Ultra-precise optical clock: new methods and approaches

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Presently, laser spectroscopy and fundamental metrology are among the most important and actively developed directions in modern physics. Frequency and time are the most precisely measured physical quantities, which, apart from practical applications (in navigation and information systems), play critical roles in tests of fundamental physical theories (such as QED, QCD, unification theories, and cosmology) [1,2]. Now, laser metrology is confronting the challenging task of creating an optical clock with fractional inaccuracy and instability at the level of 10^{-17} to 10^{-18}. Indeed, considerable progress has already been achieved along this path for both ion-trap- [3] and atomic-lattice-based [4,5] clocks.

Work in this direction has stimulated the development of novel spectroscopic methods such as spectroscopy using quantum logic [6], magnetically induced spectroscopy [7], Hyper-Ramsey spectroscopy [8], spectroscopy of "synthetic" frequency [9] and others. Part of these methods was developed in order to excite and detect strongly forbidden optical transitions. The other part fights with frequency shifts of various origins. In the present talk we will review both parts with special emphasis on methods developed and studied in Institute of Laser Physics SB RAS, Novosibirsk. The history and present status of experimental works devoted to optical frequency standards will be observed.

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