THE CO A-X SYSTEM FOR CONSTRAINING COSMOLOGICAL DRIFT OF THE PROTON-ELECTRON MASS RATIO

M. L. NIU, E. J. SALUMBIDES, D. ZHAO, J. BAGDONAITE, *Department of Physics and Astronomy, and LaserLaB, VU University, De Boelelaan 1081, 1081 HV Amsterdam, The Netherlands*; N. DE OLIVEIRA, D. JOYEUX, L. NAHON, *Synchrotron Soleil, Orme des Merisiers, St Aubin BP 48, 91192, GIF sur Yvette cedex, France*; R. W. FIELD, *Department of Chemistry, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA*; and W. UBACHS, *Department of Physics and Astronomy, and LaserLaB, VU University, De Boelelaan 1081, 1081 HV Amsterdam, The Netherlands*.

The $A^1\Pi - X^1\Sigma^+$ band system of carbon monoxide, which has been detected in six highly redshifted galaxies ($z = 1.6 - 2.7$), is identified as a novel probe method to search for possible variations of the proton-electron mass ratio (μ) on cosmological time scales. Laboratory wavelengths of the spectral lines of the A-X (v,0) bands for $v = 0 - 9$ have been determined at an accuracy of $\Delta\lambda/\lambda = 1.5 \times 10^{-7}$ through VUV Fourier-transform absorption spectroscopy, providing a comprehensive and accurate zero-redshift data set[a]. Two-photon Doppler-free laser spectroscopy has been applied for the (0,0) and (1,0) bands, achieving 3×10^{-8} accuracy level, verifying the absorption data. Accurate sensitivity coefficients K_μ for a varying μ have been calculated for the CO A-X bands, so that an operational method results to search for μ-variation. The data from both experiments were used to perform an improved analysis of the perturbations in the $A^1\Pi$, $v = 0$ and 1 levels by vibrational levels in the $D^1\Delta$, $I^1\Sigma^-$, $e^3\Sigma^-$, $d^3\Delta$, and $a'^3\Sigma^+$ states. The object Q1237+064 will be observed in May 2013, aiming for a good signal-to-noise spectrum containing the CO A-X bands as well as the H_2 Lyman and Werner bands. This should result in an accurate and robust constraint on $\Delta\mu/\mu$.

[a]E.J. Salumbides, M.L. Niu, J. Bagdonaite, N. de Oliveira, D. Joyeux, L. Nahon and W. Ubachs, Phys. Rev. A 86, 022510 (2012).