Circumnuclear dust in radio galaxies

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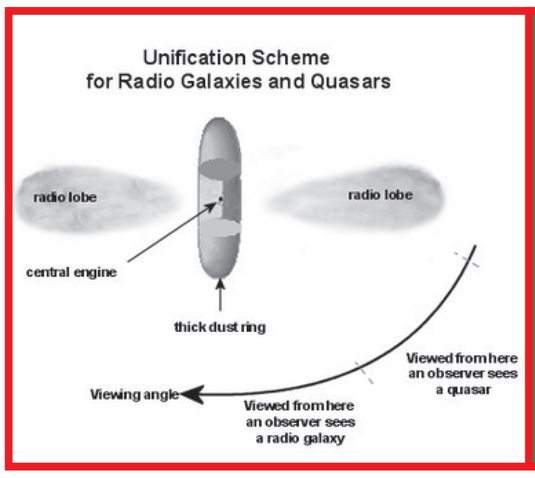
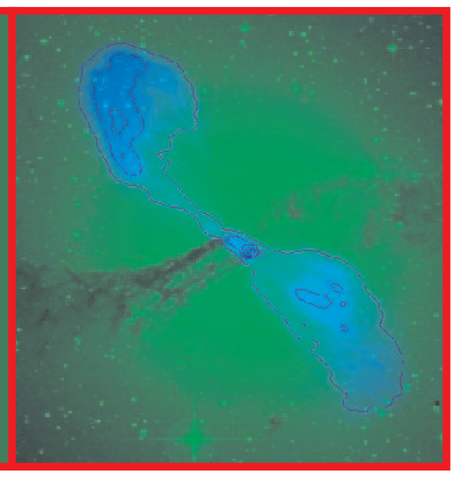


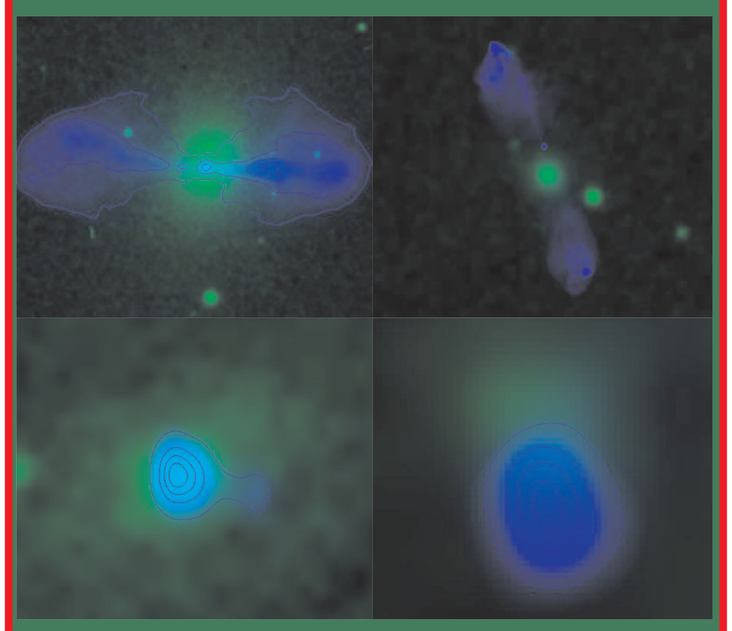
Abstract

We investigate the validity of the quasar and radio galaxy unification scheme and search for inactive nuclei among the low excitation radio galaxies. We have obtained the currently highest angular resolution mid-infrared images of the nuclei of 27 radio galaxies. While three-fifth is non-detected, we find clear indications that Fanaroff-Riley I (FRI) objects have non-thermal nuclei but lack dusty tori, that low excitation FRII objects are non-active and more than half of the high excitation and almost all broad line radio galaxies have thermal, active nuclei.



Introduction

The levels of activity of the nuclei of radio galaxies can be revealed through mid-infrared imaging. Circumnuclear dust will reradiate emission arising from accretion on a black hole. The presence of this heated dust is predicted by orientation unification schemes. Spitzer detections show that Fanaroff-Riley II, edge-brightened and very luminous radio galaxies, have dusty tori hiding the quasar-like nuclei, while BLLac objects and quasars are considered to be observed from a preferred aspect angle. However, it is far from clear that all FRIIs harbour an obscured quasar. Many intermediate radio luminosity galaxies show low-ionization emission features, while few high power radio galaxies do. They could be temporarily off or at a low level of activity. Broad line radio galaxies may be quasars of low luminosity, but their far-infrared properties argue for a special character. Also, the class of edge-darkened and low-luminosity radio galaxies, FRI galaxies, needs mid-infrared investigation. They may mark a population of active galaxies with low but certainly not absent - they have jets - nuclear activity.



Clockwise from top left, the radio jets (blue) and host galaxies (green) of FRI radio galaxy 3C270, high excitation FRIIs 3C98 and 3C105 and broad line radio galaxy 3C120.

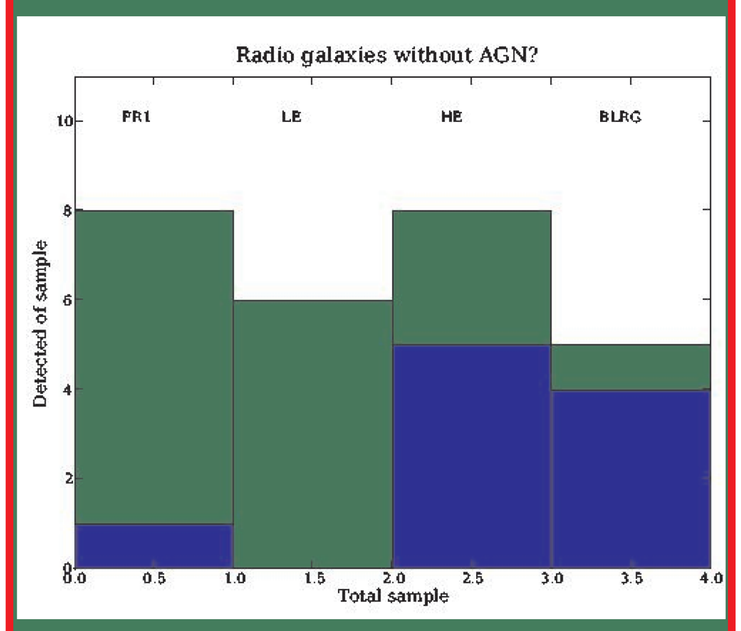
VISIR mounted on VLT telescope Melipal.

Observations

Using the Very Large Telescope Imager and Spectrometer for the mid-infrared (VISIR) mounted on the Cassegrain focus of Melipal, we have observed the nuclei of 27 radio galaxies at redshifts $z<0.36$. This instrument provides diffraction limited images at ≈0.3" in the N-band. The imaging data were obtained in GTO time in 2005 and 2006 through the SiC filter (11.85±2.34μm). To suppress the background, secondary mirror chopping was performed in North-South direction with an amplitude of 8" at a frequency of 0.2Hz. Nodding was applied every 30 seconds using telescope offsets of 8" in East-West direction. The pixel scale is 0.075"/pixel resulting in a 19.2" field of view. The detector integration time was 20 ms. Total source integration times are in the range of 6 to 60 minutes.

Discussion

On the basis of non-detections down to a level of 5 mJy we find clear indications that FRI galaxies have non-thermal nuclei but lack dusty tori. The one case that we detect the mid-infrared nucleus of a FRI is of Centaurus A, the closest active galaxy. Recently the nucleus has been imaged in the mid-infrared with VLT Interferometry and the dust luminosity derived from this is found to be of low order. Only 3C270 in our sample has an upper limit to its MIR-luminosity lower than Cen A. While HST imaged this galaxy to have a dust disk, our non-detection shows this disk to be a insignificant hiding screen. None of the low excitation FRII objects in our sample are detected. We argue that their nuclei are temporarily off or no longer active. Concurrent with the quasar and radio galaxy unification scheme and Spitzer detections more than half of the high excitation FRIIs and almost all broad line radio galaxies are detected in the mid-infrared and have thermal, active nuclei. For this sample future mid-infrared VLTI work with longer baselines will make the difference in revealing the synchroton core from its dusty environment.



One out of eight nuclei of FRIs in our sample, none of the low excitation but more than half of the high excitation FRIIs and almost all BLRGs are detected in the mid-infrared.