LETTERS TO THE EDITOR

*THE PROBLEM OF NUCLEON STRUCTURE**

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If it is assumed that the nucleon is not an elementary particle but a system composed of particles which are tightly bound by the π-meson field, the resonance interaction between π-mesons and nucleons can be interpreted in terms of an excited nucleon state while the associated production of hyperons and K-mesons can be interpreted as dissociation of the nucleon into constituent particles. Hence, we propose that the fundamental particles are the K-meson and the cascade hyperon (Ξ) and postulate that there exists between the K^{0+} and Ξ^{0-} particles and the corresponding anti-particles $\tilde{K}^{0-}$ and $\tilde{\Xi}^{0+}$ a strong attractive force which results in the formation of a bound state with a very large mass defect. This attraction does not exist between the K^{0+}, $\tilde{\Xi}^{0+}$ and $\tilde{K}^{0-}$ Ξ^{0-} particles respectively. The K^{0+} and Ξ^{0-} particles can then form the following four bound states (isotopic spin T = 0 and T = 1) which can be identified with charged and neutral hyperons:

$$\begin{array}{l|l} \Psi_{1,1} = \Xi^0 K^+ & \Sigma^+ \\ \Psi_{1,-1} = \Xi^- K^0 & \Sigma^- \\ \Psi_{1,0} = (\Xi^0 K^0 + \Xi^- K^+)/\sqrt{2} & \Sigma^0 \\ \Psi_{0,0} = (\Xi^0 K^0 - \Xi^- K^+)/\sqrt{2} & \Lambda^0 \end{array} \tag{1}$$

If the Coulomb interaction is not taken into account the $\Psi_{1,1}$, $\Psi_{1,-1}$ and $\Psi_{1,0}$ states are energetically degenerate if the Ξ^0 and Ξ^- and K^0 and K^+ masses are equal respectively. Because of the Coulomb interaction the mass of the Σ^0 should be smaller than the mean mass of $\Sigma^{\pm}$-particles by an amount which depends only on the distance between the Ξ- and K-particles.

If we consider a system consisting of a Ξ-particle and two K-mesons we obtain two groups of states with T = 1/2 and one with T = 3/2:

$$\begin{array}{ll} \eta_{1/2,1/2} = \Psi_{0,0}\varphi_{1/2,1/2}, & \chi_{1/2,1/2} = 3^{-1/2}\Psi_{1,1}\varphi_{1/2,-1/2} + \sqrt{2/3}\,\Psi_{1,0}\varphi_{1/2,1/2}; \\ \eta_{1/2,-1/2} = \Psi_{0,0}\varphi_{1/2,-1/2}, & \chi_{1/2,-1/2} = 3^{-1/2}\Psi_{1,-1}\varphi_{1/2,+1/2} + \sqrt{2/3}\,\Psi_{1,0}\varphi_{1/2,-1/2}; \\ \chi_{3/2,3/2} = \Psi_{1,1}\varphi_{1/2,1/2}, & \chi_{3/2,1/2} = \sqrt{2/3}\,\Psi_{1,1}\varphi_{1/2,-1/2} - 3^{-1/2}\Psi_{1,0}\varphi_{1/2,+1/2}; \\ \chi_{3/2,-3/2} = \Psi_{1,-1}\varphi_{1/2,-1/2}, & \chi_{3/2,-1/2} = 3^{-1/2}\Psi_{1,0}\varphi_{1/2,-1/2} - \sqrt{2/3}\,\Psi_{1,-1}\varphi_{1/2,1/2}. \end{array} \tag{2}$$

Here $\varphi_{1/2,1/2}$ and $\varphi_{1/2,-1/2}$ denote the wave functions for K^+ and K^0-mesons.

The states $\eta_{1/2,1/2}$ and $\eta_{1/2,-1/2}$ are to be identified with the proton and neutron in the ground state. Then $\chi_{3/2}$ and $\chi_{1/2}$ are excited nucleon states which appear in the interaction of π-mesons with nucleons.

Thus the structure of the nucleon is as follows:

$$p = K^+ + \Xi^- + K^+ \rightleftarrows K^+ + (\Xi^0 + K^0), \tag{3}$$

$$n = K^0 + \Xi^0 + K^0 \rightleftarrows K^0 + (\Xi^- + K^+). \tag{4}$$

The degeneracy of states (3) and (4), which holds when the masses of the K^+ and K^0-meson are equal, is removed by the Coulomb interaction in (3) between the K^+ and Ξ^--particles; this interaction can not be compensated for by the repulsion of the K^+-mesons if the mean distance between these particles is larger than the distance between the K^+ and Ξ^-.

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It is easy to see that the new "strangeness" quantum number introduced be Gell-Mann can now be interpreted as the meson charge of the K and Ξ particles which is responsible for the interaction between these particles. In contrast with electric charge, the quanta of the meson-charge field are π-mesons and this change is not conserved in weak interactions occuring 10^{12} times slower than nuclear interactions. As slower than nuclear interactions. As a consequence we have the spontaneous transformation of hyperons into nucleons according to the following scheme:

$$Y \underset{\text{(fast)}}{\rightleftarrows} (Y + \pi + \pi + \ldots) \underset{\text{(slow)}}{\rightleftarrows} (Y + K) \underset{\text{(fast)}}{\longrightarrow} N + \pi.$$

We now consider nucleon disintegration on the basis of the structural schemes in (3) and (4). The disintegration can occur as a result of the absorption of the incident π-meson by a K-meson or Ξ-particle. In the first case the K-meson angular distribution [which we denote by $f_1(\theta)$] should be highly peaked in the forward direction. In the case in which the π-meson is absorbed by the Ξ-particle, the K-meson angular distribution [which we designate by $f_2(\theta)$] should be approximately isotropic with some predominance of the K-mesons emitted in the backward direction.[1] The table lists various nucleon disintegration reactions produced by the absorption of a π-meson. To find the relative weights to be assigned to the ratio of the cross sections for the various reactions we have assumed that the absorption of the π-meson is equally probable in K and Ξ particles.

Reaction	Particle which absorbs the π-meson	Weight for the reaction	Angular distribution
$\pi^- + p \to K^0 + \Lambda^0;\ \Sigma^0$	K^+ or Ξ^0	$3 + {}^1/_2 = {}^7/_2$	$6f_1 + f_2$
$\ K^+ + \Sigma^-$	Ξ^0	${}^1/_2$	f_2
$\pi^+ + n \to K^+ + \Lambda^0;\ \Sigma^0$	K^0 or Ξ^-	$3 + {}^1/_2 = {}^7/_2$	$6f_1 + f_2$
$\ K^0 + \Sigma^+$	Ξ^-	${}^1/_2$	f_2
$\pi^- + n \to K^0 + \Sigma^-$	K^+ or Ξ^0	$1+1=2$	$f_1 + f_2$
$\pi^+ + p \to K^+ + \Sigma^+$	K^0 or Ξ^-	$1+1=2$	$f_1 + f_2$

In work with a beam of 1.3-Bev negative pions it has actually been observed that the K^0-particles produced in the reaction ($\pi^- + p \to K^0 + \Lambda^0;\ \Sigma^0$) exhibit a highly pronounced asymmetry in the forward direction in the center-of-mass system while the angular distribution of the K^+-particles produced in the reaction $\pi^- + p \to K^+ + \Sigma^-$ is relatively isotropic with some predominance in the backward direction.[2]

The system which we have formulated is absolutely stable against decay into light particles if the Ξ-particle is absolutely stable against the analogous process. It is known that the nucleon lifetime is greater than 10^{22} years.[3] From this estimate we can conclude that the lifetime of the Ξ-particle can not be less than 10^8 years since nucleon decay can occur only if the Ξ-particle decay coincides with the decay of one of the K-mesons. The probability of this event is approximately 10^{14} times smaller than the probability of decay of a Ξ-particle. If the Ξ-particle is not the bare core of the nucleon but is itself a system consisting of a heavy hyperon, in whose π-meson field we find n K-mesons, this hyperon can undergo in the free state comparatively rapid decay into light particles. Thus we arrive at the conclusion that the law of conservation of the number of baryons, formulated in the form of a conservation law for nuclear charge, may be completely invalid. In this case there is a possibility of liberating in individual collisions the total energy corresponding to the nucleon mass.

[1] J. Schwinger, Phys. Rev. **104**, 1164 (1956).
[2] J. Steinberger, Proceedings of Sixth Rochester Conference on High-Energy Physics, 1956.
[3] Reines, Cowan, and Goldhaber, Phys. Rev. **96**, 1157 (1957).

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POLAR THEORY OF METALS

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In the polar model of metals proposed by Vonsovskii one introduces a new parameter of the metal — the degree of polarization s, which can be defined as the ratio of the mean number of "pairs" or "holes" to the total number of valence electrons. In the final analysis the degree of polarization determines all