NEW ISOMER Sn$^{13m}$

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According to the systematics of the half-lives of the isotopes, one would expect the long-lived ($T = 119$ days) tin isotope Sn$^{113}$ to have an isomer with a half-life somewhat shorter than that of Cd$^{111m}$ ($T = 48.7$ min). Actually, an investigation of the isotope Sn$^{113}$ ($T = 7$ min) with a double-lens $\beta$ spectrometer has disclosed that, as a result of positron decay, this isotope is partially transmuted into a new isomer, Sn$^{113m}$, with a half-life of $27 \pm 3$ min.

There have been observed in the conversion spectrum of Sn$^{113}$ electrons with energies 49.6, 75.3, and 77.4 kev, corresponding to conversion of $\gamma$ radiation of energy $79.3 \pm 0.5$ kev on the K, L, and M shells. The ratio of the conversion on the K shell to that on the L shell is 1.75.

Theoretical values of this ratio, for transitions of various multipolarities, are: $E1 - 9.45$, $E2 - 3.8$, $E3 - 0.95$, $M1 - 7.55$, $M2 - 3.8$, and $M3 - 3.56$. The extrapolated value for $M4$ is about 1.7. Consequently, the isomer transition from the metastable state of Sn$^{113m}$ has a multipolarity $M4$.

Translated by J. G. Adashko

REMARK ON THE DECAY OF THE CASCADE HYPERON

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If the spin of the cascade hyperon is $\frac{1}{2}$, the amplitude of its decay

$$\Xi^0 \rightarrow \Lambda^0 + \pi^0, \quad \Xi^- \rightarrow \Lambda^0 + \pi^-$$

(1)
can be written in the form

$$A = 2\mu_{\Lambda}(a + le^{i\varphi}sn)\mu_{\Xi}.$$  (2)

Here $a$ and $b$ denote the amplitude for the formation of $\Lambda^0$ and $\pi$ in the S and P states, respectively, and $\varphi$ is the difference of the phase shifts for the scattering of the $\pi$ meson by the $\Lambda$ hyperon in these states. The unit vector $\mathbf{n}$ is directed along the momentum of the $\Lambda^0$ hyperon in the rest system of the $\Xi$ hyperon, the $\sigma$'s are the Pauli matrices, and $u_{\Lambda}$ and $u_{\Xi}$ are two-component spinors.

If the polarization vector of the $\Xi$ hyperon (in the rest system of $\Xi$) is denoted by $\eta$ and the polarization vector of the $\Lambda$ hyperon (in the rest system of $\Lambda$) by $\zeta$, the probability of the decay of a polarized $\Xi$ hyperon with formation of a polarized $\Lambda$ hyperon, as calculated with the help of the amplitude (2), has the form

$$W(n, \eta, \zeta) = a^2 + b^2 + 2ab \cos \varphi((\zeta n + \eta n) + (a^2 - b^2) \zeta \eta + 2b\zeta((\zeta n)(\eta n) + 2ab \sin \varphi [\eta \zeta]n).$$  (3)

Formula (3) contains, of course, all possible correlations which were recently considered by Teutsch, Okubo, and Sudarshan.1 With regard to this formula we should like to make the following observation. As is seen from formula (3), the polarization of the $\Lambda$ hyperons in the direction perpendicular to the plane defined by the vectors $\eta$ and $\mathbf{n}$ will be zero unless $\varphi \neq 0$. The study of the polarization of the $\Lambda$ hyperons in this direction (together with the measurement of the longitudinal polarization of the $\Lambda$ hyperons, for example) permits, therefore, the determination of the difference of the S and P phase shifts in the scattering of $\pi$ mesons by $\Lambda$ hyperons.

We note that, by isotopic invariance, the value of $\varphi_{\perp}$, obtained from the decay of the $\Xi^0$ hyperon, and of $\varphi_{\parallel}$, obtained from the decay of the $\Xi^-$ hyperon, should be identical.

For comparison we mention that the $S$ phase shifts for the scattering of a $\pi$ meson by a nucleon at corresponding energies (the momentum in the center-of-mass system is equal to $m_{\pi\sigma}$) are approximately equal to $\alpha_1 \approx -7^\circ$ for the channel $T = \frac{1}{2}$ and to $\alpha_3 \approx +10^\circ$ for $T = \frac{3}{2}$ (reference 2). The resonance $P$ phase is equal to $\alpha_3 \approx 12^\circ$, while the other $P$ phases are close to zero.

Translated by R. Lipperheide

CONCERNING THE ARTICLE BY S. M. BILEN'KII, R. M. RYNDIN, Ya. A. SMORODINSKII, AND HO TSO-HSIU, “ON THE THEORY OF NEUTRON BETA DECAY”

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Weinberg\(^1\) proved a theorem from which it follows that the full probability for a process of the type \(\alpha \to \beta + l + \bar{\nu}\) (\(\alpha\) and \(\beta\) are arbitrary strongly interacting particles and \(l\) is a lepton) does not contain V-A interferences. It is easy to see that the expression (12) for the total probability of neutron decay given in our paper\(^2\) satisfies this condition, since the dependence on the approximation \(12\) does not contain \(V-A\) interferences.

The expression (12) may be rewritten as follows:

\[
W = \frac{\alpha^2}{(2\pi)^3} \left( m^4 \left( E_0 - m^2 + \frac{2E_0^2}{m} \right) \right) \ln \frac{E_0 + \sqrt{E_0^2 - m^2}}{m} 
+ \frac{2}{10} \sqrt{E_0^2 - m^2} \left[ E_0^2 - \frac{9}{2} E_0^2 m^2 - 4m^4 
+ \frac{E_0^4}{m} \right] .
\]

We are grateful to Prof. J. Bernstein for bringing the work of Weinberg to our attention.

\(^2\)Bilenki, Rydin, Smorodinski, and Ho Tso-Hsiu, JETP 37, 1758 (1959), Soviet Phys. JETP 10, 1241 (1960).

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PRODUCTION OF “SUPERCOLD” POLARIZED NEUTRONS

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The rapidly developing research on “cold” neutrons could be greatly widened if “supercold” neutrons with energies of the order of \(10^{-4}\) to \(10^{-6}\) K could be successfully obtained. However, at moderator temperatures of \(1^\circ\) K, the yield of neutrons with energies of the order of \(10^{-5}\) degrees K amounts to only \(10^{-11}\) of the total flux. To increase the yield of “supercold” neutrons, a new moderation method is proposed below, based on the interaction of the neutron’s magnetic moment with a non-uniform magnetic field.

When a neutron crosses a magnetic field \(H\), the change in the kinetic energy \(\epsilon\) of the neutron will be equal to

\[
\Delta \epsilon = \int \mu_{\text{eff}} \frac{\partial H}{\partial s} \, ds,
\]

where \(\mu_{\text{eff}}\) is the component of the neutron’s magnetic moment in the direction of the field \(H\), and \(s\) is the path traversed by the neutron in the field. Since the region affected by a magnetic field can be separated into two parts, in which the gradients are directed in opposite directions, then for \(\mu_{\text{eff}} = \text{const}\) we have \(\Delta \epsilon = 0\).

The neutron energy can be changed by a corresponding change in the sign of \(\mu_{\text{eff}}\), i.e., by a reorientation of the neutron spin at the instant it passes through the maximum of the magnetic field. For this purpose a uniform magnetic field, falling off to zero at the ends, is applied along the neutron path. When a neutron with its moment opposed to the field enters the field, it is acted on by a retarding force \(F = \mu_{\text{eff}} B H / \partial s\) (neutrons with spins oriented in the opposite direction will be accelerated). At the instant when it reaches the maximum field \(H_0\), where \(\Delta \epsilon = \mu_{\text{eff}} H_0\), the change in speed will equal

\[
\Delta v_1 \approx \mu_{\text{eff}} H_0 / m v_0,
\]

where \(m\) is the mass and \(v_0\) the initial velocity of the neutron.

If a field \(H_1\) of radio frequency \(\omega = \gamma H_0\) is applied in a direction perpendicular to \(H_0\) and if it satisfies the condition \(H_1 \Delta t = h / \mu_N (\Delta t\) being the time of flight of the neutron through the field \(H_1\), \(\gamma\) the gyromagnetic ratio, and \(\mu_N\) the nuclear magneton), then the result will be a reversal of the spin of the traveling neutron, and consequently a change in the sign of \(\mu_{\text{eff}}\). This will cause retardation of the neutron during its exit from the constant-field region as well as during its entrance, and the total loss in velocity will be \(2 \Delta v_1\). The reorientation of neutron spins can be accomplished in a field \(H_0\) of length 2 to 5 cm, with \(H_1 \sim 1\) gauss. The velocity lost by a neutron during a single passage through the field is very small. Thus, if \(H_0 = 20,000\) gauss and the initial velocity is \(2 \times 10^5\) cm/sec we have \(2 \Delta v_1 = 100\) cm/sec.