Stellar Rotation
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Observational Effects of Corotating Interaction Regions in OB stars

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Abstract. The stellar winds of OB stars are perturbed by Corotating Interaction Regions (CIRs). We present a 3D radiative transfer model which predicts that variations should occur in the infrared and millimetre continuum.

1. Introduction

OB stars lose mass through their radiatively-driven stellar wind. The outflowing material around the star affects the shape of the ultraviolet resonance lines, turning them into P Cygni profiles. Superimposed on such profiles, Discrete Absorption Components (DACs) can be seen, that move through the absorption part of the profile. The recurrence time scale of the DACs is related to the rotation period of the star.

The best model to explain the DACs is the Corotating Interaction Regions model (Mullan 1986; Cranmer & Owocki 1996). This model assumes that there are irregularities on the surface of the star (due to magnetic fields or non-radial pulsations). The differences in surface flux create local differences in the radiative acceleration of the wind material. The fast material collides with the slow material, creating a Corotating Interaction Region (CIR). As the cause of the structure is rooted on the stellar surface, the model can also explain very well why the recurrence time scale of the DACs is related to the rotation period.

The question we want to investigate is whether Corotating Interaction Regions also cause variability in the long-wavelength continuum fluxes. The far-infrared, millimetre and radio fluxes are due to Bremsstrahlung emission in the stellar wind material. Bremsstrahlung is proportional to the density squared. The density enhancement due to the CIRs will therefore lead to an increased flux. How much the flux is increased will depend on the phase in the rotational period and the density contrast.

2. Modelling of CIRs

To investigate the CIR model, we developed a 3D radiative transfer code (following Adam 1990), based on the finite volume method. In this code we introduced a simplified model of CIRs, and solved the transfer equation for continuum radiation at a number of wavelengths. For the parameters of the model we take values that are appropriate for ϵ Ori (Blomme et al. 2002). The stellar wind has a $\beta = 1$ velocity law. Only Bremsstrahlung emission and absorption are included. The CIRs follow a spiral shape that is taken from the Cranmer &

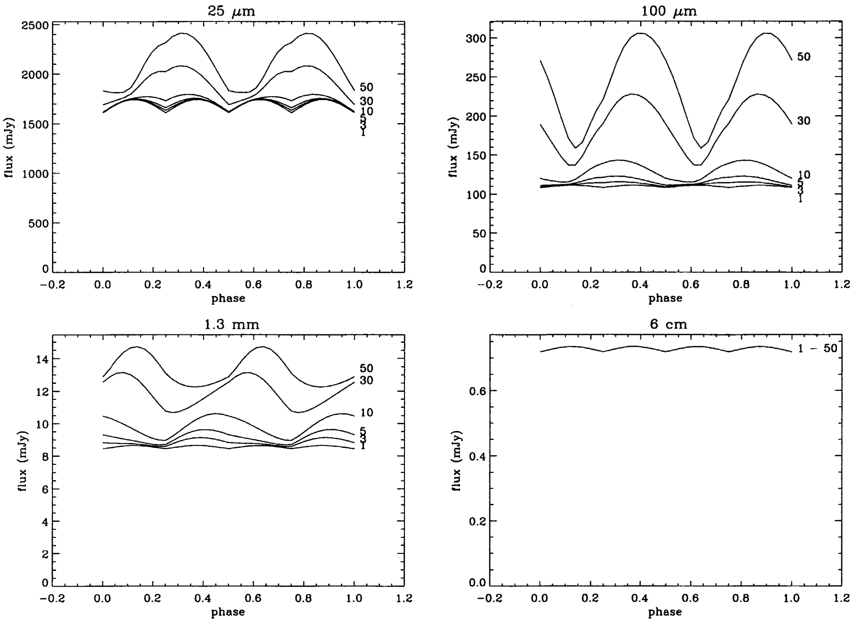

Figure 1. Calculated fluxes as a function of phase in the rotational period. Density contrasts are listed next to each curve. The star is assumed to be seen equator-on. The variations for density contrast = 1 are due to a numerical artifact.

Owocki (1996) model, and are assumed to end abruptly at 30 R_*. The material in the CIRs has an enhanced density compared to the material around it. The density contrast is taken to be constant through the wind.

3. Results

Fig. 1 shows the results at four wavelengths for different density contrasts (1–50). The major conclusion is that a sufficiently high density contrast results in detectable variability at infrared and millimetre wavelengths. This is not the case at radio wavelengths, because the CIRs are completely hidden inside the radio photosphere.

References

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