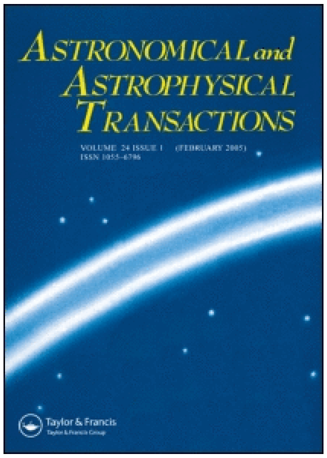

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N. A. B. Gizani [a]; M. A. Garrett [b]; J. P. Leahy [c]; P. Augusto [d]
[a] Centro de Ciĕncias Matemáticas, Universidade da Madeira, Campus Universitário da Penteada, Funchal, Portugal
[b] Joint Institute for VLBI in Europe, AA Dwingeloo, The Netherlands
[c] University of Manchester, Jodrell Bank Observatories, Cheshire, UK
[d] University of Madeira, Funchal, Madeira, Portugal

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PROBING THE PC-SCALE ENVIRONMENT OF THE POWERFUL KEY OBJECT RADIO GALAXY HERCULES A

N. A. B. GIZANI,[1,2] M. A. GARRETT,[3], J. P. LEAHY,[4] and P. AUGUSTO[5]

[1] *Centro de Ciências Matemáticas, Universidade da Madeira, Campus Universitário da Penteada, 9000-390 Funchal, Portugal*
[2] *Present address: Kalymnou 13, 11251 Athens, Greece*
[3] *Joint Institute for VLBI in Europe, Postbus 2, 7990 AA Dwingeloo, The Netherlands*
[4] *University of Manchester, Jodrell Bank Observatories, Nr Macclesfield, Cheshire SK11 9DL, UK*
[5] *University of Madeira, 900-390 Funchal, Madeira, Portugal*

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We present the most recent results from the first stage analysis of the radio data on the pc-scale structure of the powerful radio galaxy Hercules A, observed at 18 cm by the EVN–MERLIN array. The main goal of these observations was to try and detect any pc-scale jet emission on both sides of the central engine, to map the transition region between these and the kpc-scale jets with the highest possible resolution and to resolve the inner jets in detail. A faint, $\simeq$ 14 mJy, but compact radio source, coincident with the optical centre of Hercules A was detected by EVN. A misalignment of about $\sim 35°$ between a possible emission from the pc-scale jets and the kpc-scale ones has also been detected.

KEY WORDS Extragalactic Astronomy, AGN, radio

1 INTRODUCTION

Hercules A is an extended source with total radio luminosity is $\sim 6.2 \times 10^{37}$W. Its power density at 5 GHz is $P_{5GHz} = 6.9 \times 10^{25}$ WHz^{-1} sr^{-1} (assuming $H_o = 65$ kms^{-1} Mpc^{-1} and $q_o = 0$). It is classified as intermediate between the two FR classes (Dreher *et al.*, 1984). With a linear size of 540 kpc and no compact hotspots, Hercules A possesses a jet dominating morphology: the western jet shows partial or full ring-like features that form a linear sequence heading from the core to the lobes following an inner jet. The eastern jet has the highest luminosity found so far identified with an elliptical galaxy (Dreher *et al.*, 1984).

Gizani (1997) (see also Gizani and Leahy, 1999) has made extensive radio total intensity and polarization multiband, multiconfiguration observations of Hercules A using the VLA to map the Faraday rotation field at high resolution (1''.4). ROSAT PSPC and HRI X-ray observations were also made on the gas distribution in order, combined with the radio data, to map the magnetic field of the cluster. From this analysis it has been found that Hercules A exhibits a strong Laing–Garrington effect (Laing, 1988; Garrington *et al.*, 1988). Mainly, the depolarization is caused by a centrally condensed medium (most probably the 'X-ray' hot (2.45 keV) gas) in which Hercules A is embedded at $\simeq 50°$ to the line of sight. The depolarization asymmetry is probably due to the western weak jet and associated lobe being behind the bulk of the gas while the eastern lobe is in front. The X-ray observations have revealed extended X-ray emission elongated along the radio galaxy axis and a weak nuclear component. The estimated central electron density of $n_o \approx 7.8 \times 10^3$ m^{-3} reveals a dense environment in which the radio source is situated. The cluster is most probably a cooling flow. The magnetic field decreases with radius and Gizani (1997) has estimated a central value of 3 to 9 μG (see also Gizani and Leahy, 1999).

Although the VLA data provide us with a good understanding of the kpc-scale radio structure of Hercules A, the inner jets of Hercules A together with its optically thin, steep spectrum ($\alpha \simeq -1.20$) core, were unresolved with the VLA. The flux from the region of the core was estimated to be $\simeq$ 44 mJy at 20 cm at 1''.4 resolution. Using the EVN+MERLIN interferometer at the L-band, Gizani *et al.* (2000) tried to detect any pc-scale jet emission on both sides of the Hercules A central engine, to map the transition region between them and the kpc-scale jets with the highest possible resolution and to resolve the inner jets in detail.

2 RESULTS

We observed (Gizani *et al.*, 2000) Hercules A with EVN and MERLIN at λ18cm for 11 hours. We employed standard fringe-fitting and self-calibration techniques as well as phase referencing since the emission from the area of the core was so weak.

The MERLIN observations detect only the most compact regions embedded in the south-eastern jet. An unresolved compact component is also observed, coincident with the optical centre of the galaxy (see Figure 1, bottom). MERLIN only detects about 20% of the total VLA flux at this frequency, suggesting that much of the fainter, low-surface brightness emission is resolved. For the EVN only the compact core with angular size < 20 mas is detected and a peak flux of $\sim$ 14 mJy (Figure 1, top). This implies a brightness temperature in excess of 10^7 K.

From the EVN image (Figure 2) there is an indication that the core is slightly extended in the NW/SE direction. If this is indeed the case, then the VLBI structure within the core may be misaligned ($\sim 35°$) with the larger scale jets. This result is not unusual in AGNs but the angle is quite large.

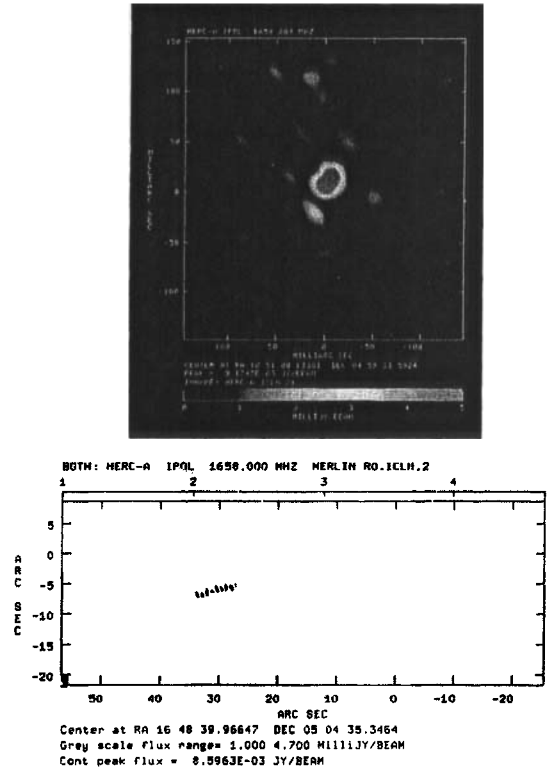

Figure 1 Top picture: The EVN detection of the core region. Bottom picture: The MERLIN detection.

3 CONCLUSIONS - FUTURE WORK

Gizani *et al.* (2000) have tried to shed some light in the case of the central engine of this powerful AGN in terms of its role in the morphological asymmetry between the features of the two jets. Since Hercules A is very extended with a very bright eastern jet, MERLIN got confused. Therefore we are planning to combine our 20 cm VLA observations with our current MERLIN data in order to help MERLIN to detect the core area more clearly, since the 'borders' of the extended structure will be supplied by the VLA.

EVN on the other hand did detect about 30% of the flux from the core area at 0.02 arcsec. However the core remains unresolved as it is very weak. A true emission is detected in the NW/SE direction, possibly from the pc-scale jets. There is a ($\sim 35°$) misalignment between this emission and the emission from the kpc-scale jets. Further observations are required to confirm this and to reveal the nature of this component. We are therefore planning to observe the core region with EVN at

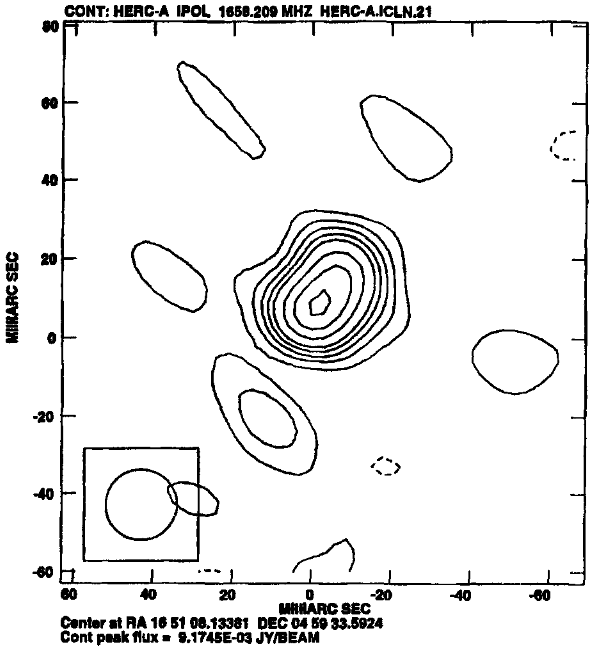

Figure 2 The contour image of the EVN detection of the core region at 0.02 arcsec resolution. There is an indication of emission in the NW/SE direction, possibly from the pc-scale jets.

6 cm.

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