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AN INTERFEROMETRIC STUDY OF NGC 1068 WITH VISIR BURST MODE IMAGES

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Abstract. We present an interferometric N-band study of the active galactic nucleus (AGN) inside the archetype Seyfert type 2 galaxy NGC 1068. From a speckle analysis of VISIR (the Very Large Telescope (VLT) Imager and Spectrometer in the InfraRed) images taken in burst mode, we attempt to establish the link between dust in the vicinity of the central engine – first observed with MIDI (the Mid-InfrareD Interferometer of VLT) – and larger scales (ionisation cone/narrow line region).

1 Introduction

NGC 1068 bright and near Seyfert 2 galaxy, is a key target for the test of the unified scheme of AGNs and the *dusty torus* paradigm. First resolved MIR observations of dust in the core of NGC 1068 were performed with MIDI in 2003. Two independent analysis of these data lead to a dusty layer of few parsecs size, temperature around 300 K and composed of amorphous silicate (Jaffe et al. 2004; Poncelet et al. 2006a; see right of Fig. 1).

Here, we present a speckle analysis of 12.8 μm images obtained with the BURST mode of the VLT/VISIR. Aims are to access structures under the diffraction limit of one UT (Unit Telsecope of pupil D=8.2 m at the VLT), and to partially fill the lack of visibility points under 30 m of baseline (the shortest length accessible with MIDI and the UTs).

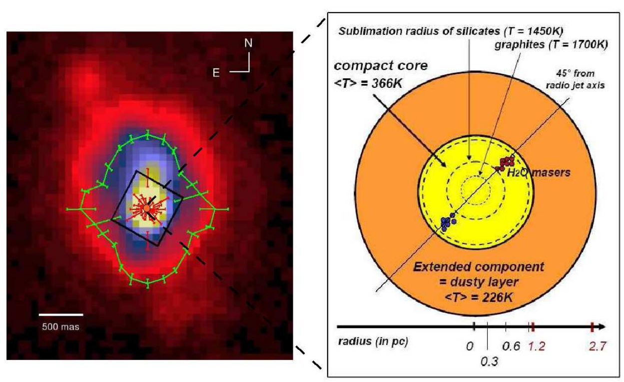

Fig. 1. Main contributions to MIR flux in the core of NGC 1068. *Left:* 12.8 μm VISIR burst mode image. Green and red lines are the small and extended structures derived from the two components model (see Sect. 2). The black box is the field of view of MIDI (see Sect. 3). *Right:* Zoom on the schematic representation of the dusty layer from the model of Poncelet et al. (2006a).

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2 Speckle analysis of VISIR BURST mode images

Basic ideas are: (1) an image taken with a UT contains all spatial frequencies between 0 and D/λ; (2) visibilities are the Fourier transform of the source brightness. Thus, to fully benefit of the diffraction limit of the UT, we perform a speckle analysis of images taken in BURST mode with VISIR at 12.8 μm (exposure-time = 16ms; the sum of all exposures is presented on the left in Fig. 1). A model of the source brightness is used to extrapolate the high-spatial frequency points from the low spatial frequency ones. Thanks to *a priori* information injected through the model, structures smaller than the diffraction limit can be estimated. The model of the source brightness used to fit *VISIR visibilities* consists in two uniform disks (free parameters are sizes and the flux ratio between the disks). This traces two main contributions to the MIR flux: a small component of size $\sim$ 300 mas, just under the diffraction limit of the UT (red lines on the left of Fig. 1); an extended one well resolved (green lines on the left of Fig. 1), extending up to $\sim$ 800 mas. Size are in agreement with the deconvolution process applied to VISIR standard mode images (Galliano et al. 2005). The flux ratio, evolving from 0.29 along the EW axis to 4.76 along the NS axis, accounts for the NS elongation of the source seen in VISIR images.

3 The link between VISIR and MIDI visibilities

To compare *VISIR visibilities* with MIDI data of 2003, we have then taken into account the limited field of view of MIDI – a $(0.6'')^2$ area, oriented at -30 deg. (north to east; see Fig. 1) – in the speckle process of VISIR images. Fig. 2 shows the comparison between low spatial frequency *VISIR visibilities* (considering the field of view of MIDI), and high spatial frequency ones obtained with MIDI in 2003. This figure illustrates the strong fall of visibilities at short baselines. This was unexpected by the model of Poncelet et al. (2006a) applied to MIDI data. Nevertheless, both data sets are well reproduced by a model of two components entering in the field of view of MIDI: a compact one ($\sim$ 35 mas) associated to the dusty layer, and an extended ($<$ 500 mas) maybe associated with heated dust in the ionisation cone.

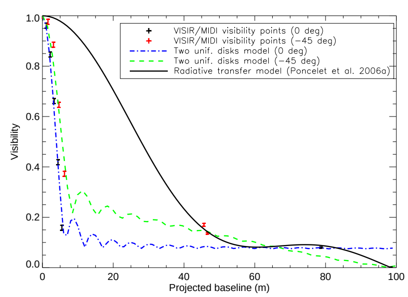

Fig. 2. Comparison between [0-8] m visibilities from the speckle analysis of VISIR images, long baselines MIDI data points at 12.8 μm, and the radiative transfer model of Poncelet et al. (2006a; black line). A model of two components of $\sim$ 35 mas and $<$ 500 mas is mandatory to reproduce the two data sets (Poncelet et al. 2006b).

4 Conclusion

This speckle study of the nucleus of NGC 1068 with VISIR burst mode images allow to derive sizes under the diffraction limit of one UT, in full agreement with deconvolution techniques. The comparison with MIDI observations traces the presence of two contributions to the MIR flux in the core of NGC 1068: the inner one, associated to the *dusty torus*, is embedded in a more extended structure probably associated to dust inside the ionisation cone. High-resolution spectroscopy should establish the direct link between these sources of emission.

References

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