Highlights of Astronomy, Volume 15
XXVIIth IAU General Assembly, August 2009
Ian F. Corbett, ed.
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doi:10.1017/S1743921310009610

Sensitivity of microwave and FIR spectra to variation of fundamental constants

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Microwave and far infrared (FIR) spectra of atoms and molecules are in general more sensitive to the variation of the fundamental constants than optical spectra. For example, FIR transitions between levels of the ground state multiplet ^3P_J of Carbon-like ions are sensitive to α-variation, (Levshakov *et al.* (2008)). Moreover, sensitivities of the transitions (1 - 0) and (2 - 1) are different, (Kozlov *et al.* (2008)). This allows to study α-variation by comparing apparent redshifts for these two transitions of the same ion and significantly reduce systematic errors from the Doppler noise.

Molecular microwave lines are typically sensitive to the variation of the electron-to-proton mass ratio $\mu = m_e/m_p$. In some cases, such as the inversion spectrum of ammonia, this sensitivity is additionally enhanced compared to rotational and vibrational transitions, van Veldhoven *et al.* (2004). This makes ammonia very promising candidate for the studies of μ-variation, Flambaum & Kozlov (2007). In partly deuterated ammonia inversion and rotational transitions are mixed and sensitivities of microwave lines to variation of μ are significantly varying, Kozlov, Lapinov, & Levshakov (2009).

Another case, where enhancement takes place, corresponds to the Λ-doublet spectra of diatomic radicals OH and CH. These transitions are sensitive to both α- and μ-variation. Most interestingly, the coupling of the electronic angular momentum to the molecular axis for these light molecules depends on the rotational quantum number J. As a result, the sensitivity coefficients to the variation of α and μ also strongly depend on J. Therefore, one can compare apparent redshifts of Λ-doublets of different rotational levels. For some rotational quantum numbers the dimensionless sensitivity coefficients become very large (~ 1000) providing significant increase in sensitivity to variation of fundamental constants, Kozlov (2009).

Acknowledgements

This research is partly supported by the RFBR grants 08-02-00460, 09-02-00352, and 09-02-12223.

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https://doi.org/10.1017/S1743921310009610 Published online by Cambridge University Press