BISECTOR VELOCITIES OF Hα IN THE roAp STAR α CIR

Probing the Principal Pulsation Mode

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α Circini is the brightest of the known rapidly oscillating Ap (roAp) stars. Previous observations of this star in photometry (Kurtz et al. 1994) have shown that it has one dominant pulsation mode, which is a pure oblique dipole mode ($\ell = 1$) with a frequency of 2442 μHz ($P = 6.825$ min). Kurtz et al. (1994) measured the amplitude of the principal mode to be 2.55 mmag (Strömgren v).

Baldry et al. (1997) showed that the velocity amplitude and phase of the principal pulsation mode in α Cir varied significantly from line to line. However, it was difficult to interpret the data because of blending effects. In this paper, we look at the Hα line in more detail using the same set of observations taken during two weeks in May 1996. These observations include 6366 intermediate-resolution spectra taken from the 1.88-m telescope at Mt. Stromlo, Australia and the Danish 1.54-m at La Silla, Chile.

The Hα line in each of the spectra was divided vertically into 22 contiguous sections. For each section, a time-series of bisector velocity measurements (4900 from Mt. Stromlo, 1466 from La Silla) was produced. Each time-series was high-pass filtered and then cleaned for bad data points. Next, a weighted least-squares fitting routine was applied to each time series. In order to analyse the principal pulsation mode in α Cir, we have measured the amplitude and phase of each time-series at 2442.03 μHz and estimated the rms-noise level by averaging over surrounding frequencies (1100–2300 μHz and 2600–4400 μHz).

The velocity amplitude and phase of the principal mode at different heights in the Hα line is shown in Figure 1. From height 0.4 to 0.8 in the line (where 0.0 is zero intensity and 1.0 is the continuum level), the amplitude decreases from 300 ms^{-1} to zero and then increases again, with a change in phase of 150°. We believe the velocity node (at $\sim$0.65) and phase jump between height 0.4 and 0.8 is caused by Hα line formation effects, above 0.8 we do not trust the results due to significant line blending. There is good agreement between the two independent data sets from La Silla and Mt. Stromlo which we have analysed separately for this paper.

These results suggest there is a radial node in the atmosphere of α Cir because the bisector velocity reflects the velocity at different heights in the atmosphere depending

F.-L. Deubner et al. (eds.), New Eyes to See Inside the Sun and Stars, 309–310.

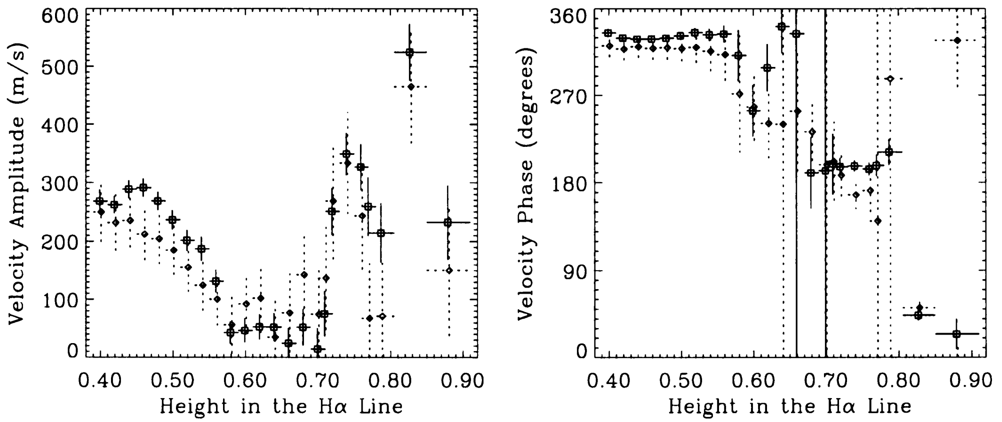

Figure 1. Amplitudes and phases of the principal pulsation mode for the bisector velocity at different heights in the Hα line. The solid lines represent the Mt. Stromlo data and the dotted lines represent the La Silla data. For each measurement, the vertical line is an error-bar while the horizontal line shows the extent of the section in the Hα line.

on the height in the Hα line. There are other possible explanations such as a weak emission component or changes in the continuum which affect the bisector due to the asymmetry of the line. We think that a radial node is the most plausible explanation because of the supporting evidence of the amplitude and phase variations of metal lines (Baldry et al. 1997) and the steep decline of photometric amplitude with increasing wavelength (Medupe & Kurtz 1997). This would imply a surprisingly small radial node separation in the atmosphere of roAp stars (Matthews 1997). Theoretical work needs to be done to determine how this would be possible.

It is interesting to note that similar behaviour has been seen in the Sun. Deubner et al. (1996) have observed a phase discontinuity in the solar oscillations using spectroscopy. The discontinuity occurs in (Velocity – Line Intensity) phase spectra at a frequency of 7000 μHz.

Further results and analysis on the spectroscopy of α Cir will be presented in Baldry et al. (1998).

References

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