sary to resort to assumptions about the behavior of the S matrix off the energy shell.

Such assumptions can lead to more detailed predictions. For example, if the virtual π^- meson goes off mainly in the direction of the initial π^- meson, just as a real π^- meson resulting from shadow scattering at high energies, then in the center-of-mass system, the summed K-meson momentum is directed mainly forward. Similar assumptions have been used widely by Pais[5] in describing the reaction $\pi + N \rightarrow Y + K$ and others.

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*If the K^+ and K^0 have the same parity, then only the combined parity IC is conserved in the interaction of Eq. (1).

†If the K^+ and K^0-mesons have the same parity and strong baryon-meson couplings are symmetrical according to Pais,[6] then one might introduce a 4-boson coupling to avoid the difficulties. Then for non-derivative couplings, for example, $\overline{K}(\tau, \pi)K\pi^0$, considerations about the isotropy of K^- and K^0 in the system A remain valid.

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POLARIZATION OF Au^{198} *NUCLEI IN A SOLUTION OF GOLD IN IRON*

B. N. SAMOĬLOV, V. V. SKLYAREVSKIĬ, and E. P. STEPANOV

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KHUTSISHVILI[1] proposed a method for the polarization of ferromagnetic nuclei. We undertook to apply this method to nuclei of non-ferromagnetic elements introduced into a ferromagnet. In this communication we report the results of experiments on the polarization of nuclei of Au^{198} in a gold-iron alloy. A specimen (with 0.3% gold by weight), made into a disk 0.3 cm in diameter and 0.01 cm thick, was exposed to thermal neutrons in a reactor. The activity of the Au^{198} nuclei formed in the specimen was approximately 4 microcurie during the time of the experiment. After irradiation, the specimen was annealed in vacuo and soldered to the end of a copper "cold pipe," joined to copper plates pressed into a potassium-chrome-alum block. The salt was adiabatically demagnetized at initial field and temperature values of 20000 gauss and 1.05°K. The gamma rays were registered by two scintillation counters with CsI crystals (diameter 40 mm, height 40 mm).

The Au^{198} disintegrates via β decay ($2^- \rightarrow 2^+$ transition), followed by emission of 411-kev gamma rays ($2^+ \rightarrow 0^+$ transition). At a temperature near 0.015°K the anisotropy of this gamma radiation is $\epsilon = 1 - N(0)/N(\pi/2)$ (where $N(0)$ and $N(\pi/2)$ are the readings of the counters placed parallel and perpendicular to the direction of the polarizing field of the permanent magnet) was found to be 3.3%. The magnetization of the specimen in the field of the permanent magnet was ~ 0.6 of saturation. The true value of the anisotropy, corresponding to 100%magnetization of the specimen, was therefore $\epsilon = 3.3/0.6 = 5.5\%$. It follows from this value of ϵ that the quantity $\beta = \mu H/kTI$ (μ is the magnetic moment of Au^{198}, I the spin of Au^{198}, and H the magnetic field on the Au^{198} nucleus) ranges from 0.3 to 0.4, while the polarization f_1 of Au^{198} ranges from 0.25 to 0.35. The values of β and f_1 were computed from the values of ϵ by the Tolhoek and Cox formulas.[2] The indeterminacy in β and f_1 is caused by the fact that the parameter λ, which depends on the matrix elements of the forbidden Au^{198} transition ($2^- \rightarrow 2^+$), is unknown.

The magnetic moment of Au^{198} is 0.5 ± 0.04 nuclear magnetons.[3] This, together with a value $\beta = 0.3$ to 0.4 measured at T = 0.015°, makes $H = (0.5 \text{ to } 0.7) \times 10^6$ oe.

So strong a field can be apparently explained only by the presence of a magnetic moment at the electron shells of the gold atoms in the gold-iron alloy (unlike the gold atoms in the metallic gold, which are diamagnetic). This magnetic moment may be due to an exchange interaction between the electron shells of the gold and iron atoms in the alloy, similar to the interaction between the electrons of the iron atoms. However, it is not impossible for the gold atoms in the alloy to be paramagnetic ions having no exchange bonds with the iron atoms.

It is hoped that the method of introducing nuclei into ferromagnetic alloys will increase considerably the number of elements capable of polarization. In addition, an investigation of the polarization of nuclei in various alloys may yield information on the magnetic properties of the atoms in these alloys.

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DEPOLARIZATION OF μ^- MESONS IN THE FORMATION OF μ-MESIC ATOMS

I. M. SHMUSHKEVICH

Leningrad Physico-Technical Institute

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In the formation of μ-mesic atoms, the μ^- mesons initially fall into highly excited states. Therefore, during the cascade transitions into the ground state, the mesic atom, on the average, passes through a large number of intermediate states. At lower levels, the inequality

$$\Delta_{nl} \gg \Gamma_{nl}, \tag{1}$$

is valid, where Δ_{nl} is the distance between fine-structure levels with the quantum numbers n and l, but different j $(j = l \pm \frac{1}{2})$, and Γ_{nl} is the width of the corresponding level and is equal to the sum of the radiative width and the width with respect to Auger transitions (the greater Z, the greater the values of n for which condition 1 is satisfied). Physically, inequality (1) signifies that the time during which the μ-mesic atom remains at a given level is considerably greater than the time required for a change of the μ-meson spin under the action of the field of the nucleus. This leads to depolarization of the μ^- mesons, if they were initially polarized. Below, we will estimate the degree of polarization of the μ^- mesons falling into the K shell of the mesic atom. In order not to complicate the question by the necessity of taking hyperfine structure into account, we limit ourselves to the considerations of μ-mesic atoms formed with nuclei of zero spin.

Considering radiative or Auger transitions between levels for which Eq. (1) is satisfied, and remembering that these transitions are essentially dipole transitions, we obtain the following relation between the average values of $\sigma = 2\mathbf{s}$ ($\mathbf{s}$ is the spin operator of the μ^--meson), $\bar{\sigma}_1$ and $\bar{\sigma}_2$, in the initial and final states:

$$\bar{\sigma}_2 = \beta\bar{\sigma}_1, \tag{2}$$

where

$$\beta = \frac{[j_2(j_2+1) - l_2(l_2+1) + {}^3/_4][j_1(j_1+1) + j_2(j_2+1) - 2]}{[j_1(j_1+1) - l_1(l_1+1) + {}^3/_4]2j_2(j_2+1)}. \tag{3}$$

The bar over σ signifies that the average is taken firstly over states with given nlj and μ (μ is the projection of j), and secondly over all μ for given nlj.

Let us now consider some excited level of the μ-mesic atom with sufficiently large quantum numbers $n_0 l_0 j_0$, for which condition (1) is still satisfied. Let $\bar{\sigma}_0$ be the average value of σ at this level. The successive application of Eqs. (2) and (3) to the cascade transition from the given level to the K shell leads to a relation between the average values of the spin in the K shell and $\bar{\sigma}_0$ with a definite set of intermediate states passed through by the μ-mesic atom. Averaging over the various possible cascades by using the formulas for the probabilities of radiative[1] and Auger transitions,[2,3] we obtain

$$\bar{\sigma}_K = \beta_K \bar{\sigma}_0. \tag{4}$$

for $\bar{\sigma}_K$, the average value of σ in the K shell.

Analysis of the result thus obtained indicates that if n_0 and l_0 are large and $j_0 = l_0 + \frac{1}{2}$, then for all practical purposes, $\beta_K \approx 1$. But if under the same conditions $j_0 = l_0 - \frac{1}{2}$, then $\beta_K = 0$.[4]

Initially, in the formation of a mesic atom, the μ^- mesons fall into states with large n ($n \approx 14$, 15) and large l. In these excited states, the sign of inequality (1) is reversed, owing to Auger transitions. Therefore, depolarization does not occur in these states. It does not begin until the μ^- meson falls to a level at which Eq. (1) holds. This makes it possible to evaluate $\bar{\sigma}_0$ in the following way: at the instant at which the polarized μ^- meson drops into the level with the quantum numbers $n_0 l_0$, the wave function has the form

$$\Psi_0 = \sum_m a_m \chi_{1/2} \varphi_{n_0 l_0 m} = \sum_{m j_0} a_m C^{j_0 m + 1/2}_{l_0 m, 1/2 1/2} \Phi_{n_0 l_0 j_0 m + 1/2}. \tag{5}$$