Nuclear Spin-Independent Effects of Parity NonConservation in Molecule of Hydrogen

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Theoretical study of discrete symmetry (e.g. spatial parity $\mathcal{P}$) violation effects in atomic and molecular systems plays a key role in developing theories and models of fundamental interaction physics. In all atomic experiments only the $\mathcal{P}$-odd electron-nucleus (*e*-N) interaction was observed since it is enhanced in heavy atoms, while the $\mathcal{P}$-odd electron-electron (*e*-*e*) interaction is negligible [1]. In 1977 it was proposed to observe the effect of optical rotation on oxygen molecule [2]. According to very rough estimates in this case the $\mathcal{P}$-odd *e*-*e* interaction effect should prevail over the $\mathcal{P}$-odd *e*-N one. The idea was that all electrons of a molecule involved in formation of the chemical bond are concentrated in the region between the nuclei, so there should not arise additional smallness in the matrix element of the $\mathcal{P}$-odd *e*-*e* interaction, which is present in atoms for that effect. It follows from our recent calculations via coupled cluster method [3] that for O_2 the $\mathcal{P}$-odd *e*-*e* interaction is suppressed compared to the $\mathcal{P}$-odd *e*-N one and, in principle, cannot be separated out in this case. Note also that this suppression in O_2 is less than the one in an atom with the same nuclear charge.

This contribution is devoted to the description and the calculation of the $\mathcal{P}$-odd effects in diatomic homonuclear molecule of parahydrogen H_2. For this purpose the M1 transition between the states with the same rotational number of the vibrational $v = 1 \leftarrow 0$ band in the H_2 ground electronic $^1\Sigma_g^+$ state [4] is considered. It is shown that in this case the effects of the $\mathcal{P}$-odd *e*-*e* and *e*-N spin-independent interactions are of the same order of magnitude. H_2 molecule is therefore the first example of atomic system where the *e*-*e* PNC interaction can be directly observed. Since the constants of the *e*-N PNC interaction were already accurately measured in atomic experiments, the *e*-*e* PNC interaction constant also can be extracted from these experiments. In all other atoms and molecules the *e*-*e* PNC interaction is usually deeply screened by the *e*-N interaction. Then the evaluations of the PNC effect in the parahydrogen molecule H_2 may acquire another important sense. The parahydrogen molecule H_2 is the unique atomic system also because in this molecule the *e*-*e* and *e*-N weak interaction constants are the same. Then a moment's consideration shows that the PNC experiments with H_2 molecule may become a source of the most accurate values for the Weinberg's angle.

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