Enhanced Sensitivity to m_p/m_e Variation from Microwave Transitions between Vibration-Inversion States of Ammonia

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Transitions between near-resonant molecular energy levels have the potential to probe with high sensitivity time variation of fundamental constants. Microwave transitions of acetylene between degenerate vibration states, that may be accessed by optical pumping, display enhanced sensitivity coefficients to the proton-electron mass ratio variation and suitable metrological performances[1] that may tackle some performances expected in optical spectroscopy.

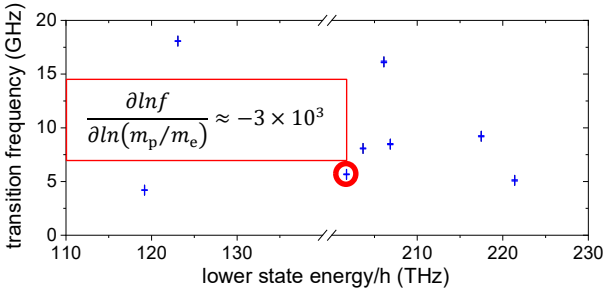

Fig. 1: Selected E1 transitions between vibration-inversion states with enhanced sensitivity coefficients

This contribution addresses potentialities of the microwave transitions between excited levels of $^{14}NH_3$. Energy levels of $^{14}NH_3$ and transition dipole moments were predicted by high-level ab-initio calculations[2]. Microwave transitions and sensitivity coefficients to m_p/m_e variation at the ± 10 level were calculated using the TROVE *ab-initio* approach up to the $2\nu_2$ and ν_4 states[3].

The effective Hamiltonian approach is used here for prediction of microwave transitions. Energy levels up to the $3\nu_2$ and $\nu_4+\nu_2$ states were predicted at the level of the experimental uncertainty[4] using a state-of-the-art Hamiltonian that takes into account rotation and centrifugal distortion, vibration and anharmonicity, inversion and suitable rotation-vibration interactions. This model is exploited to predict new microwave transitions with high sensitivity coefficients. The 1.5 μm range shows a lot of vibrational bands, including $\nu_1+\nu_3$, $\nu_1+2\nu_4$, $\nu_3+2\nu_4$, $2\nu_1$ and $2\nu_3$. Ammonia empirical energy levels, derived using MARVEL approach[5], are exploited here to search for near-coincidences that lead to E1 transitions in the microwave range. Some are shown in Fig.1 and may be addressed by double-resonance optical-microwave spectroscopy, used previously in the ground state[6]. Sensitivity coefficients by $\pm 10^3$ are calculated using single-state diagonal Hamiltonians.

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