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ORIGINAL ARTICLE

Reflection effect in close binaries: effects of reflection on spectral lines

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Abstract Reflection effect phenomenon is studied on the formation of spectral lines in a close binary system when primary component has an extended atmosphere and the secondary component is a point source.

Irradiation effect is calculated using one dimensional rod model and self radiation is calculated using continuum radiative transfer equation in spherically symmetric atmosphere. The total radiation is the sum of the radiation of the individual components and the mutually reflected light. Line profiles are also computed along the line of sight observer at infinity for irradiation, self radiation and total radiation and compared in order to study the reflection effect on spectral lines.

It is found that the radiation field varies on the primary component when angle of incidence changes from the secondary component. The contour maps show that the radiative interaction makes the outer surface of the primary star warm when its companion illuminates the radiation. The effect of reflection on spectral lines is studied and noticed that the flux in the lines increases at all frequency points and the cores of the lines received more flux than the wings and equivalent width changes accordingly.

Keywords Reflection effect · Binaries: close · Radiative transfer · Scattering medium · Line profiles

1 Introduction

Series of papers by Peraiah (1982, 1983a, 1983b) and Peraiah and Srinivasa Rao (1983a) have investigated the effect of irradiation on the atmosphere of the primary component in close binary system in a purely scattering medium. The law of limb-darkening has been calculated when the atmosphere of the primary component is illuminated by the extended surface of the secondary component in a binary system. Peraiah and Srinivasa Rao (1983b) studied reflection effect phenomenon on spectral line and saw the variation in the equivalent width with reflection and without reflection. Napier and Ovenden (1970) tried to explain by means of reflection effect, the correlation between the velocity amplitudes of individual absorption lines and their wavelengths in 57 Cygni. In close binaries equivalent width of the lines changes between eclipses. The spectral lines in 12 Lacertae undergo a periodic variation in width, the lines become wide and diffuse at periastron passage and sharper and narrower at apastron (Young 1922). Vaz (1985) had written a review article on reflection effect phenomenon and covered most of the connected articles. Wilson (1990) discussed various classes of close binary systems which require a treatment of reflection effect. Wilson (1990) has also said that the radiative interaction only creates a small change in the atmosphere structure and the variation of the emitted flux can be strongly affected. Recent models by Alencar et al. (1999), Kubat et al. (1999), Kubat (2000), Pustynski and Pustylnik (2005) address the reflection effect phenomenon in a binary system.

Srinivasa Rao and Varghese (2009) attempted to study reflection effect in 3D geometry by considering monochromatic transfer equation in spherical geometry. They noticed that the radiating field changes along the line of sight with and without reflection depending upon the position of secondary component. The present paper deals with continuum transfer equation to study the reflection effect with an analysis that solves the surface of the irradiated star.

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