Search for the Electronic Decay of the Positive Pion (*).

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Summary. — A double focussing magnetic spectrometer of high transmission (1.8%) and good resolution (3.0%) was used in a search for the electronic decay of the positive pion. No evidence was found. The fraction of decays of the type $\pi \to e + \nu$ was found to be $f = (-0.4 \pm 9.0) \cdot 10^{-6}$. The result appears to be statistically significant and thereby allows only a 1% probability that $f$ could have a value greater than $2.1 \cdot 10^{-6}$. From a search for electrons of momentum 60.3 MeV/c we could conclude that the fraction of decays of the type $\pi \to e + \gamma + \nu$ was $f_\gamma = (-2.0 \pm 1.6) \cdot 10^{-4}$ assuming tensor interaction determines the spectrum. Much lower limits for this last process have been recently reported by CasseLS and by Lokanathan.

1. - Introduction.

The normal decay of the charged pion is into a muon and a light neutral particle, presumed to be a neutrino. An alternative possibility, the decay into an electron instead of the muon, has never been observed. This seems par-...
particularly strange in view of the fact that the muon appears to have just those properties which would be expected of a more massive electron. Thus, the scattering of muons by nuclei is mostly an effect of the Coulomb field. What anomalies have been observed in the scattering seem to find their explanation in the inelastic processes which can be induced by the electromagnetic behavior of the muon \(^{(1)}\). That this can hardly be different from that of an electron of muonic mass has been demonstrated in several ways. The energy levels of the \(\mu\)-mesic atoms bear the correct relationship to those of an electron with augmented mass \(^{(2)}\). In fact, the electric charge distribution of the heavy nuclei as determined from the \(\mu\)-mesic X-ray measurements is just that which is found from the scattering of high energy electrons. Moreover, observations of the precession of polarized muons in a magnetic field have confirmed the fact that their gyromagnetic ratio is, to within 0.24 \%, not different from that of the electron \(^{(3)}\). In addition, the production of \(\mu\)-meson pairs by high energy \(\gamma\)-rays seems to proceed with the Bethe-Heitler cross-section calculated for a heavy electron \(^{(4)}\).

While these evidences point to an identical electromagnetic behavior of the muon and the electron and to the absence of other strong interactions, it is remarkable that also in the weak interaction which it exhibits with the neutrino field the behavior of the muon is closely the same as that of the electron. Thus, GODFREY \(^{(4)}\) was able to demonstrate the close identity of the coupling strength involved in the \(\mu\) capture reaction

\[
\mu^- + ^{12}\text{C} \rightarrow ^{12}\text{B} + \nu
\]

and the \(\beta\)-decay process

\[
^{12}\text{B} \rightarrow ^{12}\text{C} + e^- + \nu
\]

involving the same nuclear levels. This experiment, among many others, has served to reinforce the idea that a single "universal" Fermi interaction sufficed to explain not only \(\mu\) capture, \(\beta\)-decay and \(\mu\)-decay \(^{(6)}\), but also pion decay as well.

\(^{(1)}\) G. N. Fowler: *Nuclear Physics*, 3, 121 (1957).