fluctuations in the corresponding voltage is of the form:

$$(V_M^2)_\omega = 16\pi^2 S^2 N^2 c^{-2} \omega^2 R_0^2 |Z(\omega)|^{-2} (M^2)_\omega, \qquad (4)$$

where N is the number of turns, S is the cross section of the coil placed perpendicular to the field H_0.

By utilizing (2) we obtain:

$$(V_M^2)_\omega = 8\pi\chi'' S^2 N^2 \omega^2 c^{-2} \hbar R_0^2 |Z(\omega)|^{-2} \coth(\hbar\omega/2kT). \qquad (5)$$

As may be seen from (5) the voltage fluctuations have a resonance character, and as a result of the large value of the relaxation time $T_\perp$ attain a sharp maximum in the field $H_0 = \pm\omega/\gamma$.

If one takes for water $\gamma = 2.8 \times 10^4$ gauss-sec, $\chi_0 = 3.3 \times 10^{-10}$ and $T_\perp = 3$ sec, then the ratio of the spectral densities (5) and (1) for $H_0 = \omega/\gamma$ has the form:

$$\eta = (V_M^2)_{\gamma H_0} / (V_T^2)_{\gamma H_0} = 6.3 \cdot 10^{-8} S^2 N^2 H_0^2 / R, \qquad (6)$$

where R is the effective resistance of the receiver circuit in ohms. In the case $N = 10^3$ turns, $S = 100\ \text{cm}^2$ in the earth's magnetic field $H_0 = 0.6$ gauss, $\eta = 220/R$.

Thus, in this case under appropriate conditions one may separate from the spectrum of thermal noise the signal due to the random free precession of magnetic moments of atomic nuclei. The ratio η in the case of resonance is proportional to $(\gamma H_0)^2$. This last consideration may be used as the basis of the theory of self excitation of a spin generator.[2]

[1] L. D. Landau and E. M. Lifshitz, Электродинамика сплошных сред (Electrodynamics of Continuous Media), Gostekhizdat, 1957.

[2] S. S. Kurochkin, Радиотехн. и электрон. (Radio Engineering and Electronics) 2, 198 (1958).

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PRODUCTION OF STRANGE PARTICLES IN 3-Bev p-p COLLISIONS

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In references 1 — 3, the statistical theory of multiple production of strange particles was considered. In the case of π-N collisions, this theory describes the experiments satisfactorily, if the energy of the colliding particles is sufficiently high.[4,5] Comparison between theoretical calculations and experiments can now also be carried out for p-p collisions.

If we assume that the effective inelastic cross section for 3-Bev p-p collisions is equal to 26 mbn,[6] then the cross section for production of K^+-particles in p-p collisions calculated according to references 1 — 3 is $\sigma^+ = 1.0$ mbn for the variant $V = V_2$ (the K mesons being produced in a volume of radius $r_k = \hbar/m_k c = 0.4 \times 10^{-13}$ cm; all other particles in a volume of radius $r_\pi = \hbar/m_\pi c = 1.4 \times 10^{-13}$ cm), and $\sigma^+ =$ 0.05 mbn for the variant $V = V_3$ (all strange particles produced in a volume of radius r_k; all other particles, in a volume of radius r_π). The calculated cross section for production of all strange particles $\sigma_{st} = 1.5$ mbn for $V = V_2$ and $\sigma_{st} = 0.07$ mbn for $V = V_3$.

Baumel et al.[7] obtained the value $\sigma_{exp} = (4.5 \pm 0.9) \times 10^{-32}$ cm^2/sterad-Mev for the cross section for the production of K^+ particles of momentum $1.9 m_\pi$ ($m_\pi = 140$ Mev) at $\theta = 180°$ (center-of-mass-system) in 3 Bev p-p collisions. In order to integrate the cross section over all momenta, we calculated the momentum distribution of the K mesons produced. Assuming an isotropic angular distribution in the c.m.s., for $V = V_2$, $\sigma^+ = 0.33$ mbn.* An analogous calculation for the variant $V = V_3$ gives nearly the same value. However, this quantity is an order different from the cross section calculated for $V = V_3$ from only the statistical weights without use of σ_{exp} and the momentum distribution. Thus, as in the case of π-N collisions, the variant $V = V_3$ leads to contradictions. For the variant $V = V_2$, the value of σ^+ calculated taking into account the momentum distribution is three times smaller than that calculated only on the basis of statistical weights without employing σ_{exp} and the momentum distribution. This difference can be explained by the fact that at low energies $E \leq 3$ Bev, the energy of the strange particles produced in N-N collisions is near to threshold, and the number of them is not appreciable. Hence, statistical methods can give only 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.

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*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. ($E_{lab} \leq 2$ Bev).

[1] Barashenkov, Barbashev, Bubelev, and Maksimenko, Nuclear Phys. **5**, 17 (1957).

[2] Barashenkov, Barbashev, and Bubelev, Nuovo cimento, Suppl. **1**, 7, 177 (1958).

[3] V. S. Barashenkov and V. M. Mal'tsev, Acta Phys. Polon. **17**, 177 (1958).

[4] V. S. Barashenkov, J. Exptl. Theoret. Phys. (U.S.S.R.) **34**, 1016 (1958), Soviet Phys. JETP **7**, 701 (1958).

[5] E. K. Mikhul, J. Exptl. Theoret. Phys. (U.S.S.R.) **35**, 298 (1958), Soviet Phys. JETP **8**, 205 (1959).

[6] Block et al., Phys. Rev. **103**, 1484 (1956); Fowler et al., Phys. Rev. **103**, 1489 (1956).

[7] Baumel, Harris, Orear, and Taylor, Phys. Rev. **108**, 1322 (1957).

[8] Proc. Seventh Rochester Conf. and Proc. Padua-Venice Conf., 1957.

[9] Cool, Morris, Ran, Thorndike, and Whittermore, Preprint (1958).

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

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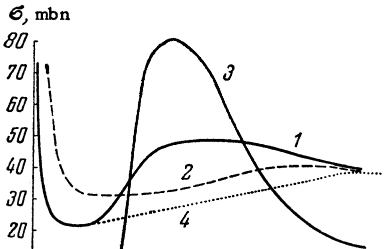
In the last few years, several articles[1-4] have employed the resonance interaction between the π meson and nucleon ("isobar") in the 200 Mev region; this follows from the presence of the maximum in the total cross section for scattering of π^+ and π mesons on protons in this energy range.[5]

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

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

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 $P\sigma_{3/2}$.