power of the radiation was not changed significantly by this. During operation of the generator with Q-modulation the energy was emitted in the form of one or several peaks (not more than ten) of varying amplitude.

Such Q-modulation can be useful in the design of amplifiers, since the number of active particles in the upper level accumulated during the flash time is practically independent of the power level of the pump.

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MEASUREMENT OF THE PROBABILITY FOR THE REACTION $\mu^- + He^3 \rightarrow H^3 + \nu$

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THE probability of the reaction

$$\mu^- + He^3 \rightarrow H^3 + \nu \qquad (1)$$

was measured in order to study the question of the muon-electron symmetry in interactions with nucleons.

We used a method which had been developed earlier.[1] A diffusion cloud chamber filled with He^3 gas at a pressure of 20 atm was exposed in a magnetic field of 6000 Oe to an extracted beam of 217-MeV/c pions from the synchrocyclotron at the Nuclear Problems Laboratory of the Joint Institute for Nuclear Research. The mesons were slowed down by a copper filter placed in front of the chamber.

The entire experimental material (about 10^5 pictures) was scanned twice. Since the stopping mesons could be identified with great reliability for a track length $L_0 \geq 20$ mm, we considered only such stopping particles. It was found that the scanning efficiency for stopping mesons was close to unity and was practically independent of the character of the events at the end of the track.

The absolute probability of capture can be determined from the well-known muon lifetime (2.21×10^{-6} sec) and the observed ratio of the number of capture events to the number of μ-e decays from the He^3 mesic-atom state. Since the triton produced in reaction (1) has a unique energy (1.897 MeV), the problem of identifying these reactions (triton stars) was reduced to the separation of a group of one-prong stars of corresponding range from the background due to other processes. We used the following two methods to determine the total number of events of type (1):

1. We considered the spectrum of the visible lengths of secondary particle tracks from all stars, except those which could not be triton stars because of the character of their ionization (Fig. 1).

2. We considered the range spectrum of secondary particles which were reliably found to come to rest (Fig. 2). In this case it is necessary to introduce an additional correction to take into account the number of triton stars with stopping H^3, but whose endings were of an uncertain nature.

Two peaks are clearly visible in both spectra. One peak falls within the ranges 2.0—2.6 mg/cm², corresponding to reaction (1), and another falls within the ranges 5.3—5.9 mg/cm², corresponding

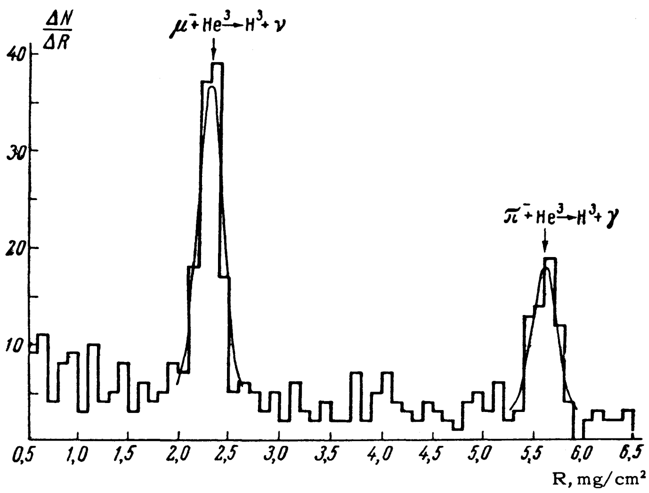

FIG. 1. Spectrum of visible track lengths of secondary particles for all stars produced by stopping mesons.

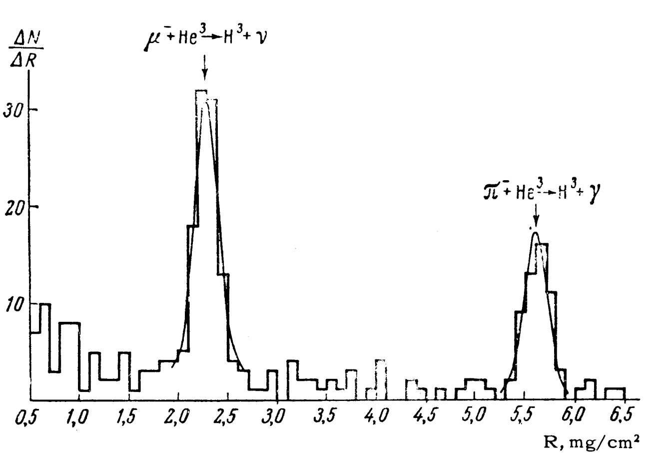

FIG. 2. Range spectrum of secondary particles which were reliably found to stop.

to radiative capture of π^- by He^3 ($\pi^- + He^3 \rightarrow He^3 + \gamma$). The resolution curves are shown by solid lines in Figs. 1 and 2.

The experimental results pertaining to the number of triton stars for methods 1 and 2 are shown in the table. Also shown are the experimental data on the number of μ-e decays from the He^3 mesic-atom state.

Number of events (1) ($L_0 \geq 20$ mm)		
recorded:	95.5±11.9	88.3±10.4
with efficiency correction:	106.0±13.1	105.2±12.7
Number of μ–e decays ($L_0 \geq 20$ mm)		
visible electrons:	24.861±157	
electrons not visible:	10 963±440	
correction for C and O mesic atoms:	—358±121	
used in the calculation:	35 466±615	

The final result for the probability of reaction (1) is $(\Lambda_{He^3})_{expt} = (1.36 \pm 0.18) \times 10^3\ sec^{-1}$. It is necessary to compare this value with the theoretical value given by Wolfenstein:[2] $(\Lambda_{He^3})_{theor} = 1.54 \times 10^3\ sec^{-1}$ (see also [3]). The calculation of $(\Lambda_{He^3})_{theor}$ was based on the theory of the universal vector and axial vector interaction with pion corrections under the assumption that the vector current is conserved and the hyperfine structure levels of the mesic atom of He^3 are populated statistically.

The absence of effective mechanisms for transition between hyperfine structure levels in the He^3 mesic atom and the insensitivity of $(\Lambda_{He^3})_{theor}$ to a deviation from a statistical population allows us to conclude that the interpretation of the experiment with He^3 from this standpoint is unambiguous. The size of the uncertainty in $(\Lambda_{He^3})_{theor}$, owing to the uncertainty in our knowledge of the mean-square radius of the nucleus and the errors in the value of ft for tritium, is 5%.[2,3] The difficulty in the estimation of the uncertainty connected with calculations of the pseudoscalar constant g_P^μ proves to be important only in the region $g_P^\mu \lesssim +8g_A^\mu$, where g_A^μ is the axial-vector constant in μ capture. The experimental value of the probability of reaction (1) is definite evidence that g_A^μ and g_P^μ have the same sign and that the absolute value of g_P^μ is not small ($5g_A^\mu < g_P^\mu < 35g_A^\mu$).1) Consequently, the uncertainty in the calculated value of g_P^μ cannot play an important role.

Hence it should be concluded that the probability of reaction (1) predicted by the universal theory is in agreement with experiment, within the limits of the theoretical and experimental uncertainties. This signifies that in interactions with a nucleon the muon-electron symmetry, which is fundamental to the universal theory, does not contradict the experimental results to an accuracy of 13%.

We now consider the question of the Fermi interaction, whose presence in μ capture has yet to be proved.

Reaction (1) is a mixed transition dependent on two phenomenological constants: the Fermi constant G_F and the Gamow-Teller constant G_G [$\Lambda_{He^3} \sim (G_F^2 + 3G_G^2)$]. The combined analysis of the results of our experiment and the experimental data on the probability for the reaction

$$\mu^- + C^{12} \rightarrow B^{12} + \nu, \qquad (2)$$

in which the pure Gamow-Teller transition occurs, allows us to estimate $|G_F|$. Here, no assumptions should be made about the form of the four-fermion interaction. Unfortunately, there are considerable disparities among the various experimental data on the probability for reaction (2). All that seems possible is to give preference to the more recent measurements of Maier et al[5] [$\Lambda_{C^{12}} = (6.31 \pm 0.24) \times 10^3\ sec^{-1}$]. We then find that $|G_F| = (0.87^{+0.4}_{-0.8})\,|G_G|$. The error takes into account the experimental uncertainty in $(\Lambda_{He^3})_{expt}$ and the uncertainty in the ratio of the nuclear matrix elements for reactions (1) and (2). According to Wolfenstein,[2] the latter is about 20% and constitutes the main error.

Another possibility for obtaining information on the Fermi constant is to include the results of an experiment with hydrogen.[6] The relative probability of muon capture from mesic-molecular hydrogen states and the mesic atom states of He^3 ($\Lambda_{p\mu p}/\Lambda_{He^3}$) is very sensitive to the ratio G_F/G_G.[2] The result will naturally depend on the accuracy of the calculation of $\Lambda_{p\mu p}$; this accuracy is not very well known. If we take into account only the experimental errors, then we find that $G_F < -0.1$. The final estimate of the Fermi constant can be taken as $G_F = -(0.8^{+0.4}_{-0.7})G_G$.

This result, which confirms the presence of the Fermi interaction along with the Gamow-Teller interaction in muon capture, excludes the possibility that G_F is considerably greater than G_G and is quite compatible with the value expected on the basis of the theory of the universal (V–A) interaction.

Of course, the existence of the vector interaction more clearly follows from our measurements if it is assumed that $g_A^\mu = g_A^\beta$ (see [2]) $g_P^\mu = 8g_A^\mu$ (see [7]). As a matter of fact, if the vector interaction is not present, the probability of reaction (1) under these assumptions is expected to equal $0.93 \times 10^3\ \text{sec}^{-1}$, i.e., much less than the measured value. However, the values of g_A^μ and g_P^μ which were used cannot be considered equally well founded.

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ANOMALOUS REFLECTION OF SOUND FROM THE SURFACE OF A METAL AT LOW TEMPERATURES

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WE shall show that in certain cases the conduction electrons can significantly alter the reflection coefficient for sound incident from a liquid onto the surface of a metal. A treatment is presented of the low temperature case for which the absorption of sound in a metal is chiefly due to the electrons.

Consider a liquid occupying the semi-infinite space $z > 0$, from which a plane sound wave is incident upon a metal surface. The velocity field is defined in the liquid by specifying the scalar potential φ, namely $\mathbf{V} = \text{grad}\ \varphi$; and in the solid by a scalar potential Φ and a vector potential $\boldsymbol{\Psi}$ such that $\dot{\mathbf{u}} = \text{grad}\ \Phi + \text{curl}\ \boldsymbol{\Psi}$, where $\mathbf{u}$ is the displacement vector. If the wave vector $\mathbf{k}$ for the incident wave lies in the xz plane, $\boldsymbol{\Psi}$ can be chosen in such a way that only its y component differs from zero; we shall call this component Ψ. Let the angle of incidence of the sound be θ, and its frequency ω; then

$$\varphi = \{A_0 \exp [ik (x \sin\theta - z\cos\theta)] + A \exp [ik (x \sin\theta + z\cos\theta)]\} e^{-i\omega t},$$

$$\Phi = A_l \exp \{ik_l (x \sin\theta_l - z\cos\theta_l) - i\omega t\},$$

$$\Psi = A_t \exp \{ik_t (x \sin\theta_t - z\cos\theta_t) - i\omega t\},$$

$$k = \frac{\omega}{c}, \quad k_l = \frac{\omega}{c_l}, \quad k_t = \frac{\omega}{c_t}; \qquad \frac{\sin\theta}{c} = \frac{\sin\theta_t}{c_t} = \frac{\sin\theta_l}{c_l}, \tag{1}$$

where c is the velocity of sound in the liquid, and c_l and c_t are, respectively, the velocities of the longitudinal and transverse components of the sound in the metal. For simplicity, we assume the metal to be isotropic. Further, we assume that $c < c_t$.

The coefficients A, A_l, and A_t are determined by the system of boundary conditions at $z = 0$, which equate the normal displacements and pressures on either side of the boundaries.

If $\theta > \theta_0$, where $\sin\theta_0 = c/c_t$, total internal reflection occurs. This is true only insofar as we neglect the absorption of sound in the metal.