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"SHADOW UNIVERSE" AND THE NEUTRINO EXPERIMENT

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To explain the θ decay of the long-lived K^0 meson [1-3], Nishijima and Saffouri recently proposed the "shadow universe" hypothesis [4], according to which there exists besides our universe U_a also a universe U_b. To each particle a from U_a corresponds a particle b from U_b. Strong and electromagnetic interactions are the same within each of the universes, but there are none between particles from different universes. Weak interaction exists between a particles, and also between a and b, but there is no weak interaction between particles b, so that if there were no a ⟷ b transitions then K^b mesons would be stable. This form of weak interaction prohibits the unobservable decays of K^a mesons into b particles (for example, π^b mesons).

In the "shadow universe" model, the K_1^0 mesons are degenerate: there exists K_1^a with $\Gamma_a = 10^{10}\ \text{sec}^{-1}$ and K_1^b with $\Gamma_b = 0$. Owing to $K_1^a \longleftrightarrow K_1^b$ in vacuum transitions, two diagonal states K_1 and K_3 are produced

$$\begin{aligned} iK_a &= \lambda_a K_a + \lambda K_b \\ iK_b &= \lambda K_a + \lambda_b K_b \\ \lambda_a &= \mu_a - i\Gamma_a/2 \\ \lambda_b &= \mu_b \end{aligned} \qquad (1)$$

The frequencies of the diagonal states are

$$\lambda_{1,3} = \frac{\lambda_a + \lambda_b}{2} \pm \frac{(\lambda_a - \lambda_b)^2}{4} + \lambda^2 \qquad (2)$$

If we assume that $\beta = \lambda/(\lambda_a - \lambda_b) \ll 1$, then

$$\begin{aligned} \lambda_1 &= \mu_1 - i\Gamma_1/2 = \lambda_a + \beta^2(\lambda_a - \lambda_b) \\ \lambda_3 &= \mu_3 - i\Gamma_3/2 = \lambda_b - \beta^2(\lambda_a - \lambda_b) \end{aligned} \qquad (3)$$

It follows therefore that $\Gamma_1 \simeq \Gamma_a \simeq 10^{10}$ sec^{-1} and $\Gamma_3 \simeq \beta^2\Gamma_a$. When $\beta \sim 0.1$ we have $\Gamma_3 \sim 10^8$ sec^{-1}.

The states K_a and K_b in vacuum are described by the functions

$$K_a = e^{-i\lambda_1 t} + \beta^2 e^{-i\lambda_3 t}$$
$$K_b = \beta(e^{-i\lambda_1 t} - e^{-i\lambda_3 t}) \qquad (4)$$

The probability of θ^0 decay of the long-lived component is equal to

$$\Gamma_3\beta^2 e^{-\Gamma_3 t} \qquad (5)$$

Experiments [1-3] have shown that the lifetime of the long-lived θ^0 component is close to the lifetime of the K_2^0 meson. These experiments, however, cannot finaly "close" the "shadow universe" hypothesis.

The purpose of this letter is to point out that the "shadow universe" hypothesis is in sharp contradiction with the results of the neutrino experiment [5]. Indeed, the number of K^0 mesons produced in the target of the neutrino experiment is of the order of 10^{15}. Assuming a detector located approximately 50 meters from the target and with effective dimension ~ 10 meters (spark chamber), then, according to (5), the number of θ decays in the detector would amount to ~ 10^{11}-10^{12} (at an average K-meson energy of ~ 5 BeV). This number remains practically unchanged if we take into account the presence of an iron shield 25 meters thick. This is the principal statement of this letter and is based on the fact that the presence of a medium changes only the coefficient λ_a in Eq. (1), leaving the other coefficients unchanged. This change in λ_a is on the order of $\sigma CN \sim 10^{-26} \times 3 \times 10^{10} \times 8.6 \times 10^{23} \sim 1.5 \times 10^9$ sec^{-1}, which is small compared with the difference $\lambda_a - \lambda_b$, becoming of the same order only because of relativistic effects when $E/m \sim 10$. Thus, in matter we also have $\beta \ll 1$ and $\Gamma_3 \sim 10^8$ sec^{-1}. This result can be easily understood qualitatively by recognizing that K_b does not interact with matter, while K_a is absorbed in matter not much more strongly than in vacuume (when $E/m \sim 1$, the interaction length exceeds the decay length). As a result, the iron wall is "transparent" to the K_3 mesons. Since the number of possible θ decays did not exceed 10^2 in the neutrino experiment, the discrepancy between experiment and the model of the "shadow universe" amounts to ten orders of magnitude. (The number 10^2 is apparently an upper bound, and characterizes the neutrino-experiment background unrelated to the neutrino; the total number of neutrino events was ~ 10^4.)

The considerations presented above do not apply to the hypotheses [6,7] according to which the long-lived θ_L meson can have strong interactions. Here, however, the degeneracy of the masses of the long-lived and short-lived θ mesons remains incomprehensible, since their strong interactions are different (their production cross sections are different). To check on these hypotheses it would be sensible to place an absorber in the path of the K^0-meson beam and to ascertain whether the θ_L meson has the same absorption cross section as the K_2^0 meson. Several authors [8] have proposed to place for the purpose of observing interference between the decays of K_2^0 and K_1^0 mesons, and several such experiments are being planned. Our suggestion differs in that the plates should be sufficiently thick and should be located at a large distance from the detector, so that no regenerated K_1^0 mesons reach the detector.

In conclusion we note that if there exist two CP-even K mesons, namely K_1 and K_3, then two CP-odd K mesons, K_2 and K_4, should exist. It is therefore of interest to search for the two components in ordinary K_2^0-meson decays ($K_{\pi 3}$, K_{U3}, K_{e3}).

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NEW EFFECT OF INCREASING THE PHOTOCONDUCTIVITY OF ORGANIC SEMICONDUCTORS IN A WEAK MAGNETIC FIELD

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In an investigation of the photoconductivity of condensed aromatic hydrocarbons (anthracene and tetracene), we have noted a new effect, wherein the photocurrent through the sample increased when a constant magnetic field was applied to it.

The photoconductivity was measured in vacuum-sputtered films with an electrometric dc amplifier. The photoconductivity of the films, 3-20 μ thick, was investigated in surface cells and in "sandwich" type cells. In the cells of the latter type, the sputtered-aluminum electrodes were semi-transparent. The illumination was with visible light from a 20 watt incandescent lamp, focused by means of an optical system and transmitted through a water filter. To study the photoconductivity of anthracene, which is not sensitive to the visible light, a DKSSh-1000 lamp was used. The investigated substances were purified by multiple recrystalliza-