NEW ISOMER Sn^{113m}

I. P. SELINOV and V. L. CHIKHLADZE

Submitted to JETP editor January 19, 1960

J. Exptl. Theoret. Phys. (U.S.S.R.) **38**, 1012 (March, 1960)

ACCORDING to the systematics of the half-lives of the isomers, 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 Sb^{113} (T = 7 min) with a double-lens β 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 ± 3 min.

There have been observed in the conversion spectrum of Sb^{113} electrons with energies 49.6, 75.3, and 77.4 kev, corresponding to conversion of γ radiation of energy 79.3 ± 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
201

REMARK ON THE DECAY OF THE CASCADE HYPERON

I. Yu. KOBZAREV, L. B. OKUN', and A. P. RUDIK

Submitted to JETP editor January 23, 1960

J. Exptl. Theoret. Phys. (U.S.S.R.) **38**, 1012-1013 (March, 1960)

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

$$\Xi^0 \to \Lambda^0 + \pi^0, \quad \Xi^- \to \Lambda^0 + \pi^- \tag{1}$$

can be written in the form

$$A = 2\bar{u}_\Lambda (a + be^{i\varphi}\sigma\mathbf{n}) u_\Xi. \tag{2}$$

Here a and b denote the amplitude for the formation of Λ^0 and π in the S and P states, respectively, and φ is the difference of the phase shifts for the scattering of the π meson by the Λ hyperon in these states. The unit vector $\mathbf{n}$ is directed along the momentum of the Λ^0 hyperon in the rest system of the Ξ hyperon, the σ's are the Pauli matrices, and u_Λ and u_Ξ are two-component spinors.

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

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

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 Λ hyperons in the direction perpendicular to the plane defined by the vectors $\boldsymbol{\eta}$ and $\mathbf{n}$ will be zero unless $\varphi \neq 0$. The study of the polarization of the Λ hyperons in this direction (together with the measurement of the longitudinal polarization of the Λ hyperons, for example) permits, therefore, the determination of the difference of the S and P phase shifts in the scattering of π mesons by Λ hyperons.

We note that, by isotopic invariance, the value of φ_-, obtained from the decay of the Ξ^- hyperon, and of φ_0, obtained from the decay of the Ξ^0 hyperon, should be identical.

For comparison we mention that the S phase shifts for the scattering of a π meson by a nucleon at corresponding energies (the momentum in the center-of-mass system is equal to $m_\pi c$) are approximately equal to $\alpha_1 \approx -7°$ for the channel $T = 1/2$ and to $\alpha_3 \approx +10°$ for $T = 3/2$ (reference 2). The resonance P phase is equal to $\alpha_{33} \approx 12°$, while the other P phases are close to zero.

[1] Teutsch, Okubo, and Sudarshan, Phys. Rev. **114**, 1148 (1959).

[2] J. Orear, Phys. Rev. **100**, 288 (1955).

Translated by R. Lipperheide
202

CONCERNING THE ARTICLE BY S. M. BILEN'KIĬ, R. M. RYNDIN, Ya. A. SMORODINSKIĬ, AND HO TSO-HSIU, "ON THE THEORY OF NEUTRON BETA DECAY"

Submitted to JETP editor January 27, 1960

J. Exptl. Theoret. Phys. (U.S.S.R.) **38**, 1013 (March, 1960)

WEINBERG[1] proved a theorem from which it follows that the full probability for a process of the type $\alpha \rightarrow \beta + l + \bar{\nu}$ (α and β 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 first power of λ is only apparent. Indeed, in the approximation $E_0/M = \Delta/M$, which we used, expression (12) may be rewritten as follows:

$$W = \frac{G^2}{(2\pi)^3}(1+3\lambda^2)\left\{m^4\left(E_0 - \frac{m^2+2E_0^2}{2M}\right)\ln\frac{E_0+\sqrt{E_0^2-m^2}}{m} + \frac{2}{15}\sqrt{E_0^2-m^2}\left[E_0^4 - \frac{9}{2}E_0^2m^2 - 4m^4 + \frac{E_0}{M}\left(E_0^4 - 2E_0^2m^2 + \frac{49}{4}m^4\right)\right]\right\}.$$

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

[1] S. Weinberg, Phys. Rev. **115**, 481 (1959).

[2] Bilenkiĭ, Ryndin, Smorodinskiĭ, and Ho Tso-Hsiu, JETP **37**, 1758 (1959), Soviet Phys. JETP **10**, 1241 (1960).

Translated by A. M. Bincer
203

PRODUCTION OF "SUPERCOLD" POLARIZED NEUTRONS

G. M. DRABKIN and R. A. ZHITNIKOV

Leningrad Physico-Technical Institute, Academy of Sciences, U.S.S.R.

Submitted to JETP editor January 27, 1960

J. Exptl. Theoret. Phys. (U.S.S.R.) **38**, 1013-1014 (March, 1960)

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°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 ϵ of the neutron will be equal to

$$\Delta\varepsilon = \int_0^s \mu_{\mathrm{eff}} \frac{\partial H}{\partial s} ds,$$

where μ_{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 μ_{eff} = const we have $\Delta\epsilon = 0$.

The neutron energy can be changed by a corresponding change in the sign of μ_{eff}, i.e., by a reorientation of the neutron spin at the instant when 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 $F = \mu_{\mathrm{eff}}\,\partial H/\partial s$ (neutrons with spins oriented in the opposite direction will be accelerated). At the instant when it reaches the maximum field H_0, where $\Delta\epsilon = \mu_{\mathrm{eff}} H_0$, the change in speed will equal

$$\Delta v_1 \approx \mu_{\mathrm{eff}} H_0 / m v_0,$$

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 $H_1\Delta t = \hbar/g\mu_N$ (Δt being the time of flight of the neutron through the field H_1, g the gyromagnetic ratio, and μ_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 μ_{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 2×10^3 cm/sec we have $2\Delta v_1$ = 100 cm/sec.