deviations greater than 7 per cent up to an energy of about 7 Mev. The agreement with experiment is also satisfactory for Cf^{252}, although the experimental accuracy is not high.[12] Similar results can be obtained assuming that $\omega(\epsilon) \sim \exp(-\epsilon/\tau_{L,H})$, where $\tau_{L,H}$ are the temperatures of the fragments which correspond to their mean excitation energies. These temperatures can be calculated using the formula

$$\tau_{L,H} = \left[\frac{\bar{E}_{L,H} - E^{B}_{L,H} - \bar{\varepsilon}_{L,H}}{a_{L,H}}\right]^{1/2},$$

and for U^{235} fragments we obtain $\tau_L \sim 1$ Mev and $\tau_H \sim 0.8$ Mev.

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THE POSSIBILITY OF ESTIMATING THE MEAN LIFETIME OF ALPHA PARTICLES WITHIN NUCLEI

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It has often been shown[1-6] that α-particle substructures and others exist within the nucleus. According to the references cited, these substructures participate in nuclear cascade processes and can be knocked out of a nucleus by a fast particle passing through it. Cuër, Combe, and Samman[1-5] assumed that these substructures are unstable in nuclei. Combe[4] considers their lifetimes to be probably of the order of 10^{-22} sec. If this is so, it may be possible to obtain experimental indications as to their mean lifetimes. Let us consider knockout of α particles from nuclei.

If the α particles are stable within the nucleus, then the energy spectrum with which they are knocked out will be given by $N(E) = f(E)P(E)$, where $f(E)$ is the recoil-energy distribution function of the α-particles within the nucleus for positive E, and $P(E)$ is the Coulomb barrier penetration factor for the α particles. If the α particles are unstable within the nucleus with a mean lifetime τ_α of the order of 10^{-22} sec, the expression for $N(E)$ should contain a factor which accounts for their disintegration during the time they move within the nucleus. If this disintegration can be described by an exponential law of the form $N = N_0 \exp(-t_{eff}/\tau_\alpha)$, the knockout α-particle energy spectrum will be of the form

$$N(E) = f(E)P(E) \exp\{-[m_\alpha/2(E+U)]^{1/2} l/\tau_\alpha\}, \quad (1)$$

where $t_{eff} = l/v$ is the time it takes an α-particle which attains the velocity v at the point of collision to move through the shortest distance l to the surface of the nucleus. This distance l should be chosen from the condition that in a spherical shell of thickness l low-energy recoil α particles can be produced efficiently and can leave the nucleus with the least possible losses due to disintegration. In the above equation m_α

is the mass of the α particle, and U is the depth of the potential well.

Let us evaluate the exponent of Eq. (1) with $\tau_\alpha = 10^{-22}$ sec and for an energy E equal to the height of the Coulomb barrier U_C; we shall treat nuclei in which U is known. For C^{12} nuclei,[5] $U \approx 11$ Mev. For different nuclei the distance l can be chosen about equal to the α-particle diameter. For C^{12} we have $l \approx R = 1.4 \times 10^{-13} A^{1/3}$ cm and $U_C \approx 4$ Mev. With these assumptions the exponent for C^{12} is 1.2. For silver nuclei, we again set $E = U_C$ and assume that $l(\mathrm{Ag}) = l(C^{12})$ and $U(\mathrm{Ag}) \approx U(C^{12})$; the exponent is then -0.8.

These values of the exponents indicate that if $\tau_\alpha = 10^{-22}$ sec, the α-particle spectrum given by (1) should be measurably weakened in the energy region around $E = U_C$.

The situation changes drastically if τ_α is actually somewhat less than 10^{-22} sec. A lifetime smaller by a factor of 2 or 2.5 is sufficient to decrease the exponent for C^{12}, for instance, to 0.05 for $E = U_C$. Then for this energy there should be practically no α-particles knocked out, and they should appear in measurable quantities only for $E \geq E_{\alpha\,\mathrm{eff}} > U_C$.

Now 10^{-22} sec is the time it takes a 20-Mev nucleon in the nucleus to pass entirely through a C^{12} nucleus. It is very probable that internal α-particles can be destroyed in collisions with fast nuclei located in their vicinity when they are formed. There is therefore reason to suppose that τ_α is considerably less than 10^{-22} sec. If this is so, experiment should observe almost the complete absence of α particles knocked out in the energy region $U_C(A) < E < E_{\alpha\,\mathrm{eff}}$. An experimental determination of $E_{\alpha\,\mathrm{eff}}$ could be used to estimate τ_α.

It should be noted that this effect is more probably observable for nuclei with A around 12 or 20 than for nuclei with A around 100, since there may be quite a large number of α particles produced in the latter in a shell with low l.

Deuteron knockout will be observed if τ_d is less than τ_α, for if we consider deuterons with energy $E = U_C$ and set $U \approx 30$ Mev,[6] $l(d) = l(\alpha)$, and $\tau_d = 10^{-22}$ sec, the exponent in Eq. (1) becomes -0.6.

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NONLOCAL EFFECTS IN WEAK INTERACTIONS OF FERMIONS

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RECENTLY Lee and Yang[1] have studied the nonlocal four-Fermion interactions as applied to μ decay. Phenomenologically these interactions can be described using a Lagrangian corresponding to the interaction of pairs of fermions separated by a space-like interval of the order of 10^{-13} to 10^{-14} cm.

The present communication gives a similar treatment of nonlocal effects in μ^- capture by a proton. The neutrino is described by the two-component theory.[2-4]

1. The nonlocal Lagrangian for the interaction which gives rise to the $\mu^- + p \rightarrow n + \nu$ reaction is

$$L = \sum_i g_i \int [\bar{\psi}_n(x) O_i \psi_p(x)] K_i(x - x') \times [\bar{\psi}_\nu(x') O_i \psi_\mu(x')] d^4x d^4x'; \psi_\nu = -\gamma_5 \psi_\nu. \quad (1)$$

In this expression the summation is taken over all possible S, V, T, P, and A couplings; the O_i are the appropriate Dirac matrices, and $K_i(x - x')$ is an invariant function of $x - x'$ which accounts for the nonlocal extension of the interaction. Assuming that the space-time extension of $K_i(x - x')$ is smaller than the inverse of the energy momentum transfer involved in the process, we can write

$$K_i(x - x') = \delta^4(x - x') + \frac{\varkappa_i}{m^2} \frac{\partial^2}{\partial x_\lambda^2} \delta^4(x - x') + \ldots, \quad (2)$$

$$(i = S, V, T, P, A; \hbar = c = 1),$$

where m is the mass of the μ meson, and $|\kappa_i/m^2|^{1/2}$ is the length characterizing the non-