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THE CIRCUMSTELLAR DISK OF THE BE STAR 28 (ω) CMA

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Abstract. We propose interferometric observations of the Be star 28 CMa. Constraints on the geometrical and physical parameters of the disk could be obtained by combining three VLTI auxiliary telescopes.

1 Introduction

According to the generally accepted definition by Jascheck et al. (1980) a non-supergiant B-type star, whose spectrum showed at some time one or more Balmer lines in emission, is classified as a Be star. Numerous observations obtained during about one and a half century after discovery of the first Be star γ Cas prove that both, the line emission and the continuum IR excess come from a circumstellar disk around the rapidly rotating B-type star. However, at the present time two fundamentalquestions still wait for their answers:

1. What is the mechanism responsible for the emission outbursts observed in Be stars on time scales of months to years?
2. How can matter ejected during the outbursts or continuous mass outflow get enough angular momentum to reach stable Keplerian orbits in the disks? We have indications for Keplerian disks from spectroscopic studies.

High-resolution echelle spectroscopy over the whole visible and near IR spectral region, carried out during the nineties, extended significantly our knowledge about central stars and correlations between photospheric and circumstellar phenomena. Some of the central stars are proved to be non-radially pulsating. The first diameters of Be star disks were measured by the GI2T and MkIII interferometers.

Interferometry may bring the most important progress in studies of Galactic Be stars in the first decade of the 21^{st} century. We expect it to provide direct measurements of geometrical and physical parameters of circumstellar disks and their dynamics. However, the closest Be star disks have angular diameters of only

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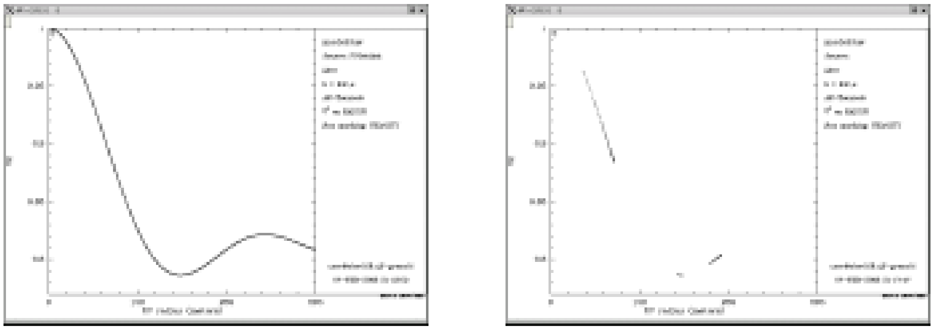

Fig. 1. Visibility curve for 28 CMa derived from a) the model of point source and uniform disk and b) simulated observations

a few mas (Quirrenbach et al. 1997). A resolution of a few tenths of mas is needed for detailed studies of disks structure. Such studies will be possible only with VLTI-size interferometers.

28 (ω) CMa (HR 2742, HD 56139, B2IV-Ve) is one of the most observed Be stars. Its brightness (V = $3.^{m}6$ - $4.^{m}1$, K $\approx$ $4.^{m}3$), the pole-on view of the disk and a relatively long time-scale of the outburst evolution are very convenient for both, VLTI observations and modeling of the disk.

2 Proposed observations

Scheduling of observations: The goals of the first ("static") part of the project is to determine the outer and inner disk radii and the ratio of fluxes of the disk and central star of 28 CMa. The ideal period for the observations is January, when the VLTI can follow the star for more than 7 hours.

Choice of the instrument and configuration: Circumstellar disks of Be stars, which have temperatures of 6000 - 8000 K, show spectral energy distribution which peak in the visible spectral region. Fluxes from the star and the disk are comparable and still sufficiently high in the near IR region. The project is therefore well suited for the AMBER instrument. The goals of the project can be achieved with the help of only VLT auxiliary telescopes, because the star is very bright and the low resolution is sufficient.

Using the mean diameter of the Be star disks observed by Quirrenbach et al. (1997) and the Hipparcos distance we can estimate the diameter of the disk to be $\approx$5 mas. The flux ratio of the star and the disk is assumed to be 0.9/0.1. Assuming a simple model, consisting of a point source and a uniform disk, the ASPRO package yields a visibility curve shown in Fig. 1a. The choice of the baselines follows from the properties of the visibility curve. The outer radius of the disk can be determined from the steep part of the visibility curve, what implies a short baseline of $\approx$ 40-60m. The flux ratio and

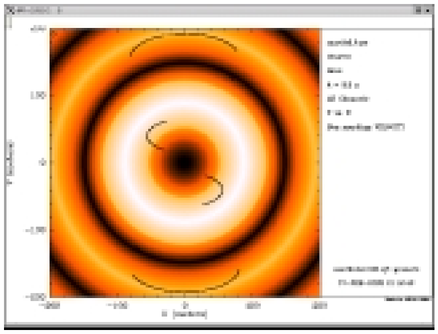

Fig. 2. Simulated coverage of the UV plane

inner radius can be derived from the sinusoidal part of the visibility curve. We need to cover at least two more intervals corresponding to baselines of 180-200m and 140-150m.

Simulated observations: By choosing a configuration with the three auxiliary telescopes D0 + G1 + J6, we can fulfill the requirements mentioned above. We used the ASPRO package to simulate the observations. The expected coverage of the UV plane is shown in Fig. 2. The most important parts of the visibility curve can be covered during one night and fitted by models; compare Figs. 1a and b.

3 Strategy and astrophysical analysis of the data

Analysis of the data will be done with the help of the ASTRO package. We also plan to develop more sophisticated non-uniform models of the disk with different density distribution. By fitting the visibility curve with model curves for different wavelengths, we should be able to test a ring-like structure of the disk and distinguish between disk models with different density distributions. Outer and inner radii of the disk and the flux ratio of the disk and central star will be derived.

Experience obtained during analyses of data from the proposed observations will allow us to proceed to a dynamical study of the Be star outburst, which means monitoring of the disk evolution after a big outbursts. Such outbursts may occur every 3-8 years in 28 CMa (Štefl et al., in preparation). A typical time scale of variability reflecting the outburst is about one week. The aim of the dynamical study will be to map (using also simultaneous spectroscopy) the time dependent velocity field in the disk and answer the basic question - where the extra angular momentum necessary to form the Keplerian disks comes from?

References

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