

SENSITIVITY TO VARIATION OF FUNDAMENTAL CONSTANTS FROM FREQUENCY MEASUREMENTS OF ACETYLENE REFERENCE TRANSITIONS

FLORIN LUCIAN CONSTANTIN, *Laboratoire PhLAM, UMR 8523 CNRS - Université Lille 1, Villeneuve d'Ascq, France.*

Space-time variations of fundamental constants that are assumed in theories beyond the Standard Model may be investigated by precision molecular spectroscopy. The molecular energy levels are intrinsically sensitive to a variation of the proton-to-electron mass ratio μ and the transitions between closely-spaced energy levels display an enhanced sensitivity^a. The lasers stabilized to isotopic acetylene lines probed by saturated absorption spectroscopy provided secondary frequency references in the 1.5 μm spectral region. The acetylene optical clock enables now access to fractional frequency stability of 3×10^{-13} at one second in a compact and robust setup that ensures optical frequency referencing with drifts lower than 1 Hz/day, as it is indicated in ref.^b. This contribution discusses the potential in constraining time variation of μ from precision spectroscopy of $^{12}\text{C}_2\text{H}_2$ transitions pertaining to the $\nu_1+\nu_3$ and $\nu_1+\nu_2+\nu_4+\nu_5$ combination bands^c. The acetylene energy levels are modeled with a state-of-the-art Hamiltonian that takes into account different rovibrational interactions and the sensitivities of the reference acetylene transitions are calculated. The frequency splittings between near resonant transitions, that may arise from the cancellation of the rotational intervals with frequency shifts associated to the origins of the vibrational bands, the anharmonicity, and the rovibrational interactions, display sensitivity coefficients up to $\pm 10^3$ level. The systematic frequency shifts are conservatively evaluated for intracavity spectroscopy setups. The constraint to the time variation of μ derived from absolute frequency measurements of acetylene optical clocks is estimated at the $10^{-13}/\text{yr}$ level.

^aV.V. Flambaum and M.G. Kozlov, *Phys. Rev. Lett.* 99, 150801 (2007).

^bT. Talvard *et al*, *Optics Express* 25, 2259-2269 (2017).

^cF.L. Constantin, *Vibrational Spectroscopy* 85, 228-234 (2016).