GLOBAL DISK OSCILLATIONS: THEORETICAL LINE PROFILES

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Abstract. Based on 3D radiative line transfer calculations we present Hα emission line profiles of Be star circumstellar envelopes undergoing one-armed global disk oscillations. The results are in agreement with the observed line profile variability.

1. The model

Kato (1983) and Okazaki (1991) proposed one-armed global disk oscillations (GDO) as an explanation for the long-term variability of optical Be star emission lines. The disk perturbation pattern is rotating retrograde around the star ($P \simeq 10$ years) giving rise to the observed long-term line profile variability (Hanuschik et al., 1993). The perturbed density distribution consists of a significant maximum region located nearby the central star at azimuthal angle $\phi = 0^0$. The particle trajectories are similar to ellipses. Based on Okazaki's perturbation pattern and on a 3D radiative line transfer code (Hummel, 1993) we calculated Hα emission line profiles of circumstellar disks extended up to $R_\mathrm{d} = 5R_*$ with a radial density run of $N \sim N_0(\frac{r}{R_*})^{-2}$.

2. Results and discussion

In Fig.1 and in Fig.2 the line profile sequences of different values of ϕ simulate the observed long-term profile variability. At $\phi = 0^0$ the line of sight is parallel to the symmetry axis of the GDO pattern and the maximum density region is in front of the star. At $\phi = 90^0$ the maximum density region is on the left hand side of the star moving towards the observer.

At nearly pole-on view ($i = 10^0$) variations of asymmetric winebottle-type profiles are presented, at $i = 30^0$, typical V/R-ratio variabilities of double-peak profiles are shown and for an edge-on view ($i = 90^0$) the calculated shell profiles exhibit variations of the radial velocity (V_cd) and of the flux (F_cd) at the central depression of the profile. The observable sequence of $[V/R > 1] \Rightarrow [F_\mathrm{cd}^\mathrm{min}] \Rightarrow [V/R < 1] \Rightarrow [F_\mathrm{cd}^\mathrm{max}]$ (Cowley & Gugula, 1973) is in agreement with a retrograde pattern rotation (Fig.2; $i = 60^0$).

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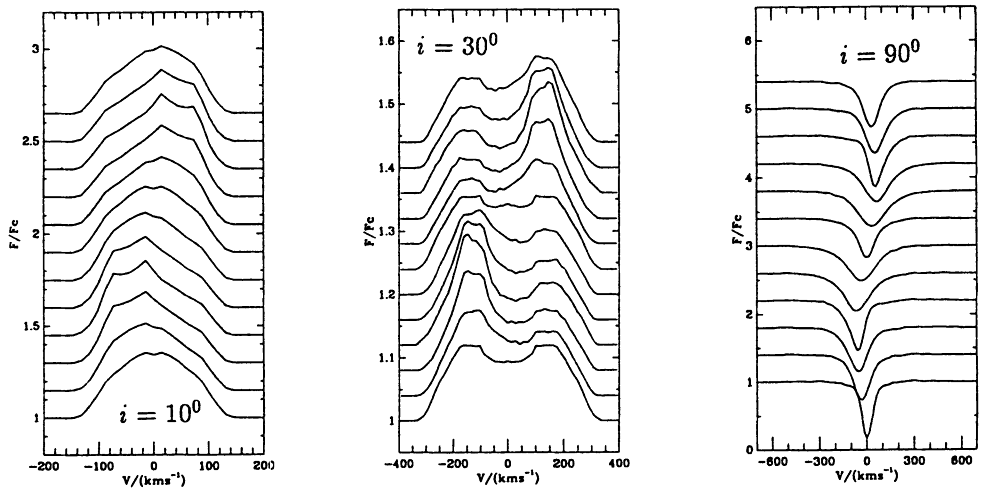

Fig. 1. Three sequences of calculated emission line profiles of a nearly Keplerian disk ($N_0 = 10^{13}\mathrm{cm}^{-3}$) at $i = 10^0, i = 30^0$ and $i = 90^0$. In each sequence the azimutal angle ϕ varies from bottom to top: $\phi = 0^0, 30^0, 60^0, \ldots 330^0$.

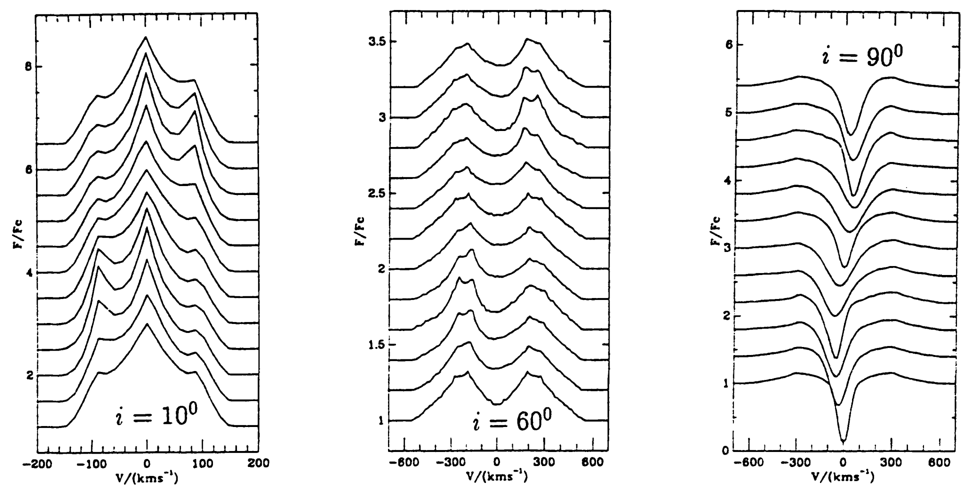

Fig. 2. As Fig.1, except $N_0 = 10^{14}\mathrm{cm}^{-3}$ and $i = 10^0$, $i = 60^0$ and $i = 90^0$.

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