Highlights of Astronomy, Volume 15
XXVIIth IAU General Assembly, August 2009
Ian F. Corbett, ed.

doi:10.1017/S1743921310009609

Probing fundamental constant evolution with redshifted radio lines

Nissim Kanekar[1]

[1]National Radio Astronomy Observatory, 1003 Lopezville Road, Socorro, NM 87801, USA;
e-mail: nkanekar@nrao.edu

Abstract. I report new results from radio studies of fundamental constant evolution, using comparisons between (1) conjugate satellite OH lines, and (2) inversion and rotational lines.

Keywords. Atomic processes, line:profiles, galaxies: high-redshift, radio lines: galaxies

---

Comparisons between the redshifts of radio lines from a cosmologically-distant object provide an interesting probe of changes in fundamental constants like the fine structure constant α, the proton-electron mass ratio μ, and the proton g-factor g_p (see Kanekar (2008) for a review). The best present radio techniques are based on comparisons between "conjugate" satellite OH 18cm lines, and between inversion and rotational lines; this article reports new results based on these two techniques.

The satellite OH 18cm lines are said to be "conjugate", when the lines have the same shapes, but with one line in absorption and the other in emission; this implies that the lines arise in the same gas, making them excellent probes of changes in α, μ and g_p (Kanekar, Chengalur, & Ghosh (2004)). We have obtained deep WSRT and Arecibo spectra in the conjugate satellite OH 18cm lines from the $z \sim 0.25$ source, B1413+135. A cross-correlation analysis finds that the line profiles are conjugate within the errors, but with a velocity offset of $\Delta V = (-0.23 \pm 0.09)$ km s^{-1}. This corresponds to $[\Delta G/G] = (-1.18 \pm 0.45) \times 10^{-5}$, where $G \equiv g_p \left[\mu\alpha^2\right]^{1.85}$, tantalizing ($\sim 2.6\sigma$) evidence for a change in α, μ and/or g_p over a lookback time of 2.9 Gyrs.

Comparisons between the redshifts of ammonia (NH_3) inversion lines and rotational lines have a high sensitivity to changes in $\mu \equiv m_p/m_e$ - Flambaum & Kozlov (2007). We have obtained deep GBT spectra in the optically-thin NH_3 1-1 and CS 1-0 lines from the $z \sim 0.685$ absorber towards B0218+357. A joint fit to these lines finds a velocity offset of $\Delta V = (-0.51 \pm 0.36)$ km s^{-1}, yielding $[\Delta\mu/\mu] = (-4.9 \pm 3.5) \times 10^{-7}$. This limit, $[\Delta\mu/\mu] < 7 \times 10^{-7}$, is the best present constraint on fractional changes in μ.

The main drawback of the radio methods is the paucity of radio absorbers at high redshifts, $z > 1$. In the near future, new telescopes like ALMA and the EVLA will allow "blind" absorption surveys in the strong mm-wave rotational lines, yielding large samples of high-z molecular absorbers. Radio techniques are thus likely to play an important role in studies of fundamental constant evolution over the next decade.

Acknowledgements

I thank J. N. Chengalur and T. Ghosh for permission to present our OH results here.

References

Flambaum, V. V. & Kozlov, M. G. 2007, Phys. Rev. Lett., 98, 240801
Kanekar, N. 2008, Mod. Phys. Lett. A, 23, 2711
Kanekar, N., Chengalur, J. N., & Ghosh, T. 2004, Phys. Rev. Lett., 93, 051302