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REACHING THE JET ENGINE WITH AMBER/VLTI

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Abstract. To understand star formation and its evolution, one needs to solve the problem of ejection and collimation mechanisms in jets from young stars. By measuring the jet opening angle at the ejection region we can test models for jet origin. However this very small region cannot be investigated with current monolithic telescopes. Only the AMBER near-IR instrument coupled with the VLTI provides enough resolution to reach the ejection region and enough spectral resolution/coverage to properly separate the emission line jet from the continuum. In this proposal we show that expected visibilities from jets can constrain the jet opening angle.

1 Introduction

The importance of jets in star formation relies in the fact that they locally regulate the system angular momentum, and at large scales they inject momentum into the cloud affecting star formation efficiency and evolution. Pre-main-sequence stars are very good candidates since they show a strong jet activity. The chosen astrophysical target (RU Lupus) is a T Tauri star, which means that its accretion and ejection activity is still intense. Furthermore since T Tauri stars at this stage have lost most of their infalling envelope, they provide an unobscured line of sight to the jet. This is also the brightest jet source in the southern hemisphere (m_J=8.6 and m_K=7.3) with known jet position angle (Takami, M *et al.* 2001).

2 Observational predictions

This proposal aims at using a large collecting interferometer with VLTI auxiliary telescopes (ATs) in order to have a large (u, v) coverage and medium spectral

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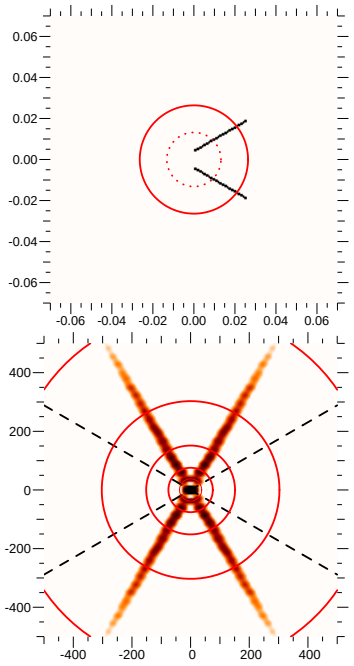

Fig. 1. Left panel: Toy model of a hollow jet with opening angle 30° in the image space. Scale is in arcseconds. The inner (dashed) circle is the FWHM of a 8.2m diffraction limited image at 1.28 μm, the outer the first zero of the Airy function. **Right panel:** Toy model visibility, scale in cycles/arcsec. The dashed lines plot the jet opening angles. The circles plot the cutoff frequencies for 10m, 20m, 40m, 80m and 160m baselines.

resolution (J band). Figure 1 (left) has a field of view of roughly the size of an auxiliary telescope diffraction limit at 1.28 μm. It shows that the VLT cannot resolve the inner jet region. We need therefore to use the VLT Interferometer to achieve a higher angular resolution. In the first phase VLTI will work only with two telescopes, which means that we will only have access to visibilities. So, in order to verify the feasibility of our program we shoud start from a toy model and illustrate how the visibilities can constrain the jet opening angle. In the (u, v) plane, we obtain a visibility map with an X shape, perpendicular to each hollow jet arm in the image plane (see right part of fig. 1). A good coverage of the (u, v) plane, using baselines from 10 to 160 m, allows us to constrain this opening angle since each baseline path crosses the visibility arms. AMBER is a near-infrared focal instrument and it will operate between 1 and 2.5 μm. It should be capable of reaching a K=10 magnitude limit with the ATs and its spectral resolution can achieve 10000. This means that interferometric observations of jets are feasible in AMBER first phase since we can obtain visibility changes large enough to be detected by AMBER (>0.01 as we can see in fig.2). Calculations of signal-to-

noise ratio (SNR) for a 0.5" seeing reveal that it is possible to obtain a SNR=100 (Garcia, P. J. V. *et al.* 2001).

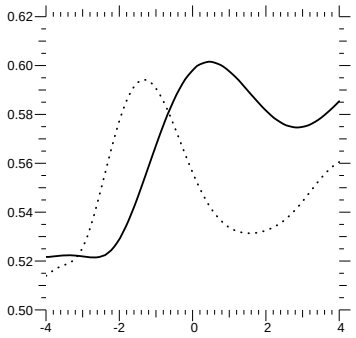

Fig. 2. Plot of visibility versus hour angle for UTs (filled) and ATs (dotted) . In this plot one can see the contribution of the star plus jets.

3 Conclusions

Analysing the scientific case of interferometric observations of jets we conclude that it is possible to measure the jet opening angle based only on the visibilities. Using the auxiliary telescopes (ATs) we should obtain a good coverage of the (u, v) plane and the signal-to-noise ratio calculated is compatible with the precision needed to measure the jet visibilities. Measuring the jet opening angle will allow us to constrain jet origin models.

References

Baccioti, F. and Eislffel. A&A, 342:717-735, Feb. 1999

Casse, F. and Ferreira, J. A&A, 361:1178-1190, Sept. 2000

Garcia, P. J. V. *Thése de Doctorat.* 12 1999. Université Lyon I, France

Garcia, P. J. V. *Into the twillight zone: reaching the jet engine with AMBER/VLTI* in the proceedings of ESO workshop on The origins of stars and planets: the VLT view Garching b. Muenchen, 24-27 April 2001

Glindemann, A. e. a. *SPIE*, 4006, 2000

Lawson, P. R., editor. *Principles of long baseline stellar interferometry.* JPL Publication 00-009, 7 2000. http://sim.jpl.nasa.gov/michelson/iss.html

Malbet, F. and Bertout, C. A&A, Supplement, v.113, p. 369, 113:369, Nov. 1995

Mundt, R. and Eisloffel, J. AJ, 116:860-867, Aug. 1998

Ouyed, R. and Pudritz, R. E. ApJ, 484:794+, July 1997

Spruit, H. C. In *NATO ASI Series C.*, volume 477, p. 249, Kluwer, 1996

Takami, M., Bailey, J., *et al.* 323:177-187, May 2001