sample made of 99.996% pure yttrium oxide the sign reversal is observed only at ~10°K.

It must be noted that no anomalies were observed on the temperature dependence we obtained for the saturation magnetization of the same samples (Fig. 2). This indicates that the saturation magnetization is a characteristic insensitive to the terbium impurities. This absence of correlation between the magnetization and magnetostriction of yttrium iron garnet containing rare-earth impurity is apparently due to the fact that at low temperatures the decisive role is played by the magnetoelastic energy, causing the change in the coupling between the orbital momentum of the rare-earth ion and the intracrystalline field of the iron garnet. However, the detailed character of this mechanism is still unclear.

In conclusion we note that the temperature dependence of the magnetostriction constant of YIG can serve as a qualitative indicator of the degree of purity of the investigated sample (or of the oxide from which it is made), the sensitivity of the magnetostriction to the terbium impurity being apparently much higher than that of the existing methods for spectral analysis of rare-earth oxides. Thus, in the purest yttrium oxide (99.996%) from which one of our samples was made, spectral analysis (sensitivity 0.002%) showed no terbium-oxide impurities, yet their presence is clearly disclosed by the anomalous variation of the temperature dependence of the YIG saturation magnetostriction.

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CHECK ON T-INVARIANCE IN THE $\pi^+ \to e^+ + \nu + \gamma$ DECAY

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Bernstein et al. [1] advanced the hypothesis that electromagnetic interactions of hadrons are not invariant under time reversal. In this letter we consider a possible check on this hypothesis in the radiative pion decay

$$\pi^+ \to e^+ + \nu + \gamma$$

by observing the polarization of the γ quanta.

Experimental data on this decay are given in [2,3]. A theoretical analysis is presented in [4-6]. The matrix element is represented in the form of a sum of three parts, corresponding to the accomapnying radiation and to the vector and axial-vector transitions

$$M = M_{IB} + M_V + M_A, \tag{1}$$

where

$$M_{IB} = -i\sqrt{4\pi\alpha}\,\frac{fmG}{\sqrt{2}}\,\varphi\bar{u}_e\left[\frac{(Ap)}{(kp)} - \frac{(AP)}{(kP)} + \frac{F_{\mu\nu}\sigma_{\mu\nu}}{4(kp)}\right](1+\gamma_5)u_\nu, \tag{2}$$

$$M_V = ia\sqrt{4\pi\alpha}\,\frac{G_V}{\sqrt{2}}\,\varphi\,\tilde{F}_{\mu\nu}\mathcal{J}_\mu\,P_\nu, \tag{3}$$

$$M_A = ib\sqrt{4\pi\alpha}\,\frac{G_A}{\sqrt{2}}\,\varphi\,F_{\mu\nu}\mathcal{J}_\mu\,P_\nu, \tag{4}$$

where

$$F_{\mu\nu} = A_\mu k_\nu - A_\nu k_\mu, \quad \tilde{F}_{\mu\nu} = \frac{i}{2}\epsilon_{\mu\nu\lambda\sigma}F_{\lambda\sigma}, \quad \mathcal{J}_\mu = \bar{u}_e\gamma_\mu(1+\gamma_5)u_\nu.$$

P, p, and k are the momenta of the pion, electron, and γ quantum, respectively, while the quantities $|f|^2$ amd $|a|^2$ are expressed [4] respectively in terms of the probabilities of the processes $\pi^+ \to e^+ + \nu$ and $\pi^0 \to 2\gamma$

$$W_{e+\nu} = \frac{G^2|f|^2m^2\mu}{8\pi}, \qquad W_{\pi^0} = \frac{\pi}{4}\,\alpha^2|a|^2\mu^3. \tag{5}$$

It is known [4] that f, a, and b are real quantities in the case of T-invariance. When T-invariance is violated, the quantity $\lambda = bG_A/aG_V$ should in general be complex:

$\lambda = \lambda' + i\lambda''$.

If, as proposed in [1], 100% violation of T-invariance takes place, then λ' and λ'' should be of the same order.

The differential probability of $\pi^+ \to e^+ + \nu + \gamma$ decay with emission of a plane-polarized quantum is (the accompanying radiation does not interfere with the remaining parts if the lepton mass is neglected)

$$dW = dW_{IB} + dW_{V+A}, \tag{6}$$

$$dW_{IB} = W_{e+\nu}\,\frac{\alpha}{2\pi^2}\,\frac{1+\cos\theta}{1-\cos\theta}\,\frac{dx}{x}\,d\theta\,\frac{1}{[2-x(1-\cos\theta)]^2}\left[\tfrac{1}{2}(1-x)^2 + \tfrac{1}{2} + (2(\vec{e}\cdot\vec{n}_1) - 1)(1-x)\right], \tag{7}$$

$$dW_{V+A} = \frac{1}{32\pi^4}\,W\pi^0\,\frac{G_V^2\mu^4}{\alpha}\,\frac{(1-x)^2\,x^3\,dx\,d\theta}{[2-x(1-\cos\theta)]^3}\left\{\frac{(1+|\lambda|^2)}{2}\left[2 - x(1-\cos\theta) + \frac{2(1-x)\sin^2\theta}{2-x(1-\cos\theta)}\right]\right.$$
$$\left. - \lambda'[x(1-\cos\theta) + 2\cos\theta] + \frac{(1-x)\sin^2\theta}{2-x(1-\cos\theta)}\left[(1-|\lambda|^2)(2(\vec{e}\cdot\vec{n}_1) - 1) + 4\lambda''(\vec{e}\cdot\vec{n}_1)(\vec{e}\cdot\vec{n}_2)\right]\right\}. \tag{8}$$

Here $\vec{e}$ is the unit vector of plane polarization of the photon, x its energy in fractions of the maximum possible value $k = x\mu/2$, θ the angle between the electron and γ-quantum momenta, and $\vec{n}_1$ and $\vec{n}_2$ unit vectors orthogonal to the γ-quantum momentum, with $\vec{n}_1$ in the decay plane and $\vec{n}_2$ normal to this plane:

$$\vec{n}_1 = \frac{\vec{k}\times[\vec{p}\times\vec{k}]}{|\vec{k}\times[\vec{p}\times\vec{k}]|}, \qquad \vec{n}_2 = \frac{\vec{k}\times\vec{p}}{|\vec{k}\times\vec{p}|}. \tag{9}$$

The fact that the term in (8) proportional to λ'' is T-odd can be seen directly from (8), by noting that under time reversal $\vec{n}_1 \to -\vec{n}_1$, $\vec{n}_2 \to -\vec{n}_2$, and $\vec{e} \to -\vec{e}$.

To observe the T-noninvariant term it is best to measure the plane polarization of the photons in a direction making a 45° angle with the vectors $\vec{n}_1$ and $\vec{n}_2$, when this term is a maximum. In the absence of such a term the probability that the photon will be polarized in this direction is equal to 1/2. To estimate the expected effect in the case of T-noninvariance we write the probability **w**, integrated with respect to the energy of the γ quantum from x_{min} to 1, in the form

$$w = \tfrac{1}{2}(1 + \lambda'' f(\theta)). \qquad (10)$$

From the experimental data [3] we can determine only the connection between $|\lambda|^2$ and λ'. (We assume [6] that $\tau_{\pi^0} = 0.74 \times 10^{-16}$ sec.)

$$|\lambda|^2 + 1.72\lambda' - 0.7 = 0. \qquad (11)$$

$1 - \cos\theta$	1.0	1.2	1.4	1.6	1.8	2.0
$f(\theta)$	0.21	0.29	0.43	0.58	0.44	0.00

The values of $f(\theta)$ for $|\lambda|^2 = 2$ and $x_{min} = 0.3$ are gathered in the table. $f(\theta)$ reaches a maximum value of 0.58 at $\theta \approx 127°$. If we assume that in the case of total violation of T-invariance $\lambda'' \sim 1$, then the effect turns out to be rather large.

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DIFFERENTIAL CROSS SECTION OF CHARGE EXCHANGE OF 4.8-GeV/c π^- MESONS WITH PROTONS

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Azimov et al. [1] described a method of detecting high-energy π^0 mesons with the aid of a spark chamber and a total-absorption Cerenkov counter. Unlike the already described method of detecting π^0 mesons with the aid of cascade spark chambers [3,4], this method makes it possible to measure with good accuracy both the angle and the energy characteristics of γ quanta from π^0 meson decays. We present below preliminary results of the measurement of the differential cross section of the reaction