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THE COMPLEX ENVIRONMENT OF THE FAST ROTATING STAR ACHERNAR

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Abstract. We report recent observations of Achernar (α Eri) and its circumstellar environment obtained with interferometric and single-telescope techniques. We also briefly summarize the SIMECA modeling of the near-infrared polar envelope detected by interferometry around this star. From these results, the close environment of Achernar appears to be shaped at least by the fast stellar wind pushed by the von Zeipel effect and possibly by interactions between the two stars Achernar A and B.

1 Introduction

Achernar is the brightest and nearest Be star. Domiciano de Souza et al. (2003) and Kervella & Domiciano de Souza (2006, hereafter K06) established that its photosphere is extremely flattened, and that an elongated circumstellar envelope (CSE) is present along the direction of its polar axis. Kanaan et al. (2008), reproduced these observations using the SIMECA modeling code. Recently, Kervella & Domiciano de Souza (2007) discovered a close-in companion, that proved to be an early A-type dwarf (Kervella et al 2008) on a close-in orbit. After a summary of our recent observations in Sect. (2), we summarize the SIMECA modeling results in Sect. (3).

2 Observations

Achernar was extensively observed by long-baseline interferometry with the VLTI instruments VINCI (near-IR, Kervella et al. 2004) and more recently MIDI (thermal IR, Ratzka et al. 2007). The VINCI data revealed the spectacular flattening of its photosphere ($\rho_{\rm eq}/\rho_{\rm pol} \approx 1.41$, K06) and the presence of an elongated CSE aligned with the polar axis of the star. This CSE contributes approximately 5% of the photospheric flux in the K band (2.2 μm), and 13% in the N band (10 μm; Kervella et al. *in prep.*), with a typical FWHM extension of approximately $10\,R_\star$ (Fig. 1). Unfortunately, our baseline coverage along the equator of the star is limited both in azimuth and spatial resolution, hence we constrain only marginally the equatorial CSE properties.

The stellar companion of Achernar discovered by Kervella & Domiciano de Souza (2007) orbits A on an apparently excentric orbit (Fig. 2). Although the parameters of this orbit are still to be determined, the approach of B at periastron could be sufficiently close to trigger the ejection of material from either Achernar A and/or B (based on its early spectral type, Achernar B could also be a fast rotator).

3 SIMECA modeling

Kanaan et al. (2008, hereafter Ka08) presented a SIMECA model based of the K06 interferometric observations as well as the historical spectroscopic observations of this star. The SIMECA code (Stee & Bittar 2001) allows to model the environment of active hot stars, producing line profiles, spectral energy distributions, and intensity maps. Ka08's best model for the epoch of VINCI observations (2002-2003) is a polar wind with an opening angle of $\approx 20°$ (the model parameters are listed in their Table 1), but little or no equatorial disk component. In this model, the overheated polar caps of Achernar (due to the von Zeipel effect, see von Zeipel 1924) eject a fast stellar wind that radiates free-free emission in the K band. Based on the observed historical variations of

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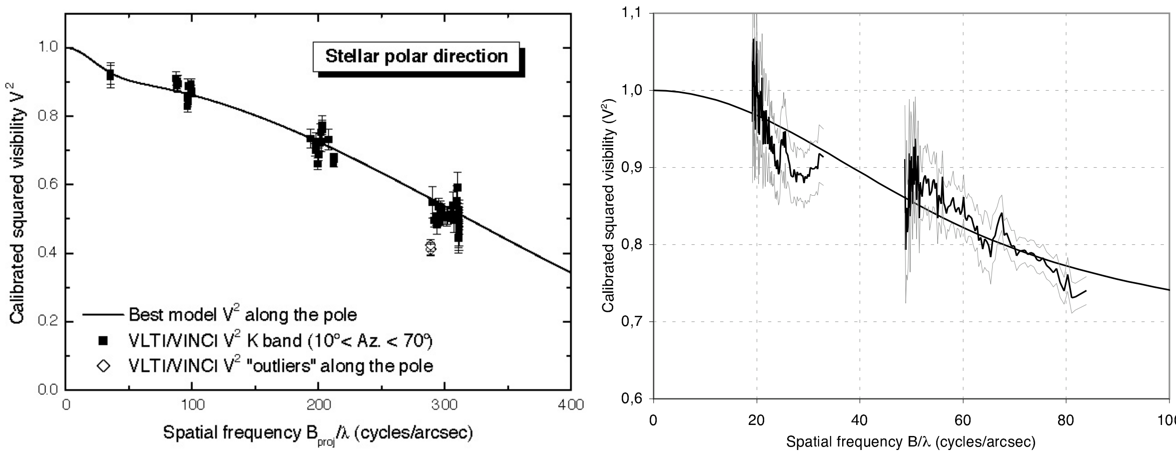

Fig. 1. Left: Interferometric observations of Achernar along its polar axis in the near-IR with VINCI (K06). **Right:** MIDI visibilities in the thermal IR (Kervella et al., *in prep.*). The adjustment of a model of the polar photosphere + Gaussian CSE is shown as a solid curve in both cases.

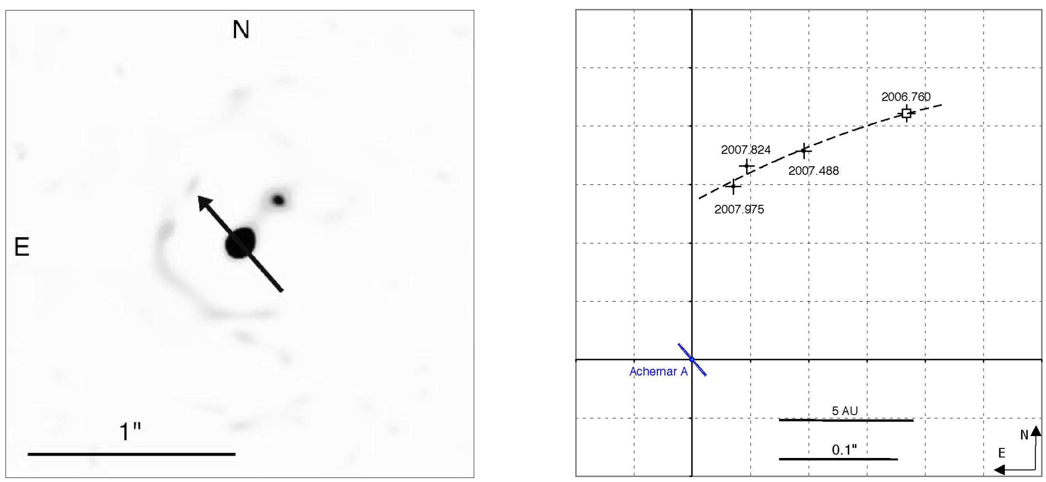

Fig. 2. Left: Deconvolved VISIR image of Achernar and its companion ($\lambda = 8.7\,\mu$m) obtained by Kervella & Domiciano de Souza (2007). **Right:** Portion of the orbit of Achernar B over approximately one year (Kervella et al. 2008).

the Hα profile, Ka08 also modeled the pseudo-periodic formation and dissipation of the equatorial disk (period of 10-15 years) by an outburst scenario in which the matter is briskly ejected from the stellar surface and then expands in the CSE with $v_{exp} \sim 0.2\,\mathrm{km.s^{-1}}$.

4 Conclusion

The SIMECA modeling of Achernar proposed by Ka08 reproduces well the VINCI observations in the near-IR K band. The passage at periastron of the close-in companion Achernar B is possibly the trigger of the Be episodes, that seem to have a 10-15 years periodicity. We did not detect an equatorial CSE, but the VLTI interferometric observations obtained up to now have a limited sensitivity along the equatorial direction of Achernar A.

Based on observations made with ESO Telescopes at Paranal Observatory under an unreferenced commissioning program with VINCI in P70, programs 078.D-0295(A) and (B) with VISIR, 279.D-5064(A) with NACO, and 078.D-0295(C), (D) and (E) with MIDI. This research used the SIMBAD and VizieR databases at the CDS, Strasbourg (France), and NASA's ADS bibliographic services. The Programme National de Physique Stellaire (PNPS) with the Bonus Qualité Recherche (BQR) from the Observatoire de la Côte dAzur are acknowledged for their financial supports. We also received the support of PHASE, the high angular resolution partnership between ONERA, Observatoire de Paris, CNRS, and University Denis Diderot Paris 7.

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