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New insights on Be shell stars from modelling their Hα emission profiles

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Abstract.
Be shell stars are believed to be ordinary Be stars seen edge-on, which makes them particularly desirable objects for study since the uncertainty in the inclination of the rotation axis is largely eliminated. We have recently modelled high resolution Hα spectroscopic observations for eight Be shell stars, using the non-local thermodynamical equilibrium radiative transfer code Bedisk (Sigut & Jones 2007) and the new spectral synthesis package Beray (Sigut 2011). Generally, we confirm that these systems are oriented at high inclination angles, although we find that they are not necessarily as close to edge-on as initially expected.

Keywords. stars: emission-line, Be, line: profiles, radiative transfer, circumstellar matter

1. Introduction

The emission that characterizes Be stars arises in a circumstellar disk of gas which receives photoionizing radiation from the central B-type star. Observed Hα profiles take a variety of shapes, but are generally grouped into one of three broad categories: singly-peaked, doubly-peaked, or shell spectra. The different profile shapes are thought to be an effect of the system's orientation to the observer's line of sight, with singly-peaked profiles corresponding to (near) pole-on orientations, doubly-peaked profiles to mid inclination angles, and shell spectra to (near) edge-on orientations (i.e. $i \sim 90°$).

Our disk simulations assume that the density in the equatorial plane takes the form $\rho(r) = \rho_0 (r/R_*)^{-n}$, where ρ_0 is the initial disk density at the stellar surface, and n is the power-law index that governs its decrease with increasing distance (r) from the central star. The disk is assumed to be axisymmetric about the star's rotation axis, as well as symmetric about the midplane of the disk. Bedisk computes the thermal structure and atomic level populations of the disk, and Beray then solves the transfer equation along a series of rays ($\approx 10^5$) through the star+disk system to compute synthetic Hα profiles.

2. Results

Some preliminary results of our modelling are shown in Fig. 1 (full results are in Silaj *et al.* 2014, submitted). Table 1 lists the parameters of the best fit models for these stars. We generally confirm that these stars are oriented at high inclination angles, as the adopted value of i directly affects the central absorption depth of the model, and no suitable models for these observations could be found at low i values. However, in some cases, the best fit value of i is not as close to 90° as initially expected, and in the case of 4 Aql, the observation could only be matched with models created at mid inclination angles.

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Table 1. Best fit parameters for the observations shown in Fig. 1.

HR	HD	Name	Sp.Type	n	ρ_0 (g cm^{-3})	i (°)
8053	200310	60 Cyg	B1V	3.5	1.8×10^{-11}	65
7040	173370	4 Aql	B8V	2.5	3.3×10^{-12}	46
7836	195325	1 Del	B9V	3.5	3.0×10^{-11}	84
8260	205637	ϵ Cap	B3V	3.0	1.7×10^{-11}	80

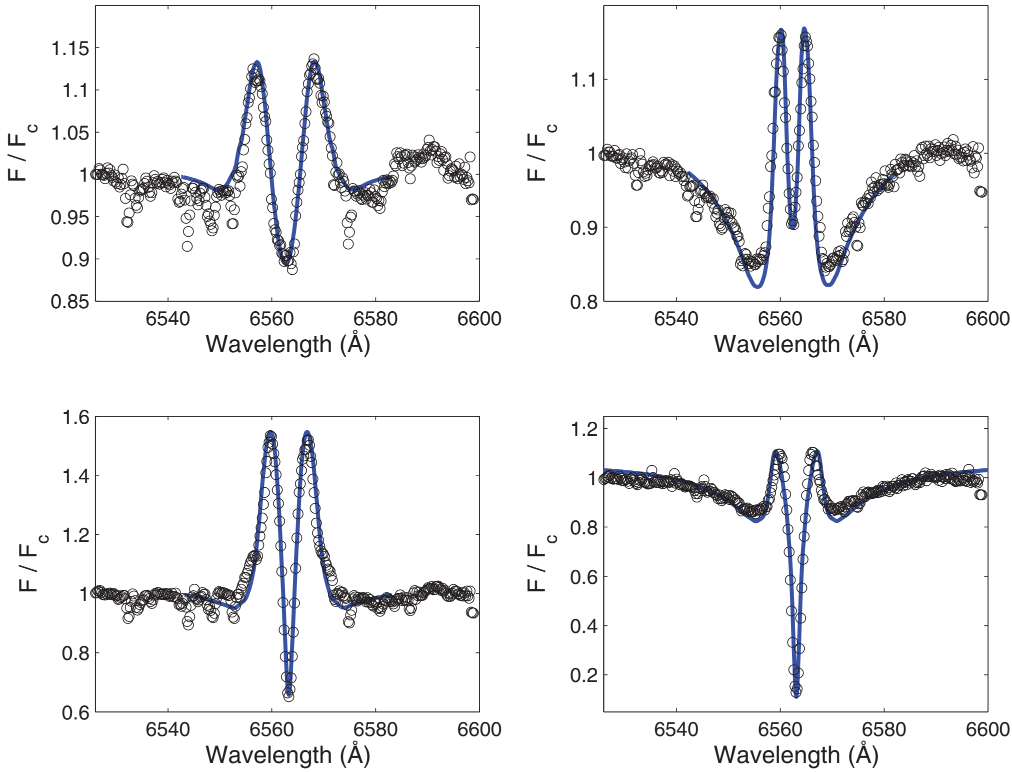

Figure 1. Observed Hα emission lines (open circles) of 60 Cyg, 4 Aql, 1 Del, and ϵ Cap (clockwise from top left). Model spectra, computed with Beray, are shown in solid lines.

3. Future Work

We are currently modifying Mctrace (Halonen & Jones 2013) – a Monte Carlo code that uses the output of Bedisk to compute continuum linear polarization – to include spectral lines, thereby allowing us to examine the polarization across the line. We also plan on using this new tool to model asymmetric emission profiles (which are believed to arise from non-axisymmetric density distributions) since non-axisymmetric geometries are relatively easy to adopt in Monte Carlo based simulations.

References

Halonen, R. J. & Jones, C. E. 2013, *ApJ* 765, 17

Sigut, T. A. A. 2011, in C. Neiner, G. Wade, G. Meynet, & G. Peters (eds.), *IAU Symposium*, Vol. 272 of *IAU Symposium*, pp 426–427

Sigut, T. A. A. & Jones, C. E. 2007, *ApJ* 668, 481

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