Bull. Astr. Soc. India (2003) 31, 475–477

High Resolution Spectroscopy with Submillimeter-Wave

Vinay Kumar*, Hemant Dave
Physical Research Laboratory, Ahmedabad-380 009, INDIA

Abstract. In order to explain the characteristic features of planetary atmosphere, detection and precise measurements of environmentally important gases such as CO, ClO, NO becomes necessary. Since most of the polyatomic molecules have (ro-vibrational) transitions in submillimeter region (100 μ-1000μ), probing in this wavelength region is vital. The specific rotational and vibrational states are the result of interactions between different atoms in the molecule. Since each molecule has a unique arrangement of atoms, it has an exclusive submillimeter signature.' We are developing a portable heterodyne receiver system at Physical Research Laboratory, Ahmedabad to perform high-resolution spectroscopy in this wavelength region.

Keywords : high-resolution spectroscopy, heterodyne-receiver, submillimeter region.

1. Introduction

Many astronomical objects (planets and star forming regions) emit most of their radiations in this wavength range.So in order to explain the physical and dynamical conditions of planetary atmosphere, it is necessary to see the spectroscopic behaviour of gas molecules in different environmental conditions (pressure, temperature and concentration). Terahertz (sub-mm) spectroscopy probes transitions between different rotational and vibrational states of the molecule. Heterodyne detection offers high spectral resolution (> 10^6) in this wavelength range.

2. Description

In this system the experimental gas whose spectroscopic behavior is to be studied is taken in a gas cell. The gas cell has the input window made of ZnSe, which is transparent from 5μ to 15μ

*vinay@prl.ernet.in

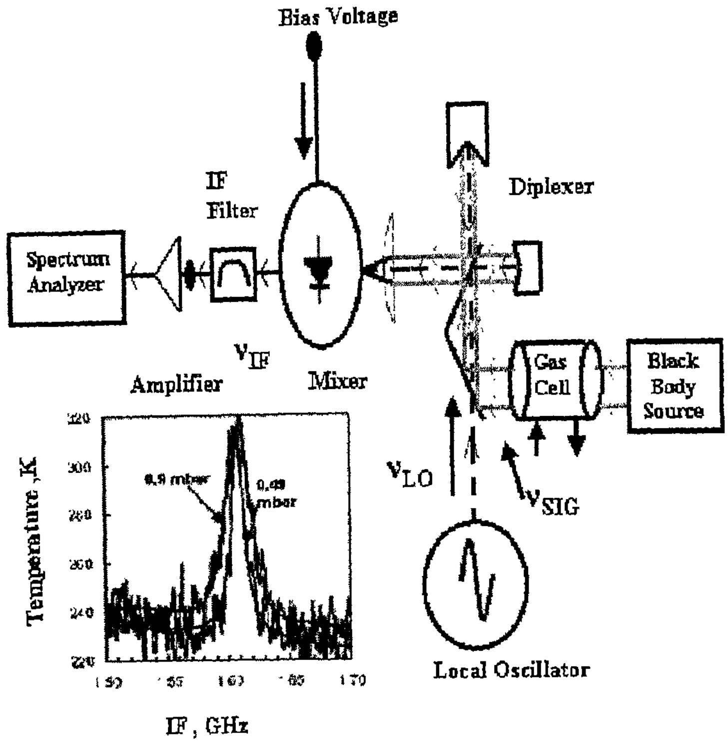

Figure 1. Up: The block diagram of the *Submillimeter Heterodyne Receiver System.* Down: The effect of pressure on molecular profile.

wavelength region. Output window of the gas cell is made of quartz, which is transparent to sub-mm region.The signal from the black body source is used to excite the gas molecules in the cell. In this way molecules go to higher vibrational excited states and then come to original state through several rotational-vibrational transitions emitting submillimeter signal v_{sig}. This signal is mixed with a local oscillator signal at frequency v_{lo} in a mixer (Schottky diode) which is a nonlinear device, to yield the intermediate frequency (IF). This IF is filtered and amplified and then fed to Spectrum Analyzer.Thus we get a highly resolved molecular profile in the Spectrum Analyzer. By applying different pressure, temperature and concentration of the gas of interest in the gas cell we analyse its spectral profile through Spectrum Analyzer. This profile will act as a reference for future remote sensing of planetary atmosphere and various other phenomenon in the universe.

3. Conclusion

In the present scenario the submillimeter region of the electromagnetic spectrum has been of great importance to eminent researchers. The vast majority of gases have rotational-vibrational spectra in this region.For a long the work in this area has been largely hampered by lack of sensitive detectors and unavailability of long wavelength high power tunable lasers. Currently we are developing a high resolution sub-mm heterodyne spectrometer to study the spectral behaviour of various atmospheric gases in the laboratory environment.

References

Gusten, R. et al, 2000, GREAT: The First Generation German Heterodyne Receiver for Sofia, *SPIE vol.* 4014, Airborne Telescope Systems, Munchen.

Crowe T.W. et al, 1999, GaAs devices and circuits for terahertz applications, *Infrared Physics and Technology*, 40.

Kostiuk, T., Espenak, F., Romani, P., Zipoy D., Goldstein, J., 1990, Ethane Abundance on Neptune, Icarus, 88, 87-96.

Blundell, R., Edward, C.Y., Submillimeter receivers for radio astronomy, proceedings of *IEEE*, 80, no. 11, 1992.