The basic aim of the work presented in this thesis, is to study the afterglow spectra of molecular gases like nitrogen and oxygen as a function of pressure, temperature and carrier gas. This will contribute to the knowledge about the possible population mechanisms of the emitting states, and also about the quenching of emitting states by carrier gas. A high resolution afterglow spectrometer which includes gas purification system, discharge region, observation vessel, high speed pumping system, monochromator, highly sensitive light detector and data acquisition system has been designed and fabricated in the laboratory. The novel feature of the experimental set up is the Wrede-Harteck gauge which has been incorporated in the system. The Wrede-Harteck gauge has been used to measure absolute atomic concentration under various experimental conditions.

The afterglow spectra of nitrogen is studied at 77°K and 300°K in the spectral range from 1900 to 8000 Å. The relative vibrational intensities for the first positive system have been computed from the afterglow spectra at both the temperatures. The pressure dependence of intensities of various bands have been investigated at pressures between 2 and 7 Torr while the effect of diluent like argon has been studied at a fixed argon pressure of 5 Torr and varying nitrogen pressure from 0.2 to 3 Torr. The mechanisms for populating the different vibrational levels of B \(3\Pi_g\) state have been discussed in the light of new results obtained in the present.
experiment and previous measurements reported in the literature.

For the first time, quenching rates of (12,8) and (11,7) vibrational bands of the first positive system of nitrogen by nitric oxide, observed in the afterglow, have been measured for temperatures varying from about 87°K to 90°K. Also, the quenching rates for vibrational level \( v' = 12, 11, 10 \) of the first positive system of nitrogen by argon have been studied at room temperature.

High resolution afterglow spectra for molecular nitrogen have been obtained, for the first time, for the (12,8), (12,9), (11,7) and (11,8) vibrational bands of the first positive system \( (B \, ^3\Pi_u \rightarrow A \, ^3\Sigma_u^+) \) and studied at 300°K and 77°K. The rotational transitions corresponding to P, Q, R branches have been unambiguously identified in the afterglow spectra. From these results, dissociation energy corresponding to the lowest dissociation limit of nitrogen has been computed and result obtained has been compared with that reported by others in relatively recent times.

The afterglow spectra of oxygen corresponding to Herzberg I system have been studied at 300°K in the spectral region from about 2400 to 4250 Å at various oxygen pressures ranging from 2 to 7 Torr. Practically no laboratory measurements have been made to study quantitatively, the deactivation of \( A \, ^3\Sigma_u^+ \) state by \( O_2 \) so far. The deactivation of \( O_2(A \, ^3\Sigma_u^+) \) state by oxygen itself has been studied in detail and the quenching rates for some of the vibrational bands of Herzberg I system have been calculated. The afterglow spectra of oxygen have also
been studied in the presence of diluents like argon and helium at oxygen pressure ranging from 0.2 to 1 Torr. The quenching rates for some bands of Herzberg I system by argon and helium have also been measured.