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Letters to the Editor

POSSIBLE OBSERVATION OF He^8 *NUCLEI*

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An investigation of the stability (relative to neutron emission) of the isotopes of light nuclei with an excess of neutrons has led Zel'dovich[1] to infer a large probability for the existence of the He^8 nucleus. The expected binding energy of the neutron is about 1 Mev, and the beta-decay energy is approximately 12 Mev. The transition to the 3.2-Mev level in Li^8 would have a half-life on the order of 0.01 sec.[2,3]

If the He^8 nucleus really exists, it seems possible to observe its formation in the process of fragmentation of heavy nuclei under the action of high-energy particles, leading to the emission of fragments with a wide spectrum of charges and masses. The nuclear emulsion technique permits observation of the He^8 track, for owing to its relatively long lifetime the nucleus will not undergo decay before being stopped in the emulsion (the slowing-down time is about 10^{-11} sec); in a certain number of cases a distinctive (T-shaped) track similar to the tracks of Li^8 and B^8 nuclei will be formed if the beta decay proceeds to the ground state of $Li^8(2^+)$. This is to be expected on the basis of the following chain of transitions for the He^8 nucleus:

$$He^8(0^+) \xrightarrow{\beta} Li^8(2^+) \xrightarrow[0.8\ \mathrm{sec}]{\beta} Be^{*8} \xrightarrow[10^{-21}\ \mathrm{sec}]{} 2He_2^4.$$

A difference between the tracks of He^8 and Li^8 nuclei will result from the difference in ionization characteristics of these two nuclei.

Another, considerably more probable decay mode for He^8 is in competition with decay by this chain. Not yielding a T-shaped track and therefore indistinguishable from the case of alpha-particle emission, this decay goes not to the ground state but to an excited state of Li^8:

$$He^8(0^+) \xrightarrow{\beta} Li^{8*}(1^+) \rightarrow Li^7 + n.$$

A very approximate estimate showed that such a decay mode is 2 — 3 orders more probable. It is impossible, however, to observe the presence of hundreds or even thousands of He^8 tracks which do not give rise to the T-shaped track in the presence of the very large number of alpha particles and protons formed in these breakups.

Below are described two cases of observation of "strange" T-shaped tracks in an emulsion irradiated by high energy (930 Mev and 9 Bev) protons.

The first track was discovered accidentally when investigating fragmentation at 930 Mev, the second after examining around 170 T-shaped tracks of particles produced by 9-Bev protons. Both tracks were strange in that the density of developed grains per unit path length was uncharacteristically low for Li^8 nuclear tracks.

Owing to the short range of the particles under investigation (23μ and 37μ in first and second cases respectively), it is impossible to determine their charge by one of the well-known methods. We can only compare the ionization characteristics of the given particles with those of He^4 and Li^8 nuclei. The measured density of developed grains in the tracks of the given particles was approximately 25% lower than the density of Li^8 tracks, and was even lower than the average grain density in He^4 tracks (by about 10%). Supposing the given particles to be Li^8 nuclei, such an unusually low density of developed grains forces us to question their nature. If the particles in question actually decay at the stopping point into two alpha particles, which is consistent with their ranges (the total lengths of the alpha-particle tracks are 7.5 and 9.7μ), and at the same time have an ionizing power lower than that of the Li^8 nucleus, we may assume that in these cases we are dealing with He^8 nuclei.

The fact that the density of developed grains in these tracks is even somewhat lower than in alpha-particle tracks is further evidence that the given tracks may be He^8 tracks. Actually, with low residual ranges ($\lesssim 20\mu$), He^8 ions may be expected to possess lower ionizing power than He^4 ions, since at low ion velocities (close to and lower than the velocity of the orbital electrons of the slowing-down material) the specific energy losses of the particles become proportional to the square of particle velocity.[4] Consequently, if the residual ranges of He^8 and He^4 ions are equal, the specific energy losses are lower for the heavier ions.

An examination of various factors which could cause such an interpretation to be rejected (accidental superposition of tracks, reduced sensitivity of emulsion, or local inhomogeneity in development of the investigated tracks) indicates that their probability is low, although it is impossible to exclude the possibility of some such accident completely. Therefore at the present time we can only speak of the possible observation of He^8 nuclei.

If such nuclei are actually formed in the process of fragmentation, further confirmation of their existence can be obtained through investigation of the T-shaped tracks in an emulsion sensitive to particles with minimal ionization, by successfully establishing the emission of two decay electrons at the stopping point.

We take the occasion to express our gratitude to Professor N. A. Perfilov for discussion of the results.

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[2] V. I. Gol'danskii, JETP **38**, 1637 (1960), Soviet Phys. JETP **11**, 1179 (1960).

[3] Baz', Gol'danskii, and Zel'dovich, Usp. Fiz. Nauk **72**, 211 (1960), Soviet Phys.-Uspekhi **3**, 729 (1961).

[4] E. Fermi and E. Teller, Phys. Rev. **72**, 399 (1947).

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A NOTE CONCERNING π-Λ RESONANCE

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IT is well known that a connection exists between the possible resonances of the pion-hyperon system and the scattering amplitude. In particular, in the phenomenological analysis of the data on the K^--proton interaction[1] one finds that if one assumes that only the S state is involved and that the real part of the K^--p scattering amplitude is negative, there exists in the nonphysical region a singularity that corresponds to a pion-hyperon resonance.

In the recently published papers by Tuan[2] and by Ross and Shaw[3] the experimentally observed Λ-π resonance was identified with the above resonance. However, the investigations of the interference between Coulomb and nuclear scattering seem to indicate that this interference is constructive.[5] But in that case there should be no resonances in the pion-hyperon system which would correspond to a K^--p interaction in an S state.* Since the K^- meson is supposedly a pseudoscalar particle[6] the orbital angular momenta on both sides of the reaction

$$K^- + p \rightarrow \Lambda + \pi^0 \tag{1}$$

have to be the same.

From this it follows that the observed Λ-π resonance should not be related to an S state. Since the momentum of the particles in the center-of-mass system at resonance is ~ 200 Mev/c, it is natural to assume that it cannot be due to D waves. This way it follows that if the foregoing propositions are true then the observed π-Λ resonance has to be in a P state.†

This conclusion is supported by the circumstance that in the K^--p reaction the yield of Λ hyperons is small compared to that of Σ hyperons for K^- capture at rest, while it increases rapidly at momenta of 300 to 400 Mev/c where P waves become important.‡

A strong resonance of the π-Λ system in a P state indicates an analogy with the $(3/2, 3/2)$ resonance of the π-N system.

At present there exist published data on the different channels of the K^--p reaction for capture at rest and for the momenta 300, 400 and 1150 Mev/c. The ratio of the Λ to Σ yields at 1150 Mev/c is still larger than at 300 and 400 Mev/c. This can be an indication of either a continuous increase of the yield ratio in the considered energy interval** or of the chance that there is some resonance of the Λ-π system close to 1150 Mev/c. In this connection one can remark that if one would want to extend the analogy between the π-Λ and π-N systems and expect a second π-Λ resonance corresponding to the second $I = 3/2$ resonance of the π-N system as well as that c.m.s. momenta are close (which they are for the first resonance), then the second resonance of reaction (1) should lie close to a K^- momentum of 1.1 Bev/c in the laboratory system.

At present there do not exist direct experimental data on the cross section of reaction (1) at 1150 Mev/c. The existing data at this energy for the different hyperon production channels[7,4] are insufficient to perform the necessary analysis in isospin states. However, approximate calculations performed on their basis show that the cross section of reaction (1) at 1150 Mev/c seems to be larger than that of any reaction leading to the production of a Σ hyperon and a π meson.