The method proposed here may be superior to the usual methods [8] in sensitivity, accuracy, and speed of determination of D.

In conclusion, I am grateful to I. L. Fabelinskii for a useful discussion of the questions touched upon in the paper.

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ON THE LIFETIME OF $^3H_\Lambda$

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Until recently there were considerable discrepancies between theory and experiment with respect to the lifetime of hypertritium. The experimental lifetime of $^3H_\Lambda$ was found by Block [1] to be $\tau(^3H_\Lambda) = (0.95^{+0.19}_{-0.15}) \times 10^{-10}$ sec. At the same time, calculations by Dalitz and Rayet [2] gave for this quantity values (2.28×10^{-10} sec $\leq \tau(^3H_\Lambda) \leq 2.44 \times 10^{-10}$ sec) much closer to the lifetime of the free Λ-hyperon ($\tau(\Lambda) = (2.51 \pm 0.03) \times 10^{-10}$ sec [3]). The latest experiments yielded $\tau(^3H_\Lambda) = (2.32^{+0.45}_{-0.34}) \times 10^{-10}$ sec [4] and $\tau(^3H_\Lambda) = (2.85^{+1.27}_{-1.05}) \times 10^{-10}$ sec [5], which are close to the value of $\tau(\Lambda)$ and to the theoretical estimate of [2].

In deriving the result of [2], certain approximations were made, and their accuracy is difficult to estimate. This pertains, first, to the taking of the δ-function outside the summation over the final states of the system, leading to an allowance to extra states (not corresponding to the conservation laws). Second, the model wave function used in [2] for $^3H_\Lambda$ does not have the correct asymptotic behavior at large distances between the Λ and the deuteron [6], (i.e., $[\exp(-\alpha r_d)]/r_{\Lambda d}$, where $\alpha^2 = 2m_{\Lambda d}\epsilon_{\Lambda d}$; m_{if} is the reduced mass of i and f and $\epsilon_{\Lambda d} = (0.20 \pm 0.12$ meV throughout [7]). The purpose of the present paper is to obtain for the lifetime of $^3H_\Lambda$ an estimate independent of these assumptions.

$^3H_\Lambda$ has three different channels of decay with emission of a negative pion [8]: $^3H_\Lambda \to \pi^- \, ^3He$, $^3H_\Lambda \to \pi^- pd$, and $^3H_\Lambda \to \pi^- ppn$. Experiments [4] have yielded the quantity $R_3 = W_{II}/(W_{II} + W_{III} + W_{IV}) = (0.38 \pm 0.09)$, where W_n is the probability of n-particle decay. In addition, it is known that W_{IV} is small and amounts to 10% of W_{III} [8]. Since the binding energy $\epsilon_{\Lambda d}$ is small, it is clear that the main contribution to the amplitude of the 3-particle decay is made by the pole diagram (Fig. 1a). The diagram making the main contribution to two-particle decay is shown in Fig. 1b (see [9] concerning the nonrelativistic diagram technique). In the calculation of the diagrams, the amplitude M_2 was assumed to be constant and its value was

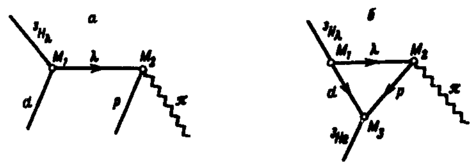

Fig. 1

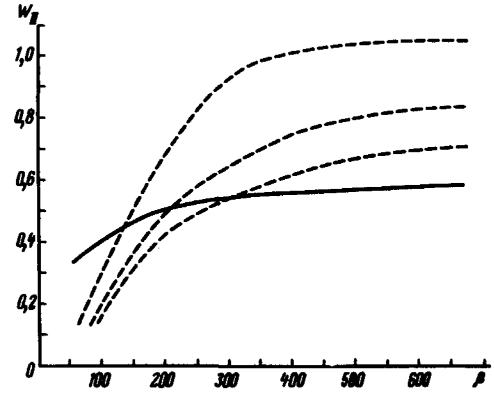

Fig. 2

Fig. 1. Diagrams making the main contribution in two- and three-particle decays of $^3H_\Lambda$; d - deuteron, Λ - Lambda hyperon, π - negative pion, p - proton.

Fig. 2. Plots of W_{II} vs. β. Abscissas - the parameter β in millielectron volts, ordinates - W_{II} in units of $\Gamma_\Lambda = \tau_\Lambda^{-1}$.

determined from the decay probability of the free Λ-hyperon

$$M_2^2 = \frac{\pi}{\tau_\Lambda} \frac{1}{m_{p\pi}\sqrt{2 m_{p\pi}\Delta}};$$

$\Delta = m_\Lambda - m_p - m_\pi$. The amplitude M_1 was assumed to be a function of the momentum transfer $p_{\Lambda d}$ at the vertex, and given by

$$M_1^2 = \frac{2\pi}{m^2_{\Lambda d}} \left(\frac{\beta^2 - a^2}{\beta^2 + p^2_{\Lambda d}}\right)^2 \sqrt{2 m_{\Lambda d}\epsilon_{\Lambda d}},$$

which corresponds to a wave function of the relative motion of Λ and d in Hulthen's form [10]. The amplitude M_3 was taken in the form

$$M_3 = G_3\left(\frac{\delta^2 - \kappa^2}{\delta^2 + p^2_{pd}}\right)$$

where the residue G_3 of the function M_3 at the pole $i\kappa$ was determined in [11] from a study of the single-nucleon transfer reactions on ^{3}He and amounts to $G_3^2 = 0.96 \pm 0.13$ F ($\kappa^2 = 2m_{pd}\epsilon_{pd}$; $\epsilon_{pd} = m_d + m_p - m_{^3He}$). Calculations yield the following expressions for $W_{II}(\beta,\delta)$ and $W_{III}(\beta)$:

$$W_{III}(\beta) = \frac{1}{\tau_\Lambda}\left\{1 - 3c^2 + \frac{4c^2(1-c^2)}{d^2 - c^2} + \frac{c}{d}(1 - 3d^2) - 4cd\frac{1-d^2}{d^2-c^2}\right\}, \tag{1}$$

$$W_{II}(\beta,\delta) = \frac{4{,}87}{\tau_\Lambda}\left[\operatorname{arc\,tg}\frac{A}{a+\kappa} + \operatorname{arc\,tg}\frac{A}{\beta+\delta} - \operatorname{arc\,tg}\frac{A}{a+\delta} - \right.$$

$$\left. - \operatorname{arc\,tg}\frac{A}{\kappa+\beta}\right]^2, \tag{2}$$

where

$$c^2 = \frac{m_{\Lambda d}\,\epsilon_{\Lambda d}}{m_{+d}\,\Delta}; \quad m_+ = m_p + m_\pi; \quad d^2 = \frac{\beta^2}{2m_{+d}(\Delta - \epsilon_{\Lambda d}) + \beta^2};$$

$$A = \frac{m_d}{m_d + m_p} p_\pi ; \quad p_\pi^2 = 2m_{^3He\pi} (\Delta + \epsilon_{pd} - \epsilon_{\Lambda d}).$$

Taking $W_{III}(\beta)$ from (1) and using the values of R_3 and $W_{IV}:W_{III}$ (see above we obtain W_{II} as a function of β only:

$$W_{II}(\beta) = 1{,}10 \frac{R_3}{1 - R_3} W_{III}(\beta) = 0{,}674\, W_{III}(\beta). \quad (3)$$

A plot of $W_{II}(\beta)$ corresponding to (3) is shown by the solid curve of Fig. 2. The point $\beta = \infty$ on this curve corresponds to the maximum decay rate of $^3H_\Lambda$ The dashed curves in Fig. 2 correspond to the functions $W_{II}(\beta,\delta)$ [Eq. (2)] at different fixed values of δ. The upper dashed curve corresponds to $\delta = \infty$. The point of intersection of $W_{II}(\beta,\infty)$ and the solid curve determines the minimum value of the $^3H_\Lambda$ decay probability. The table lists the final results (the following experimental values were used for the calculation: $R_3 = 0.38$, $G_3^2 = 0.96$ F, $\epsilon_{\Lambda d} = 0.20$ MeV; $W_{IV}: W_{III} = 0.10$). We wish to note that better statistics are needed for R_3 and $W_{IV}:W_{III}$. All widths are given in units of $\Gamma_\Lambda = \tau_\Lambda^{-1}$.

	Experiment				Theory	
Reference	[1]	[12]	[4]	[5]	[2]	Our data
$\Gamma^{min}_{^3H_\Lambda}$	2.2	2.09	0.96	0.69	1.03	1.17
$\Gamma^{max}_{^3H_\Lambda}$	3.14	6.28	1.27	1.40	1.10	1.52

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