Scientific session of the Division of General Physics and Astronomy of the USSR Academy of Sciences (April 21, 1977)

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A scientific session of the Division of General Physics and Astronomy of the USSR Academy of Sciences was held on April 21, 1977, in the conference hall of the P. N. Lebedev Physics Institute. The following papers were delivered:

1. *I. I. Sobel'man and I. B. Khriplovich.* Check on the modern theories of weak interaction in optical experiments.

2. *A. A. Komar.* Neutral currents in the physics of weak interactions.

3. *B. G. Erozolimskiĭ.* Beta decay of the neutron.

We publish below brief contents of three of these papers.

I. I. Sobelman and I. B. Khriplovich. *Check on the modern theories of weak interaction in optical experiments.* By now there are all grounds for expecting optical experiments to be able to verify the existence of parity-nonconserving weak interaction of electrons with nucleons, due to the so-called neutral currents. This question is at present exceedingly important, since we are actually dealing with a check on models that describe in unified fashion the electromagnetic and weak interactions of elementary particles. Interaction via neutral currents has been observed in experiments on neutrino scattering by protons and electrons. Experimental evidence of parity-nonconservation in such interaction has been obtained recently. As to weak interaction of electrons with nucleons or with one another, there are no experimental facts. It appears that such facts can be obtained in the nearest future only with optical experiments

If the atomic electrons and nucleons of the nucleus interact via neutral currents that violate parity conservation, then mixing of states with different parity should take place in the atom and should lead to circular polarization of the radiation of certain magnetic-dipole transitions. Experiments of two types are possible—measurement of the difference $\Delta\sigma$ of the cross sections σ_+ and σ_- for the absorption of right- and left-polarized photons, and measurement of the angle of rotation θ of the plane of polarization of the light wave. The first to point out these two possibilities was Ya. B. Zel'dovich.[1] A most important step was made by M. Bouchiat and C. Bouchiat, who showed that the discussed effects increase strongly in heavy atoms, and proposed a concrete and perfectly realistic experiment aimed at observing the difference between σ_+ and σ_- in the $6s_{1/2}$–$7s_{1/2}$ transition in the cesium atom.[2] The actual feasibility of observing optical activity of vapors of heavy elements (thallium, lead, and bismuth) was subsequently demonstrated in[3–5].

If we start our estimates with the presently most popular Weinberg-Salam model of the unified theory, then under the most favorable conditions we are dealing with quantities $\Delta\sigma/\sigma \sim 10^{-4}$ and $\theta \sim 10^{-6}$ rad/cm. Effects of this size can undoubtedly be observed, although they call for the use of the most modern optical experimental techniques (tunable lasers with etc.); see[6,7].

Optical experiments are attractive for two reasons. Searches for the unknown effects can be carried out using a large number of transitions in different atoms. Modern approximate methods of calculations of atomic characteristics make possible recalculations from the observable effects to the initial Hamiltonian of the weak interaction with accuracy ~ 30–50%. Reliable and quite complete experimental verification of various theoretical weak-interaction models thus becomes possible. Experiments aimed at searching for parity-nonconservations effects in atoms have by now been initiated in France, USA, England, and also at the Institute of Nuclear Physics in Novosibirsk and at the Lebedev Physics Institute in Moscow.

The first preliminary results of experiments on the optical activity of bismuth vapor, in England and in the USA, were published in December 1976.[8] The authors believe that these results demonstrate that the effect is much smaller than predicted by the Weinberg-Salam model. At any rate, the effect does not exceed the one predicted by the above mentioned model. There is no doubt that this process will be made perfectly clear in the very nearest future.

Note added in proof. Final results of an experiment on two lines of bismuth show[9] that, with an approximately tenfold margin, the effect predicted by the Weinberg-Salam theory does not exist.

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