

TUMISANG KEDIDIMETSE¹

PROF. JOHN MCKEAN², DR. RHODRI EVAN¹, DR. JACK RADCLIFFE³

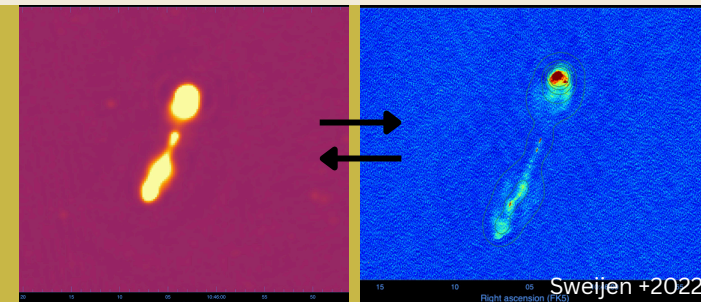
1. Department of Physics and Astronomy, Botswana International university of Science and Technology, Botswana
 2. Department of Physics, University of Pretoria, South Africa
 3. Jodrell Bank Centre for Astrophysics, University of Manchester, United Kingdom



01 INTRODUCTION

Active galactic nuclei (AGN) play an important role in galaxy evolution through the release of energy from accreting supermassive black holes (Blandford +18). In many systems, this energy is transported through relativistic jets that can extend far beyond the host galaxy and interact with the surrounding environment. Understanding the structure of AGN jets requires **high-resolution radio observations** capable of resolving

compact cores and extended emission. See fig 1. The **Lockman Hole** is an ideal field for such studies because of its extremely low Galactic **hydrogen column density**, allowing deep observations of distant extragalactic radio sources (Lockman +86). Here we investigate a candidate AGN jet in the Lockman Hole using high-resolution e-MERLIN imaging to resolve its detailed radio morphology.



Resolution comparison between LOFAR at low resolution (left) and ILT at high resolution (right) Fig. 1

02 DATA & METHODS

Observations

We use **e-MERLIN L-band (1.5 GHz)** observations of the Lockman Hole from **Cycle 16 (2023)**. The array provides **≈200 mas angular resolution**, allowing compact radio structures to be resolved. For comparison, we use **International LOFAR Telescope (ILT)** observations at **150 MHz** with a resolution of **≈300 mas**.

Source Identification

We present a candidate AGN jet source at **RA: 10h44m41s, Dec: +57d06m18.3s (Fig. 2)**, where the high-resolution radio image reveals a compact core and extended structure suggestive of jet emission.

Pipeline-Calibrated Data

We begin with e-MERLIN L-band calibrated measurement sets produced by the standard pipeline.

Initial Imaging

Images were generated using **WSClean** to inspect the field and identify candidate radio sources.

Recalibration & Self-Calibration

The calibration pipeline was rerun on **CASA** with modified parameters to improve the dataset. Self-calibration was explored but provided limited improvement.

Imaging Optimisation

Different imaging parameters were explored, including **Briggs weighting** and **UV tapering**, to better recover extended jet emission.

Data Processing Workflow

03 SCIENCE IMAGES

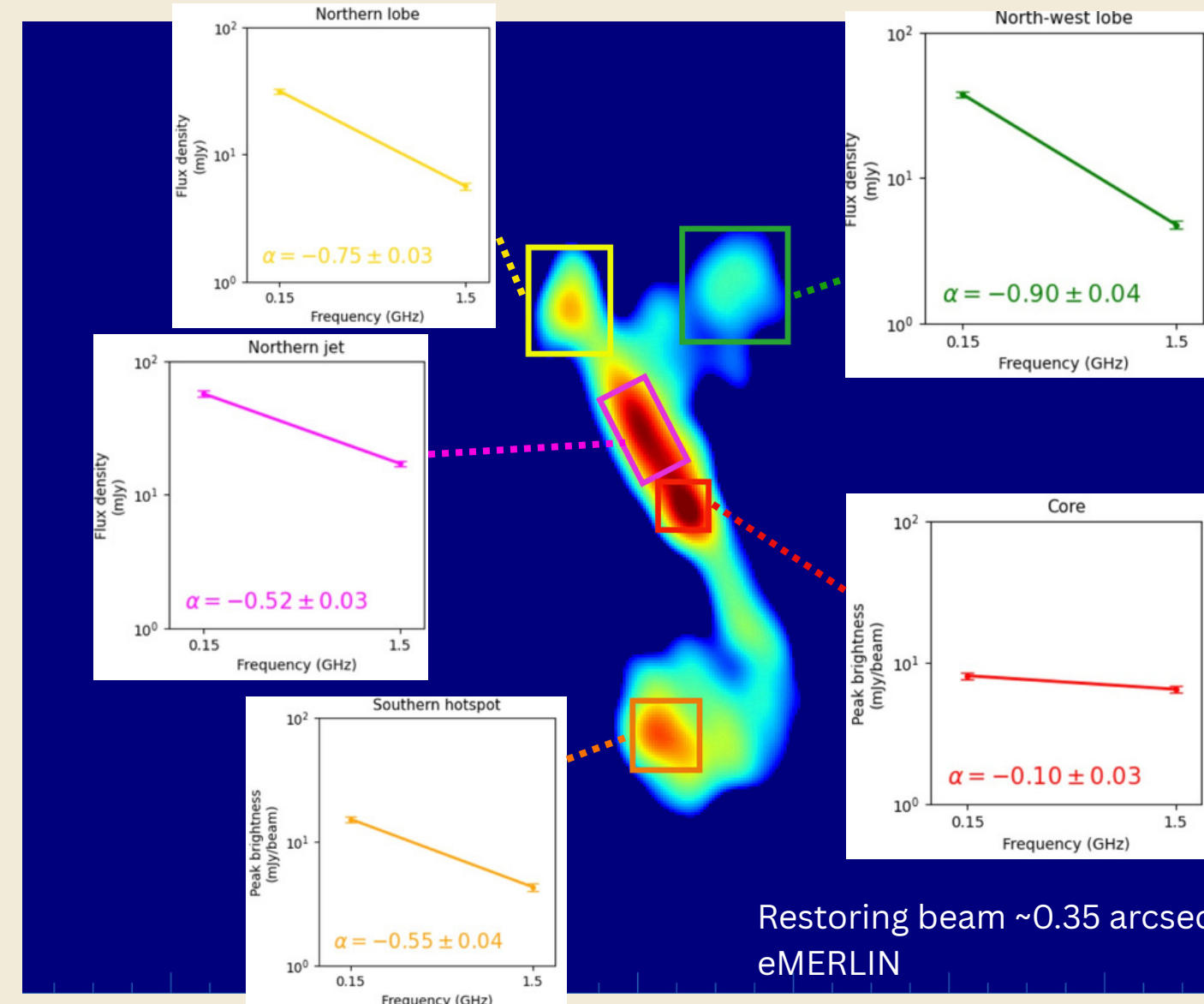


Fig 2: The spectral behavior of compact and extended components.

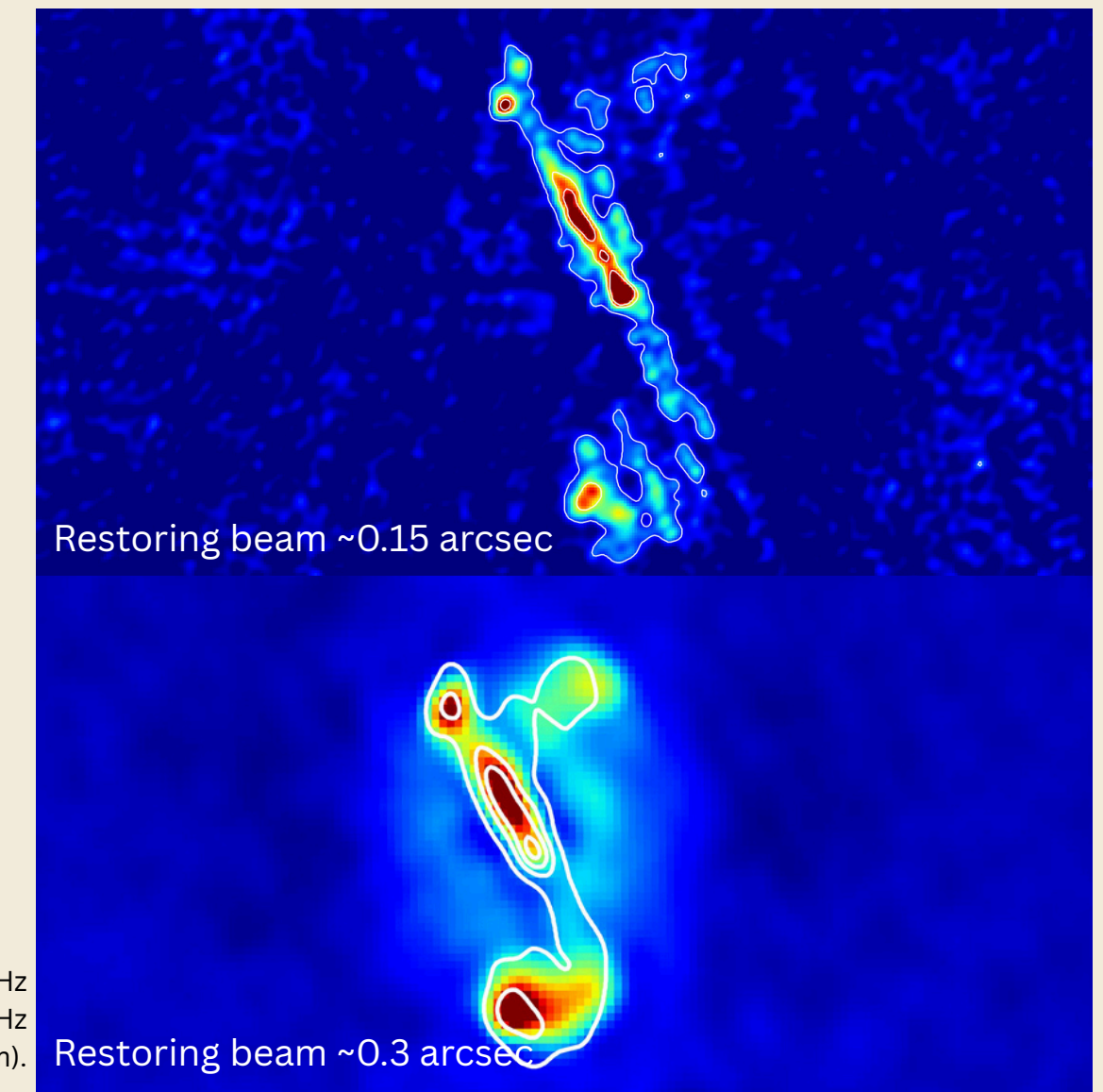


Fig 3: eMERLIN at 1.5GHz (top), and ILT at 150MHz (bottom).

04 DISCUSSION

What does all this mean?

- The e-MERLIN image reveals a bright, compact core with extended jet-like emission.
- The core exhibits a **flat spectrum ($\alpha \approx -0.10$)** and a **high brightness temperature ($T_B \approx 10^7 K$)**, consistent with synchrotron emission from the base of a relativistic jet and confirming an AGN origin.
- The **jet and hotspot spectra ($\alpha \approx -0.50$)** are consistent with particle acceleration in shocks (first-order Fermi acceleration), while the **steeper lobe spectra ($\alpha \approx -0.7$ to -0.9)** indicate synchrotron ageing during electron propagation.
- The faint emission to the upper region may represent diffuse lobe emission
- At $6''$ resolution (LOFAR) the source appears compact; ILT resolves the jets and lobes, while e-MERLIN further resolves the core and inner jet, which shows why high angular resolution is important.

05 CONCLUSION

High-resolution e-MERLIN imaging resolves the internal structure of the radio source, revealing a compact AGN core with extended jet and lobe components that are not clearly separated in ILT data. The spectral behaviour and brightness temperature ($T_B \approx 10^7 K$) confirm a non-thermal AGN origin. These results highlight the value of high-resolution radio observations for studying source morphology and improving source identification in deep radio surveys.

FUTURE WORK

- Perform **spectral index mapping** using e-MERLIN and International LOFAR telescope (ILT) data to study energy distribution along the jet.
- Conduct a detailed **morphological analysis** of the radio source to characterise the structure of the core, jet, hotspots, and lobe regions.
- Determine how many radio sources resolved by e-MERLIN compared to ILT have compact core activity.

References:

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 Lockman et al. 1986, ApJ, 302, 432
 Sweijen et al. 2022, Nat. Astron., 6, 350

Contact:

kedidimetsetumisang@gmail.com

In collaboration with:

