SUMMARY

Stellar spectroscopy is a valuable tool for an investigation of stellar atmospheres as well as the dynamics of stellar systems. In the case of binary stars, the Doppler shifts of the spectral lines enable us to derive the orbit of one component relative to the other. In pulsating stars like the Cepheids, the variations in the appearance, strength and Doppler shift of a spectral line during the cycle of pulsation could lead us to estimate the variation of stellar radii and atmospheric parameters. Spectroscopic methods are the most valuable for an accurate estimation of the abundances of different elements in the stellar atmospheres. The importance of these abundance determinations lies in the clue they give on the nuclear history of stellar matter and more generally of the matter in the whole Galaxy. The chemical composition of the interstellar medium and the composition of stars of different age groups leads us to an understanding of the chemical history of the Galaxy. Primordial matter out of which the Galaxy was formed is believed to be consisting of only hydrogen and helium. The enrichment of the interstellar matter has resulted from the processed gas ejected by stars at their advanced stages of evolution. Large and small-scale chemical inhomogeneities in the Galaxy have an important bearing on the problem of galactic evolution. The observed radial gradient
in the disk of our Galaxy, abundance anomalies across the spiral arms and also the ratios of the abundances of elements formed in primary and secondary nucleosynthesis provide the observational tests for the models of galactic evolution.

[In the present investigation, we have derived the above mentioned quantities by the spectroscopic studies of classical Cepheids.] This group of stars, due to its high intrinsic luminosity, smaller age and the existence of period-luminosity and period-age relationships, is a very good candidate for the studies of galactic evolution.

The importance of determination of elemental abundances in astrophysical objects is reviewed in Chapter 1 and the methods employed in the determination of the stellar chemical composition are described in Chapter 2. Chapter 3 describes the observational data for the present study and the reduction techniques employed. The spectra used in the present investigation were obtained using the 102-cm reflector of Kavalur Observatory between 1980-81. These spectra were analysed using the automated microphotometer of the Indian Institute of Astrophysics, using the micro-computer programmes specially written for the present work. The method of computation of the theoretical spectrum is described in Chapter 4. The computation, based on the formal
solution of radiative transfer, incorporated the simplifying assumptions of local thermodynamic equilibrium, hydrostatic equilibrium and plane-parallel geometry. These assumptions are reasonably good for the metallic lines of F-G stars. The list of spectral lines computed, and their gf values derived from an inverted solar analysis, are given in the Appendix.

The resultant abundance determinations for the Cepheids T Monocerotis, ζ Geminorum, Χ Sagittarii, W2 Sagittarii and SV Monocerotis are presented in Chapter 3. The agreement between the observed and the computed spectra is shown in the figures. These results are discussed in Chapter 6. We derive an abundance gradient of

\[ \frac{d \left[ \frac{Fe}{H} \right]}{dr} = -0.056 \pm 0.008. \]

The range in galactocentric distances of the present sample exceeds the past spectroscopic attempts, rendering the present work more reliable. The good agreement between the gradient derived here and the earlier photometric estimates shows that there are no systematic errors in the photometry of the past investigators.

The star ζ Gem shows marked overabundances of all the heavy elements for its position in the galactic disk. This
overabundance of \( \zeta \) Gem is also reported in the investigation of Luck and Lambert (1981). Similar overabundance has also been noted in \( \nu \) Sgr. To understand this abrupt departure from the smooth abundance variation across the disk, birthsites of all the Cepheids with known spectroscopic abundances were examined. For a majority of the stars with known spectroscopic abundances, Wislen (1973) has determined the birthsites by the detailed calculations of galactic orbits of these stars. For the remaining stars, birthsites were determined from galactic rotation assuming an age derived from the period-age relationship. It was seen that both \( \zeta \) Gem and \( \nu \) Sgr were born far from the inner edge of the spiral arm where a majority of the stars are born. A possible explanation for their overabundance is advocated in Chapter 6. In this picture, the massive stars born near the inner edge of the spiral arm move away from it as they evolve. At the end of their life, they explode as supernovae and enrich the local interstellar medium with processed matter. The stars \( \zeta \) Gem and \( \nu \) Sgr are probably formed from such matter. Abundances of the element derived in the present investigation do not show any significant correlation with atomic number. Also the abundance ratio of s-process elements (Ba, La, Ce, Sm) does not show any correlation with Fe. This implies that for the disk population there is no enrichment of s-process elements relative to Fe, such as
has been observed earlier for halo population. The lack of any correlation between $[s/Fe]$ and $[Fe/H]$ for disk stars can be explained by the conventional infall models of Larson. We propose that an alternative explanation that the ratio $[s/Fe]$ can also be interpreted as the ratio of the intermediate-mass stars (which contribute s-process nuclei) to high-mass stars (which contribute to Fe peak nuclei). Thus the different behaviours of halo and disk populations may indicate a difference in the mass spectrum of star formation.

These results are discussed in Chapter 7, with an emphasis on the future prospects for an improvement of the techniques of analysis as well as for framing extensive observational programmes.