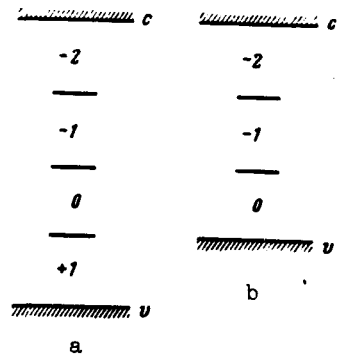
states: V^{-2}, V^{-1}, V^{0}, and V^{+1} (see Fig. a). Owing to the Coulomb interaction, the negatively charged vacancies in n-Si are apparently captured by ionized D^{+1} donors, and V^{+1} in p-type material are captured by ionized acceptors A^{-1}, in which case the Fermi level in n- and p-type silicon should tend to the center of the forbidden band. Since the donors in germanium make up VD complexes, and the acceptors of group III do not take part in defect formation, it can be assumed that a vacancy in Ge has only three charge states: V^{-2}, V^{-1}, and V^{0} (see Fig. b).



a - Energy spectrum of free vacancy in silicon in accordance with [13], b - proposed energy spectrum of free vacancy in germanium.

[1] H. James and K. Lark-Horovitz, Z. Phys. Chem., 198, 107 (1951).
[2] G.D. Watkins and J.W. Corbett, Phys. Rev. 134, A1359 (1964).
[3] E.L. Elkin and G.D. Watkins, Phys. Rev. 174, 881 (1968).
[4] G.D. Watkins, Phys. Rev. 155, 802 (1967).
[5] J. Blakemore, Statistics of Electrons in Semiconductors, Pergamon, 1961.
[6] S.H. Koenig, R.D. Brown, and W. Schillinger, Phys. Rev. 128, 1668 (1962).
[7] E.M. Gershenzon and G.N. Gol'tsman, ZhETF Pis. Red. 14, 98 (1971) [JETP Lett. 14, 63 (1971)].
[8] N.A. Vitovskii, B.M. Konovalenko, T.V. Mashovets, S.M. Ryvkin, and I.D. Yaroshetskii, Fiz. Tverd. Tela 5, 3510 (1963) [Sov. Phys.-Solid State 5, 2575 (1964)].
[9] V.V. Emtsev and T.V. Mashovets, ZhETF Pis. Red. 13, 675 (1971) [JETP Lett. 13, 478 (1971)].
[10] N.A. Vitovskii, M. Maksimov, and T.V. Mashovets, Fiz. Tekh. Poluprov. 4, 2276 (1970) [Sov. Phys.-Semicond. 4, 1960 (1971)].
[11] L.S. Smirnov, V.F. Stas', and V.V. Khainovskaya, ibid. 5, 85 (1971) [5, No. 1 (1971)].
[12] J.H. Crawford and J.W. Cleland, J. Appl. Phys. 30, 1204 (1959).
[13] G.D. Watkins, Proc. of the Santa Fe Conf. on Radiation Effects in Semicond., Plenum Press, N.Y., 1968.

SEARCH FOR BARYON RESONANCES IN THE pγ SYSTEM

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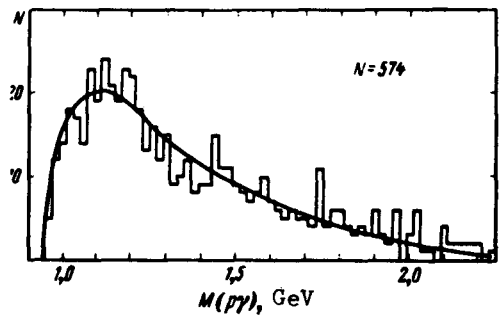
We present in this article the result of a search for baryon resonances in the mass interval $M_n < M_{N'} < M_n + M_\pi$, decaying in accordance with the scheme $N' \to p + \gamma$.

The possible existence of a new nucleon state in this mass region was considered in [1, 2]. The prediction in [1] was based on the choice of a unitary multiplet for the resonance $\Sigma(1475)$. Under the condition that it is a member of a unitary octet containing the resonances $\Xi(1630)$, $\Lambda(1330)$, and N', the Gell-Mann-Okubo formula was used to determine the mass of N'. The value of the mass of N' was refined with the aid of experimental data on πN scattering. It was shown that the most probable value of the mass of N' lies below the πN threshold. In [2] the prediction was based on the nucleon-meson model of the shell



Distribution of events of the type $\pi^-p \to \pi^-p + (2, 3)\gamma$ with respect to the effective mass of the pγ system.

type. An isobar with mass M ≈ 1040 MeV and quantum numbers $I^P = 1/2^+$ was predicted.

The experiment was based on an analysis of ∿6000 two-prong stars with two and more γ quanta, observed after scanning 230,000 photographs obtained with the meter propane bubble chamber of the Joint Institute for Nuclear Research [3]. The chamber was exposed in the beam of π^- mesons with momentum 5 GeV/c [4] from the JINR proton synchrotron.

The events selected for the study were of the type $\pi^-p \to \pi^-p + (2, 3)\gamma$, satisfying the following conditions: 1) The protons were identified by ionization and stopping in the chamber; the proton momenta did not exceed 900 MeV/c. 2) The track lengths of the secondary charged particles of the star were not smaller than 2 cm, and the momenta of these particles were measured with accuracy not worse than 30%. 3) The γ quanta belonged to the investigated interaction and had momenta larger than 30 MeV/c; the measurement accuracy was not worse than 25%. 4) The angles between two γ quanta were not smaller than 2°.

These conditions were introduced in order to ensure reliable identification and homogeneous selection of events, and to discard secondary γ quanta resulting from bremsstrahlung of an electron-positron pair located closer to the interaction.

Application of these criteria left us with 233 events of the type $\pi^-p \to \pi^-p2\gamma$ and 36 events $\pi^-p \to \pi^-p3\gamma$. The figure shows the distribution with respect to the effective mass M(pγ) for these events (574 combinations). In the mass region 940 - 1080 MeV, and also in other regions, no statistically confirmed excess of the number of events above the background curve was observed.

The background curve is the sum of the $M_i(p\gamma)$ distributions calculated for reactions making the main contribution to the total cross section of the process $\pi^-p \to \pi^-p$ + "neutral particle" [5 - 8]:

$$\pi^-p \to \pi^-p + (1, 2, 3, 4)\pi^0, \quad (1)$$

$$\to p\rho^- + (0, 1, 2)\pi^0, \quad (2)$$

$$\to \Delta^+(1236)\pi^- + (0,1)\pi^0. \quad (3)$$

The $M_i(p\gamma)$ distributions and the efficiency of registration of the reactions (1) - (3) were calculated by the Monte-Carlo method with allowance for the angular distribution of the baryons in the cms of the primary interaction, the probability of γ-quantum registration in the chamber, and the event selection criteria, in analogy with [9].

The $M_i(p\gamma)$ distributions were included in the summary background curve with a weight proportional to the cross section and to the efficiency of registration of the i-th channel. The cross sections of the reactions (1) - (3),

with the exception of channels with formation of one π^0 meson[1)], were determined by starting from the different cross sections of the corresponding (with respect to multiplicity) reactions with charged pions and statistical isospin coefficients [10].

To estimate the upper limit of the production cross section of the predicted resonance, the experimental spectrum was approximated by a sum of a background curve and a Gaussian curve. The unknown parameters were the relative contribution of the resonance N and its mass. The width of the Gaussian distribution was fixed and amounted to 16 MeV (the experimental resolution in the given mass interval). The value obtained for the contribution of the resonance N' turned out to be close to zero. At the 90% confidence level, the number of $N' \to p + \gamma$ decays is less than 1.7% of the total number of events in the spectrum, corresponding to 10 events.

To determine the cross section for the production of the resonance N', we used the total cross section of the reaction $\pi^- p \to \pi^- p$ + "neutral particles," which amounts to 3860 ± 160 μb[2)] at $P_{\pi^-} = 5$ GeV/c. At the 90% confidence level, the upper limit of the cross section for the production of the resonance N', $\sigma(\pi^- p \to N'(N' + p\gamma)\pi^- + k\pi^0, k \geq 1)$, is equal to 70 μb.

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[1] Ya.I. Azimov, Phys. Lett. 32B, 497 (1970).
[2] V.F. Dushenko, JINR Soobshchenie (Communication) R2-4987, 1970.
[3] A.V. Bogomolov et al., PTE No. 1, 64 (1964).
[4] V.S. Kladnitskii and V.B. Flyagin, ibid. No. 1, 24 (1965).
[5] A.R. Dzierba et al., Phys. Rev. D2, 2544 (1970).
[6] L. Bondar et al., Nuovo Cim. 31, 485, 729 (1964).
[7] R.P. Eisner et al., Phys. Rev. 164, 1699 (1967).
[8] B. Terreault, Ph.D. Thesis, Univ. of Illinois, 1969.
[9] V.B. Vinogradov et al., JINR Soobshchenie (Communication) 13-5516, 1970.
[10] V.B. Vinogradov et al., JINR Preprint R1-5471, 1970.
[11] D.J. Crennel et al., Phys. Lett. 28B, 136 (1968).
[12] R. Honecker et al., Nucl. Phys. B13, 586 (1969).

EXPERIMENTAL INVESTIGATIONS OF CONTAINMENT OF A HOT-ELECTRON PLASMA IN THE "URAGAN" STELLARATOR

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Theoretical and experimental investigations carried out recently have led to considerable progress in the study of plasma transport in stellarators. In

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[1)] The cross sections of the reactions $\pi^- p \to \pi^- p \pi^0$, $\pi^- p \to p\rho^-$, and $\pi^- p \to \Delta^+(1236)\pi^-$ at 5 GeV/c were obtained by interpolating the data for 4 GeV/c [6 - 7] and 6 GeV/c [11].

[2)] This quantity was determined from the data of [7, 11, 12].