NOVEL INFRARED COHERENT SOURCES AND TECHNIQUES FOR SPECTROSCOPIC TEST OF FUNDAMENTAL PHYSICS PRINCIPLES

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Recent achievements in high sensitivity and precision molecular spectroscopy in the mid-IR open new perspectives for experiments looking for possible violations of the basic postulates in quantum mechanics or quantum electro-dynamics in simple molecular systems. A new generation of hybrid infrared sources, including a direct link to optical frequency comb synthesizers (OFCSs) is under development[a]. They provide metrological frequency precision and sensitivities that have achieved record levels of tens of parts-per-quadrillion when appropriate spectroscopic techniques are implemented[b,c]. Such very recent developments will be reviewed.

An example of possible application to the test of fundamental principles is attacking the symmetrization postulate (SP). Actually, the requirement of symmetry of the wave function under exchange of identical particles has a striking demonstration in the spectra of molecules including identical nuclei. The basic idea of the spectroscopic tests is to search with extremely high sensitivity for (weak) molecular lines involving the forbidden states. Since the early test of SP violation in bosonic particles, $^{12}C^{16}O_2$ molecule has been considered a playground system. An upper limit of 10^{-11} to such violation was measured more than one decade ago by our group[d]. The recent developed spectroscopic technique[d,e] measured a minimum detected CO_2 gas pressures, in a 1-Hz bandwidth, of a few tens of femtobar, which could improve the previous test by more than two orders of magnitude. Progress in high sensitivity spectroscopic measurements in view of new violation tests will be reviewed, to investigate molecules with two and also three identical nuclei, like SO_3 and NH_3.

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