Determination of Disk Parameters of the Be Star HD45725

F. Figueroa-Tapia [1] C. Arcos [1] M. Curé [1] I. Araya [2]

[1]Instituto de Física y Astronomía, Facultad de Ciencias, Universidad de Valparaíso, Av. Gran Bretaña 1111, Valparaíso, Chile

[2]Centro de Investigación DAiTA Lab, Facultad de Estudios Interdisciplinarios, Universidad Mayor, Chile

Introduction

Classical Be stars are B-type main sequence stars holding a geometrically thin equatorial quasi-Keplerian disk with a rotational velocity between 30% and 95% of their critical rotational velocity (Zorec et al. 2016).

It's still under debate how the star transfers not only angular momentum, but also mass to the disk, but when the material is on the circumstellar orbit it is governed by viscosity (Lee et al. 1991).

HDUST

The code HDUST (Carciofi & Bjorkman 2006) is a NLTE Monte Carlo radiative transfer code capable of predicting observables from 3D circumstellar disk models. We use HDUST to model the disk of *HD 45725* using a power law with an exponential cutoff for volume density $\rho(r,z)$

$$\rho(r,z)=\rho_0\left(\frac{R_*}{r}\right)^n \exp\left(-\frac{z^2}{2H^2}\right) \quad ; \quad H(r)=H_0\left(\frac{r}{R_*}\right)^\beta \quad ; \quad H_0=\frac{a}{v_{crit}}R_*$$

with r and z respectively being the radial and vertical positions within the disk, R_* as the equatorial radius of the star, ρ_0 as the density where $r=R_*$ and $z=0$, n being a parameter which defines how quickly the density decreases with the increasing r, a being the sound speed of the disk, which is determined within the code from the temperature structure, and v_{crit} is the critical rotational velocity of the star.

Method used for modelling

In order to obtain an accurate model for the observed spectrum, we fixed (the most part of) the stellar parameters based in previous works (Chauville et al. 2001, Arcos et al. 2018), and make a grid varying between the disk parameters such as ρ_0, R_{env}, n. Because this star have several observations, we choose the most symmetrical to compare with the obtained by HDUST.

This particular observation has been done in 2011/01/15 and observed by the Observatoire di Pilat, France.

Best Model

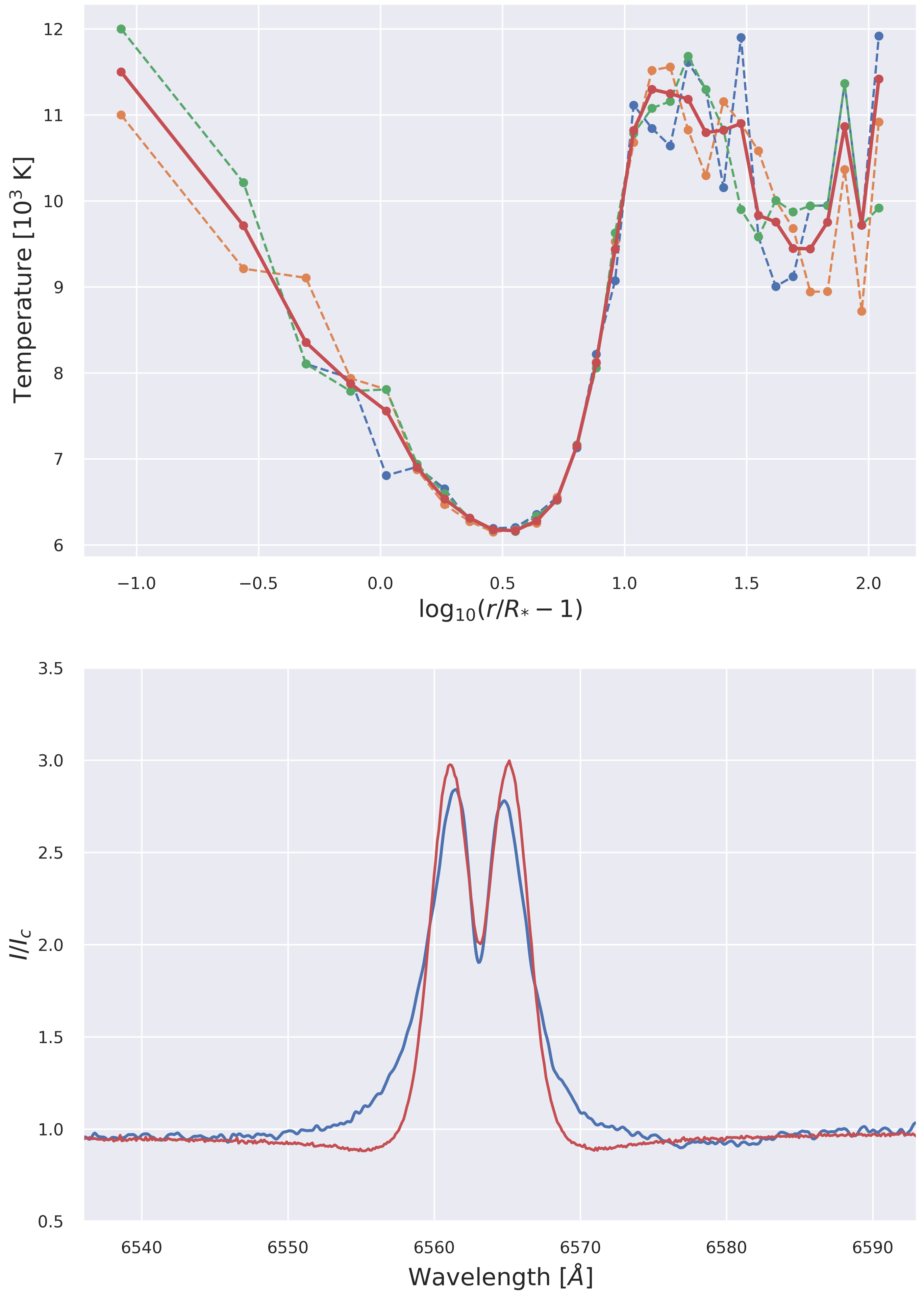

Figure 1. (a) Temperature plot of the best fit. The horizontal axis corresponds to the distance from the surface of the star in logaritmic scale and the vertical axis corresponds to the temperature. Here we can see how the temperature varies along the disk. The dashed color lines corresponds to the last three iterations, and the red one is the average of all of them. (b) $H\alpha$ line-emission comparison between observed (**blue**) and fitted (**red**) spectrum.

Results

As we can see from Figure 1a, the model could converged without problems. The way that we can know that the model is valid is because of the "U" shape of the temperature profile. The reason of that phenomena is because the density in the disk is greater in the middle, so when the disk make a "flaring", the density decrease and the radiation of the star can be transfer more easily, warming up the most distance material of the disk.

The result of the model can be seen in Figure 1b, where the wings can't be reproduced by this specific model. On the other hand, we can fit with no problem the intensity of the line and also the valley of $H\alpha$.

Fixed		Obtained	
T_{pole}	20.9 $[kK]$	ρ_0	$1.0\cdot10^{-11}$ $[g\ cm^{-3}]$
R_{pole}	4.32 $[R_\odot]$	n	1.5
$log(g)$	4.0 [dex]	R_{env}	120 $[R_*]$

Table 1. On the right side of the table we can see the fixed stellar parameters, and the left side the obtained parameters from modelling the observed spectrum.

Future work

This work had good results, but there are more observations to fit. In order to quantify the change in the disk of HD45725, we need to find the best parameters for each one and find a temporal evolution of the star. Also we are currently working to use HDUST alongside of the code HYDWIND (Curé 2004), in order to reproduce not only the spectrum, but obtain the line parameters for the stellar wind.

Acknowledgments

The authors acknowledge the financial support from Fondecyt Regular N. 1190485. C.A. Thanks to Fondecyt Iniciación N. 11190945. I.A. Thanks to Fondecyt Iniciación N. 11190147. Thanks to project FAPESP N°133541. This work has been possible thanks to the use of AWS-U.Chile-NLHPC credits. Powered@NLHPC: This research was partially supported by the supercomputing infrastructure of the NLHPC (ECM-02).