.

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174

RANGE-ENERGY DEPENDENCE OF C_{12}, C_{14}, *AND* O_{16} *IONS IN ALUMINUM, COPPER, AND GOLD IN THE ENERGY INTERVAL FROM 50 TO 110 Mev.*

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FOR detailed study of nuclear reactions caused by multiply-charged ions, data must be obtained on the range-energy dependence of the heavy ions in various substances. For ions with $Z > 3$ it is difficult to obtain the range-energy curves by calculation, since the multiple charge exchange of such ions during the slowing down process introduces a substantial indeterminacy into the quantities that enter into the equations.[1]

We have consequently set up experiments on the direct experimental determination of these relationships for ions of carbon, nitrogen, and oxygen in aluminum, copper, and gold.

The ions C_{12}^{+4}, N_{14}^{+5}, O_{16}^{+5}, and O_{16}^{+6} were accelerated in a 150-cm cyclotron with an exit system having a focusing magnet, intended for the production of a narrow beam of deuterons in a specially shielded cabin 12 meters away from the center of the cyclotron. Experience has shown that it is possible, without substantial changes, to use the same exit system to obtain in the cabin a sufficiently intense beam of ions of carbon, nitrogen, and oxygen. This is apparently due to the fact that part of the ion beam passes, as a result of scattering, through the exit channel in the field of the focusing magnet, which focuses the ions on the entrance diaphragm of the receiver of the recording apparatus. This mechanism for obtaining a working beam has insured an intensity on the order of $10^5 - 10^6$ ions/cm^2-sec at the receiver, with the current at the terminal radius of the cyclotron being on the order of 0.1 microamperes.

The ions were registered by a photomultiplier with a ZnS crystal, deposited in the form of a thin layer on glass, so as to insure a sufficient sensitivity of measurements in an ion beam on the order of $10^2 - 10^6$ ions/cm^2-sec. With the beam thus extracted from the cyclotron, the ions entering the field of focusing magnet had an energy spectrum (50 – 110 Mev). Narrow beams of practically-monoenergetic ions were gathered from this spectrum by a suitable choice of the intensity of the focusing magnetic field. A focusing magnet could be used as an analyzer because the experimentally-obtained relationship between the magnetizing current and the induction of the magnetic field in the gap was linear over the entire range of the field employed. The analyzer was calibrated with a beam of accelerated deuterons, whose energy was determined from the known range-energy curve in aluminum.[2]

The ions accelerated in the cyclotron passed through a specially installed two-micron aluminum foil on their path to the focusing magnet, and acquired in this foil an equilibrium charge corresponding to their velocity. The ions were then deflected in the magnetic field, entered the recorder in front of which foils of various thickness of aluminum, copper, and gold were mounted on a rotating disk. Thus, the ion energy was determined from the current in the windings in the magnetic analyzer, while the ranges of ions at a given energy in the selected substance were determined from the decrease in intensity with in-