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INTERFEROMETRIC STUDY OF BETELGEUSE IN H BAND

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Abstract. We present 3 telescope interferometric observations of the super giant star Betelgeuse (Alpha Ori, M2Iab) using the IOTA/IONIC interferometer (Whipple Observatory, Arizona) in early October 2005. Since IOTA is a 3 telescope interferometer, we were able to make closure phase measurements which allow us to image the star with several pixels across the disk. We discuss the fondamental parameters of Betelgeuse such as diameter, limb darkening and effective temperature. For the first time at this spatial resolution in the H band, closure phases provide interesting insights on the features of the object since we detect a spot corresponding to 0.5% of the total received flux.

1 Introduction

We observed Betelgeuse in the H band (82 nm large narrow band filter) during 10 nights. We obtained these data in the H band (1.65 μm) in two orthogonal linear polarizations. We carried out a two dimensional sampling of the coherence factor by changing the position of the telescopes from a baseline of 5 to 33 meters (i.e. a resolution from 70 to 10 mas). The coverage of the UV plane was obtained using the Earth rotation synthesis and by moving the 3 telescopes along the IOTA L-shaped tracks. We successively secured fringes on Betelgeuse and on a non-resolved star in order to calibrate our data in visibility and in phase measurements.

2 Visibilities modelling

Visibility curves are presented in Fig. 1. From these observations, we derive classical angular measurements in interferometry such as the uniform disk diameter (43.8 ± 0.1 mas, $\chi^2 = 209$). Moreover, we detect a resolved part of the flux (about 6 %) which is the signature of the environment around Betelgeuse (Danchi et al. 1994). This model gives a diameter of 43.5 ± 0.13 mas ($\chi^2 = 19$) using a quadratic limb darkening.

3 Closure phase modelling

We present here the closure phase measurements we get from our observations (Fig. 1). The closure phase is a useful tool to detect the asymmetries in an image (Wilson et al. 1997). Here we have clearly trends which can be well fitted ($\chi^2 = 2.5$) by a spot with a ratio of about 0.5 % of the total flux. Coordinates of this spot can be given by plotting the value of the χ^2 for various positions centered on the photocenter of Betelgeuse (Fig. 2, left).

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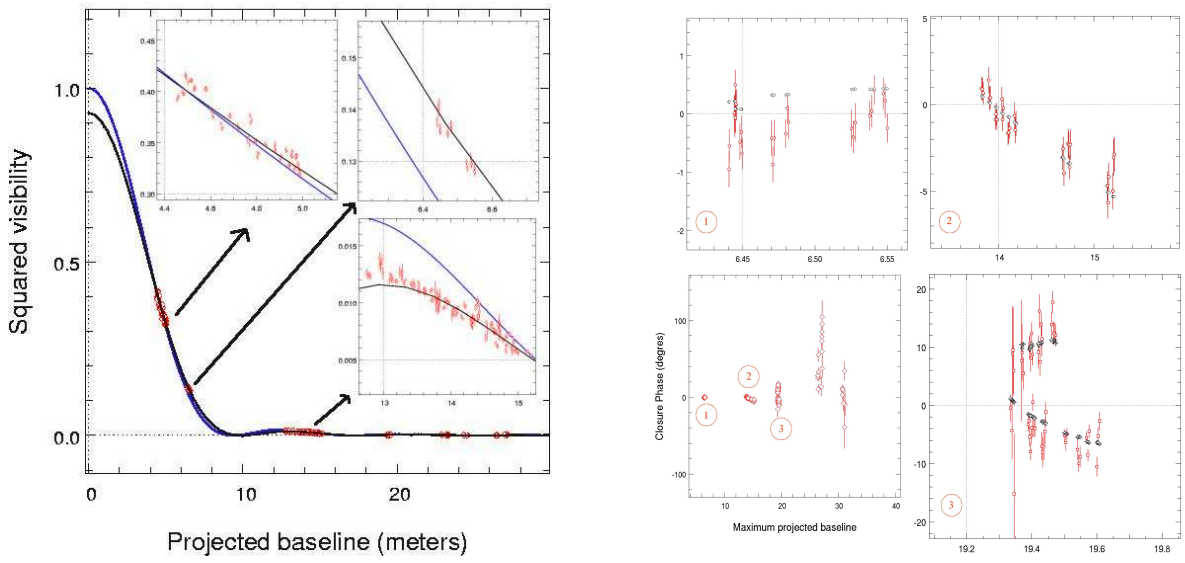

Fig. 1. Left panel : observed squared visibilities vs baselines. Data are plotted in red. A uniform disk model (blue line) and, in black, a quadratic limb-darkened disk plus a resolved extended component (the circumstellar environment) are fitted to the data. Details of the first two lobes are plotted in the other windows. Right panel : Closure phase (in degrees) versus maximum baseline of each triplet of baselines. The data (red) are fitted with a point-like spot model (black).

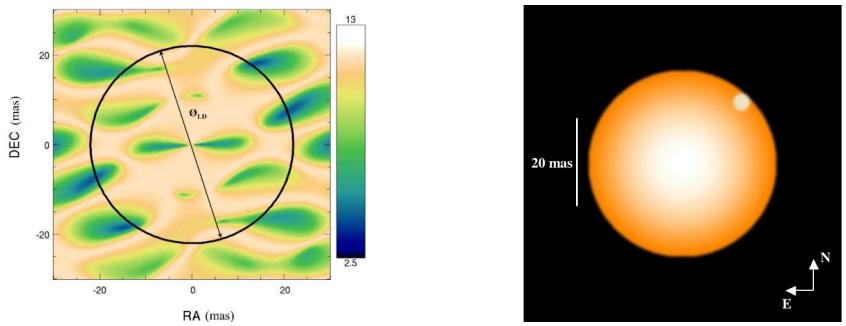

Fig. 2. Left panel : Map of the χ^2 values calculated from the fit of the closure phase data with a spot model for every angular positions of this spot across a field of 50*50 mas. The lowest value of the χ^2 (2.5) is obtained for a spot located just at the edge of the photosphere (for 1 position and its symmetric). We cannot conclude yet if this observed asymmetry is inside or outside the photospheric disk of Betelgeuse. Right panel : Image of Betelgeuse as a limb-darkened disk obtained by a parametric fit of the visibilities with a spot whose position and amplitude have been determined by fitting the closure phase measurements.

4 Conclusion

With the visibilities we measured, we estimated a uniform disk diameter and limb-darkened diameter for Betelgeuse. We also have evidenced the circumstellar environment. Closure phases show an asymmetry which could be a spot located at the photosphere edge. The analysis of the March 2006 data is still on-going.

References

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