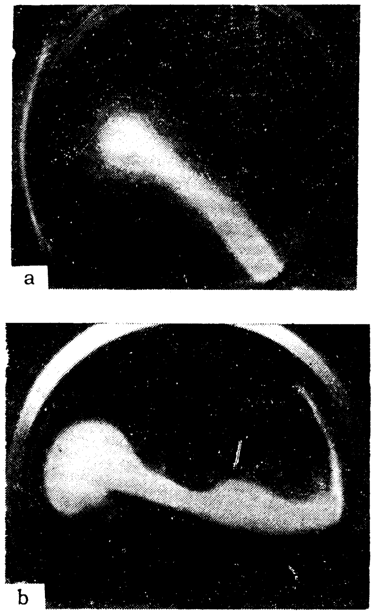

FIG. 2. Photographs of the glow of a luminescent screen located at 10 cm (a) and 80 cm (b) from the turn, 13 microseconds following the passage of the leading front of the jet through the section of the inhomogeneous field.

ing stages of the motion, the jet has a configuration similar to that shown in Fig. 2. This configuration is characterized by the presence of a nucleus, made up of the plasma moving along the force lines of the magnetic field, and a plasma tongue, in which the plasma drifts in the crossed fields E and H towards the outer wall of the chamber. Such a deduction agrees qualitatively with the curves of Fig. 1, and is confirmed by direct measurement of the electric field in the vicinity of the "nucleus" and the plasma tongue.

Since the plasma is not in magnetohydrodynamic equilibrium in a curvilinear magnetic field, it is clear that the motion of the jet should be accompanied by the ejection of plasma transverse to the field. The question is the character of the transverse motion and the rate of its development. The data given above show that under the conditions of our experiment the manifestation of the nonequilibrium nature of the plasma is the ejection of the plasma tongue, whereas the "nucleus" of the plasma jet does not experience any drift transversely to the field. The rate of escape of the plasma from the nucleus depends on the magnitude of the magnetic field, which determines the variation of the dependence of the number of particles passing through the curvilinear section on the value of H. On the whole, the velocity of plasma drift transverse to the field turns out to be in this case much smaller than predicted by Schmidt's theory

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THE QUESTION OF THE POSSIBLE EXISTENCE OF A HEAVY CHARGED LEPTON

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EARLIER the writer [1] and Zel'dovich [3] have discussed the hypothesis that there may possibly exist in nature new charged heavy leptons, whose mass must exceed that of the K meson and belong to the same domain of phenomena as the muon mass. The most direct way to the experimental detection of such leptons is to be found in experiments on the electromagnetic production by γ-ray quanta or in clashing electron beams. [1-4]

Another possibility has also been indicated earlier, [2] when for the purpose of excluding neutral lepton currents it was suggested that there exist two new charged leptons e'^+ and u'^+, which take part in weak interactions paired with the same respective neutrinos ν_e and ν_μ as the electron and muon. In this case one could expect the production of the new mesons in experiments with high energy neutrinos which are now being done at Brookhaven and at CERN. [5,6] We note that if observations were made with a hydrogen bubble chamber the only possible four-fermion process in the experiment with ν_μ would be the process involving the production of μ'^+ (cf. [2]).

Assuming that the mass m_l of the heavy lepton is less than the mass of the intermediate boson, we have the following fundamental decay channels:

$$\mu'^+ \to e^+ + \nu_e + \nu_\mu,\ \mu^+ + 2\nu_\mu, \quad (1)$$

$$\mu'^+ \to n\pi + \nu_\mu, \qquad n = 1, 2, 3, \ldots, \quad (2)$$

$$\mu'^+ \to K^+ + \nu_\mu,\ K + \pi + \nu_\mu. \quad (3)$$

For the mass $m_l = 5\ m_\mu$ the partial lifetime against decay by the channels (1) is 4×10^{-10} sec, and it falls off as $1/m_l^5$. The Michel parameter for the decays (1), unlike that for the μ decay, is zero, $\rho = 0$.

In the present note we wish to call attention to the fact that the experiments with high-energy neutrinos carried out so far [5,6] evidently do not exclude the indicated possibility of the existence of a heavy lepton μ'^+, but farther improvement of the statistics in these experiments will make it possible either to exclude or to confirm this possibility for masses $m_l \sim 5$–$9\ m_\mu$. Estimates show that in this range of masses the main decay of the heavy lepton would be the pion decay

$$l \to \pi + \nu, \quad (4)$$

which has a probability several times that of the leptonic decays (1). Assuming that the coupling constant between the lepton and pion currents is the same in the decays $\pi \to \mu + \nu$ and $l \to \pi + \nu$, we find

$$\tau(l \to \pi + \nu) = \frac{0{,}27}{(m_l/m_\pi)^2 - 2}\frac{m_\mu}{m_l}\tau_\pi. \quad (5)$$

From this it follows, for example that $\tau(l \to \pi + \nu) = 1 \cdot 10^{-10}$ sec for $m_l = 5\ m_\mu$ and $\tau(l \to \pi + \nu) = 2.4 \cdot 10^{-11}$ sec for $m_l = 8\ m_\mu$. Inclusion of other decay channels can decrease the estimate of the over-all lifetime by as much as a factor of two.

This short lifetime shows that in the neutrino experiments it may not be possible to detect the production of the heavy lepton as a free particle (especially in a spark chamber), and only the decay products will be observed, for example

$$\nu_\mu + p \to n + l^+ \to n + \pi^+ + \nu_\mu, \quad (6)$$

$$\bar{\nu}_\mu + n \to p + l^- \to p + \pi^- + \tilde{\nu}_\mu. \quad (7)$$

Such events can be imitated by neutral lepton currents ("inelastic" cases), and also by the presence of background neutrons ("neutron stars"). In these latter cases, however, there should be observed in addition to the processes (6), for example, also the products of reactions of the types $\nu_\mu + n \to p + \pi^- + \nu_\mu$ and $\nu_\mu + N \to N + \pi^0 + \nu_\mu$. If, on the other hand, the events are caused by heavy leptons, these latter processes will be absent. For the identification of the processes (6) and (7) it is important to study in detail the structure of the pion track in the immediate neighborhood of the vertex of the event. Events with pions but without visible leptons can raise suspicions of the presence of heavy leptons.

It is interesting that in a report in Sienna in October 1963 on "Preliminary Results in a Bubble Chamber" [6] it was indicated that 11 cases of events of the type $\nu_\mu + p \to n + \pi^+ + \nu_\mu$ had been noted. This was about 8 percent of the total number of events. This number can be regarded as a high estimate of the probability of process (6) under the conditions of the experiment in question. We note that the appearance of solitary strange particles observed by these authors may also be due to the production of μ'^+.

I sincerely thank L. B. Okun' for a valuable discussion.

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TRANSFER OF A NEGATIVE MUON FROM A PROTON TO CARBON

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WHEN negatively charged mesons are stopped in a hydrogen-containing compound, some of the mesons are captured by the mesic-atom orbits of the proton, forming a mesic-proton atom. In condensed media, owing to collisions with the atoms of the surrounding matter, a rapid transfer of the meson takes place to the lower energy levels of the mesic-proton atom, along with an