A&A 607, C1 (2017)
DOI: 10.1051/0004-6361/201526535e

Astronomy & Astrophysics

Multitechnique testing of the viscous decretion disk model

I. The stable and tenuous disk of the late-type Be star β CMi

(Corrigendum)

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A&A 584, A85 (2015), DOI: 10.1051/0004-6361/201526535

Key words. stars: emission-line, Be – stars: individual: β CMi – radio continuum: stars – submillimeter: stars – techniques: polarimetric – errata, addenda

After the publication of the original paper of Klement et al. (2015), a software bug was found in the radiative transfer code HDUST version 2.02. The error in the code regarded the precise nature of the photon launching mechanism at the stellar surface and resulted in slight underestimation of the mean intensities in the equatorial region, with small but detectable effects in the disk temperature and emergent spectrum. The new, corrected version (HDUST 2.10) causes the computed temperature to be slightly lower and the level populations more neutral. The changes in the resulting synthetic observables were found to be mostly minor: a decrease in the level of polarization, line emission, and the IR flux levels. The effects of the software bug get larger with increasing stellar rotational velocity.

In the specific case of β CMi, which was found to rotate very close to or even at the critical velocity, the changes in the computed spectrum required revisiting of the original modeling procedure. The changes to the model and how the revisited model reproduces the observations was fully described by Klement et al. (2017a). The results regarding individual observables after the code update can be summarized as follows:

- Spectral energy distribution (SED). The full SED is now fully reproduced using a single power-law (with $n = 2.9$) prescription for the disk density (Fig. 1 of Klement et al. 2017a). The conclusion that the outer disk is found to be truncated at the distance of 35 stellar radii remains unchanged.
- Hydrogen spectral lines. All four modeled emission lines – Hα, Hβ, Hγ, and Brγ – are now reasonably well and simultaneously reproduced by a single model (Fig. 2 of Klement et al. 2017a).
- The linear polarization. The observed polarization percentage is now reproduced within the error bars by the same model mentioned in the previous two points (Fig. 3 of Klement et al. 2017a).
- Interferometric observables. The fit of the new model to the interferometric observations mostly shows a slight increase in the quality of the fit with the exception of the AMBER spectro-interferometry, for which the resulting reduced χ^2 increased from 1.20 to 1.52 (Table 1 of Klement et al. 2017a).

To conclude, the update of the radiative transfer code HDUST resulted in the improvement of the overall agreement between the viscous decretion disk (VDD) model predictions and the multitechnique observations of β CMi. All of the observations were simultaneously reproduced using a truncated VDD with a single power-law prescription for density. This replaces the original conclusion that there is a dual behavior in the disk density profile, with the very inner parts requiring a steeper fall-off in density than the more extended parts. No physical explanation was originally found for this feature and it turns out to have been the effect of the code error. As for the structure of the outer disk and its truncation, the conclusion remains the same as that in the original paper. The outer disk structure was revisited by Klement et al. (2017b) using additional radio data.

References

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