Synopsis

The spectral line profile measurements lead to important information about molecular physics. The line shape study of atmospheric molecules in the presence of a number of perturber gases is of immense importance to the spectroscopists for atmospheric monitoring research. A high resolution recording of the spectral data contains information about the collision dynamics of the molecules and also the intermolecular potential. The recorded data should be fitted with a standard theoretical profile which includes all the contributions to the spectral line shapes. Our objective of this work is to measure the line shape of the $O_2$ A-band transitions using a near infrared diode laser spectrometer. The effects of the foreign gases like $N_2$ and helium have also been examined.

In the first chapter, i.e., the introduction, a brief discussion of the electronic structure of a diatomic molecule is given. We have also discussed the line shape of molecules in the gas phase and the different line broadening mechanisms. A discussion about the collisional narrowing of the line shape along with different collisionally narrowed line shape models is presented.

In chapter 2, we describe the fundamental characteristics of a high resolution absorption spectrometer set up in our laboratory. The spectrometer is based on commercially available wavelength tunable GaAlAs semiconductor diodes. Detailed discussions about the modulation and detection techniques which enable us to record the weak signal with a high sensitivity are also given. The different instruments and their conditions during the experiment are also described.

In chapter 3, the self-broadening measurement of the $O_2$ A-band is reported. The variations of observed line width with pressure is described. The non-Voigt nature of the measured line shapes have been reproduced by using the collisionally narrowed soft collision model of Galatry. Values of the pressure broadening and narrowing
coefficients along with the line intensities obtained from a non-linear least squares fitting of the Galatry profile are presented in tabular form. The values of pressure broadening coefficients and line strength parameters obtained from the present measurement are compared to the values obtained by earlier dye laser measurements. The earlier work could not fit the narrowing coefficient, although they showed the non-Voigt nature of the profile.

In chapter 4, nitrogen broadening measurements of the $O_2$ A-band have been described. The measured profiles have been fitted by using the Galatry profile. The various line parameters obtained from the simulation process in the presence of $N_2$ perturber are given in tabular form and they are compared with the self-broadening values.

In chapter 5, helium broadening of $O_2$ A-band is discussed. The measured profiles have been simulated using both the Voigt and Galatry profiles. The line parameters extracted from the simulation process are presented in tabular form and they are compared with the self and $N_2$ broadening values. In the case of He-broadening no significant difference between the Voigt and Galatry profiles is recorded.

In chapter 6 we conclude the results obtained in this work.