FORMATION OF THE BALMER LINE IN THE OPTICALLY THICK NOVA ENVELOPE

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Non-LTE effect and formation of the Balmer line Hα in the optically thick nova wind expected from the radiation-pressure-driven continuous ejection model (cf. Bath and Shaviv, 1976; Ruggles and Bath, 1979) was investigated by use of the pure-hydrogen spherical model atmosphere, in which constant radial expansion velocity, inverse square law of density distribution, and planar grey temperature distribution were assumed. The coupled equations of radiative transfer and statistical equilibrium on the four levels plus continuum model atom (in which Hα line and Balmer-, Paschen-, and Brackett- continua are explicitly treated) were solved by the complete linearization procedure based on the comoving frame method (cf. Mihalas and Kunasz, 1978). We calculated four models as results of the combination of the surface density ρ_{surf} (at $\tau_{Ros}=10^{-3}$) (10^{-12} g/cm^3, 10^{-13} g/cm^3) and the expansion velocity V_{exp} (0 km/sec, 1000 km/sec). We assumed 10^{12} cm for the photospheric radius r_{ph} (at $\tau_{Ros}=1$), 10000 K for the effective temperature appearing in the temperature formula, and 100 km/sec for the microturbulent parameter. The low density models have larger extension ($r_{surf}/r_{ph}\simeq4.1$) than the high density ones ($r_{surf}/r_{ph}\simeq1.7$). The results of the calculations are shown in Fig.1 and Fig.2, from which the following characteristics are noticed.

- The values of departure coefficients are greater than unity (i.e. overpopulated) and tend to increase as atmospheric extension increases reflecting the decrease of photoionization (i.e. relative increase of recombination) due to the dilution of radiation field.
- The existence of velocity field is important for the dilution of line source function of low density model due to the increase of photon escape probability induced by the transverse velocity gradient, while this effect is almost negligible in the case of high density model owing to the decrease of transparency.
- As for the LTE spectra, absorption component is absent (low density model) or very weak (high density model); i.e. emission component dominates the line profile calculated under the assumption

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of $S_l = B_\nu$. This fact indicates that the formation of absorption component is mainly due to the dilution of line source function. In what follows only non-LTE profiles of expanding models are discussed.

- Radial velocity inferred from the absorption component appears to correspond to the expansion velocity approximately correctly (or slightly smaller by <~10%). The emission lobe is round-shaped (indication of optically thick envelope) and almost centered around the rest wavelength.
- The strength of emission component grows and relative importance of absorption component decreases as the atmosphere more extends. Accordingly, the emission strength may be a good indicator of the atmospheric extension. In the meanwhile, the width of the central region of the emission component (for example, the width at the flux level $(F_{peak}+F_{cont})/2$) appears to be comparatively insensitive to the extension effect and may be determined mainly by the expansion velocity.

Fig.1

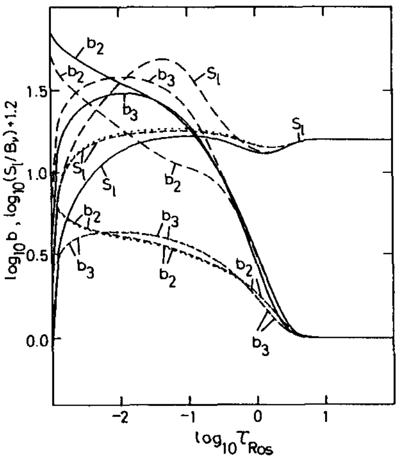

Fig.2

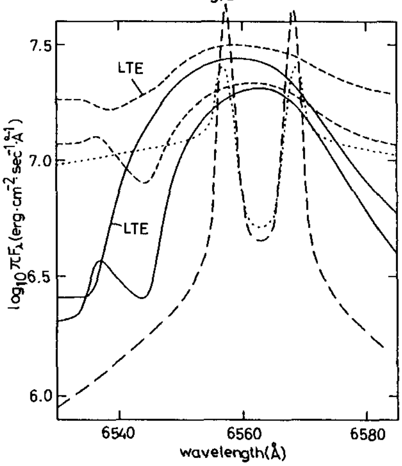

Fig.1: Run of departure coefficients b_2, b_3, and line source function for Hα (in unit of Planck function) with Rosseland optical depth. Dotted lines...(log ρ(surf)(g/cm^3), V(exp) (km/sec)) = (-12,0). Short-dashed lines...(-12,1000). Long-dashed lines... (-13,0). Solid lines...(-13,1000).

Fig.2: Surface flux in the observer's frame vs. wavelength. Fluxes calculated under the assumption of LTE (i.e. setting b=1 for all levels) are also shown for the expanding models. Same meanings of lines as in Fig.1.

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