VIOLATION OF TIME-INVARIANCE IN ATOMIC PHYSICS

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The interactions violating the time-invariance and conserving the P-parity are one of the least studied problems of modern physics.

The influence of nucleon-nucleon and electron-nucleon T-odd interactions upon electromagnetic transitions in atoms has been considered in references /1—3/.

The interaction of an electron with a nuclear quadrupole toroidal momentum is studied in /1/. This momentum does not equal zero only if the time-invariance is violated and the P-parity is conserved. The calculation of the deutron toroidal momentum and the estimation of complex nuclei toroidal momenta are also given in /1/.

The relativistic potential of the interaction of an electron with the nuclear toroidal momenta can be written as:

$$V_T = i\,4\pi\,\alpha\,[p_k, \delta(r)]\,\alpha_i\,T_{ik}\,, \qquad (1)$$

where $\alpha = 1/137$ — fine structure constant, $\vec{p} = -i\vec{\nabla}$ — operator of the electron momentum, α_i — Dirac matrices, T_{ik} — tensor of the toroidal momentum, [...] — commutator.

Potential (1) causes mixing of the atomic states with the same total momentum F of an atom and the same parity, but with different angular momenta L and total angular momenta J of an electron. As is shown in/1/ interaction can mix only s- and d-states or p-states with different J. The corresponding mixing coefficients are given for heavy and hydrogen-like atoms.

Authors of papers /2,3/ consider the influence of T-odd electron-nucleon interactions on the propagation of the light wave in a media in the presence of external field $\vec{E}$. It is shown, that this interaction results in the T-odd correlation in the refractive index of the media $\sim(\vec{E}\vec{n})$ (where $\vec{n}$ is the direction of the photon momentum). This leads to various refractive indices for the waves, traveling along and against field $\vec{E}$. For the $(6p_{1/2}\ F=0\ M_F=0)\to(6p_{3/2}F=1\ M_F=\pm1)$ transitions in thallium we have calculated the phase shift of the two waves and shown that the bound on the T-odd interaction constant can be set up on the level $\sim10^{-4}$.

REFERENCES

1. *Moskalev A. N., Porsev S. G.* Yad. Fiz., 1989. 49. 1266.
2. *Kozlov M. G., Porsev S. G.* Phys. Lett., 1989. 142 . 233
3. *Kozlov M. G., Porsev S. G.* Yad. Fiz., 1990. 51. N 4.