STATUS OF EXPERIMENTS TO SEARCH FOR P, T-VIOLATIONS IN MOLECULES

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Experiments to search for P, T-parity violation in atoms and molecules were carried out by different groups during many years. At present the best sensitivity was achieved in experiments with Xe [1], Hg [2] and TlF [3].

The null result has been used to place an upper limit on a possible, P, T-violating, weak neutral current interaction between electrons and nucleons. As to possible, P, T-violating, interactions between quarks the limitations on their value from these experiments are close to the ones from experiments in search for an electric dipole moment of the neutron. For comparision these limitations on constant k_i of possible quark interactions are shown in the table [4]:

Table

Limitations on constant k_i of P, T-violating interactions between light quarks from neutron and atomic experiments

	d_n	$d(^{199}Hg)$
1. $G/\sqrt{2}\, k_u i\, (\bar{u}\gamma_5 u)\, (\bar{u}\, u)$	$2\cdot10^{-4}$	$1\cdot10^{-4}$
2. $G\sqrt{2}k_u^c i(\bar{u}\gamma_5 t^a u)\, (\bar{u}\, t^a u)$	$1.5\cdot10^{-4}$	$5\cdot10^{-4}$
3. $G\sqrt{2}k_d i(\bar{d}\gamma_5 d)\, (\bar{d}\, d)$	$2.5\cdot10^{-4}$	$1.5\cdot10^{-4}$
4. $G/\sqrt{2}k_d^c i(\bar{d}\gamma_5 t^a d)\, (\bar{d}\, t^a d)$	$4\cdot10^{-4}$	$6\cdot10^{-4}$
5. $G/\sqrt{2}k_{du} i(\bar{d}\gamma_5 d)\, (\bar{u}\, u)$	$2\cdot10^{-4}$	$1\cdot10^{-4}$
6. $G/\sqrt{2}k_{du}^c i(\bar{d}\gamma_5 t^a d)\, (\bar{u}\, t^a u)$	$1\cdot10^{-3}$	$4\cdot10^{-2}$
7. $G/\sqrt{2}k_t 1/2\varepsilon_{\mu\gamma\varkappa\lambda}(\bar{u}\sigma_{\mu\gamma} u)\, (\bar{d}\, \sigma_{\varkappa\lambda} d)$	$3\cdot10^{-5}$	$5\cdot10^{-3}$
8. $G/\sqrt{2}k_t^c 1/2\varepsilon_{\mu\gamma\varkappa\lambda}(\bar{u}\, \sigma_{\mu\gamma} t^a u)\, (\bar{d}\, \sigma_{\varkappa\lambda} t^a d)$	$2.5\cdot10^{-4}$	$5\cdot10^{-3}$
9. $G/\sqrt{2}k^g m_p \bar{u}\sigma_{\mu\gamma}\gamma_5 g\, G^a_{\mu\gamma} t^a u$	$2\cdot10^{-5}$	$1.5\cdot10^{-6}$
10. $G/\sqrt{2}k_d^g m_p \bar{d}\sigma_{\mu\gamma}\gamma_5 g\, G^a_{\mu\gamma} t^a d$	$1\cdot10^{-5}$	$1.5\cdot10^{-6}$

Atomic and molecular experiments are based on the existence of the gain factor due to a mixture of opposite parity levels by P, T-violating interaction. As a result an electric dipole moment of molecule or atom arises. An additional gain factor, proportional to Z^2 takes place due to an increase of electron wave function density on nucleus. It was shown that the maximum value was achieved in diatomic molecules PbF [5], BiS [6], HgF [7] with a ground state $^2\Pi_{1/2}$or $^2\Sigma$.

To realize these gain factors it is necessary to have molecular beams with a maximum quantity of molecules in the ground state. The energy interval between rotating levels in these molecules corresponds to the temperature of about 0.7 K, so it is desirable to have the temperature of molecules in the beam close to the same value.

A temperature of about 20 K was obtained on a supersonic molecular beam source of LNPI [8]. At present, the experimental set-up is mounted on this source.

In previous experiments the main systematic effect was conditioned by a dependence of resonance frequency on the absolute value of the electric field. It is necessary to note that we are interested in detecting the magnetic resonance frequency shift correlated with the electric field direction.

To eliminate this systematic effect in the new experiment the polarized system singles out states degenerated in the electric field, and the interference of these states (Hanle effect [9] is used instead of the traditional magnetic resonance method). At the same time the molecular beam source is modernized for the purpose of decreasing the beam temperature down to few Kelvine degrees.

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