Chapter 7

Conclusions

7.1 Discrete space theory of radiative transfer

- We have given a concise description of the method of obtaining the solution of monochromatic radiative transfer equation in spherical symmetry, equation of transfer in comoving frame in the presence of dust and the calculation of line profiles for an observer at infinity. These solutions are used to calculate self radiation of the primary star in a binary system.

7.2 Incident radiation from a point source

- We found that maximum radiation comes from intermediate points of the atmosphere, the reason being that we have combined radiation from the star together with the incident radiation from a point source outside the star.

- We also calculated the effects of irradiation from a point source observed at infinity. The radiation is calculated and compared with two approximations i.e., plane parallel and the spherical symmetry. In plane parallel case the limb is darker than the centre. When the electron density is increased the irradiance brightens the limb but when combined with self radiation the same variation is noticed.
In spherical case (i.e., \( \frac{B}{A} = 1.5 \)), where B and A are the outer and inner radius of the star), the limb darkening is noticed. Intensities fall sharply when compared to those in plane parallel approximation. When electron density is increased, the irradiation definitely shows limb brightening and intensities fall gradually but at the limb, they start increasing.

### 7.3 Incident radiation from an extended source

In reality extended source can not be considered as a point source. We extended the method for calculating the radiation field on the primary component when secondary component is an extended source.

- We found that the reflection gradually decreases from the component towards the surface of the outermost layers of the atmosphere, since the medium is illuminated uniformly, the intensities decreasing from inner radius to the outer radius of the star.

- The specific intensities calculated at infinity show marked changes when the plane parallel approximation is replaced by the assumption of spherical symmetry. The surface along the axis facing illumination reflect maximum radiation while the innermost and outermost layers show lesser amount of reflected radiation.

- In plane parallel approximation the law of specific intensities is almost linear and falls rapidly towards the surface, whereas in spherical symmetric case the specific intensities reach maximum and then fall.

- It appears that the law of limb darkening does not depend much on the ratio \( \frac{r_1}{R} \) where \( r_1 \) is the outer radius of the star, and \( R \) is distance between centers of two components.
• The law of variation of radiation from center to limb depends on whether one considers plane parallel or spherical symmetry geometry and also on the distribution of electron density.

• We also noticed that the limb is darker than the center, when we increased the electron density the irradiance brightens the limb but when combined with self radiation, the same variation is noticed.

7.4 Effects of reflection on spectral lines

• In the next step we studied the effects of reflection on formation of spectral lines in a purely scattering atmosphere, absorbing medium, and partially scattering medium and studied how the line profiles change and how the equivalent widths change when irradiation from the secondary is taken into account. These calculations were done in a static and moving atmospheres. We also computed line profiles when dust is present in the atmosphere. We obtained P-cygni type profiles.

7.5 Distortion due to rotation and tidal forces

We studied the transfer of line radiation in the atmospheres of close binary components whose atmospheres are distorted by the self radiation and tidal forces due to the presence of the secondary component. The distortion is measured in terms of the ratio of angular velocities at the equator and pole, mass ratio of the two components, the ratio of centrifugal force to that of gravity at the equator and the ratio of the equatorial radius to the distance between the centers of gravity. We obtain the equation of the distorted surface by solving a seventh degree equation which contains the above parameters.
• We found that equatorial temperatures fall rapidly for increasing value of $f$. In the case of luminosity $f$ would give smaller values of $l_1$ (ratio of luminosity along the line of sight) and vice versa.

• We found that rotation will dilute the radiation field which is similar to the effect of expansion.

7.6 Effects of gravity darkening on spectral lines

Transfer of line radiation is studied in such asymmetric atmosphere assuming complete redistribution and a two-level atom approximation. The atmosphere is assumed to be expanding radially. Various black body temperatures are being used to describe the total luminosity of the components for the purpose of irradiation. The line profiles in a stationary atmosphere are symmetry. The self radiation produces absorption profiles while the incident radiation produces emission profiles and the combination of the self and incident radiation produces emission profiles.

• In an expanding atmosphere with $V_A=0$ and $V_B=10$ mtu the profiles due to the self radiation is almost non-existant and while those due to self and incident radiation are prominent emission lines with P Cygni characteristics. There is a perceptible change in the profiles when the parameter $\frac{r_e}{R}$ is changed from 0.1 to 0.3 and 0.5.

• The same variation is seen in other velocity laws.

• We have developed a method of obtaining radiation field along the spherical surface irradiated by an external point source, extended source of radiation as first step to understand the reflection effect in close binary systems. And also the method has been extended to the
case of atmospheres distorted due to self rotation of the component and tidal effects due to the presence of its companion. We notice that the expansion of the medium produces P Cygni type profiles and the irradiation enhances the emission in the lines although the equivalent widths reduce considerably. Finally we suggest that while modeling the binary system one has to consider the effects of reflection.

In future we would like consider reflection model for light curves of close binary systems considering multiple reflections and Roche geometry (primary component heats the secondary component and secondary component heats the primary component).

We also would like to consider the reflection effect in 3-D geometry which will help us to achieve accuracy, to approach exactness in the fine computation limit.
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