Spectral analysis of a bent-tail radio galaxy using MeerKAT data

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Abstract

Bent-tail radio galaxies provide important insights into the interaction between relativistic jets and their environments. In this work, we present a detailed study of the peculiar source MKAT J131855.02–184708.00, only the second known system exhibiting a pronounced omega-shaped jet morphology. We will discuss how the surrounding environment interacts with the jets and investigate its spectral index and spectral ageing.

Science goals:

- Identify all the radio galaxies present within the MeerKAT field of view.
- Examine the structure and morphology of Ω-tail galaxy.
- Investigate the spectral index and the spectral ageing using CI, JP and KP models in order to estimate the age of the relativistic electrons.

Data :

ν_{ref} : 1.28 GHz (L-band)
Target: FRB 20211127

Calibration :

- oxKAT
- CARACal

} 1GC → 2GC

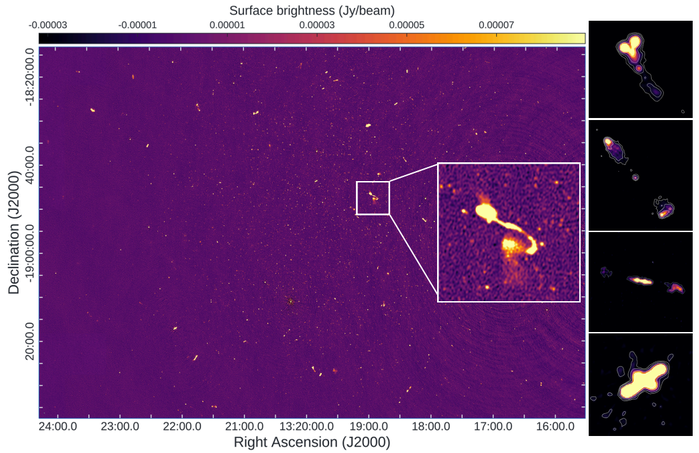


Fig 1: OxKAT image of FRB 20211127 field with a resolution of 5"6 x 5"6 and a sensitivity of 7.22 μJy/beam.

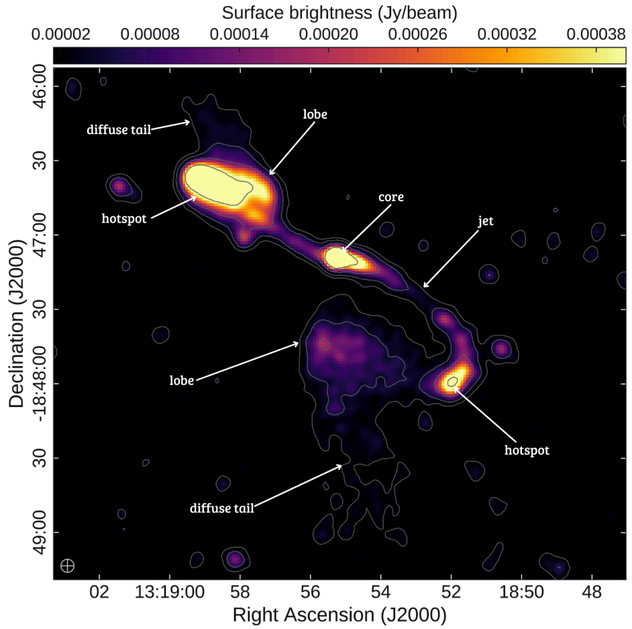
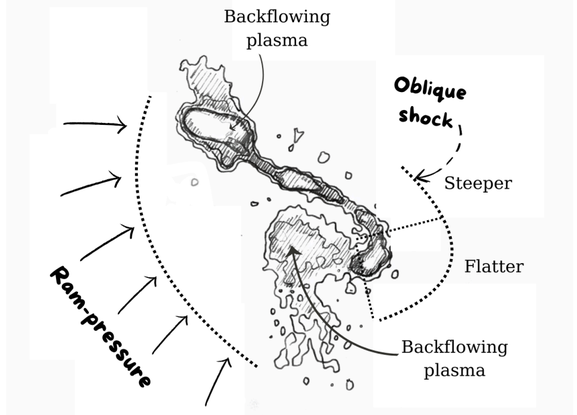


Fig 2: Top: Intensity map of MKAT J131855.02-184708.00 with a contour of [1,3,9,27] x 3σ= 5.68 μJy/beam. Bottom: bending mechanisms acting on the jets.



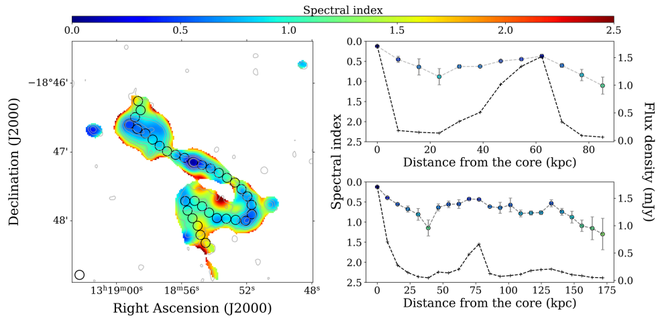


Fig 3: spectral index map with the variation of flux density

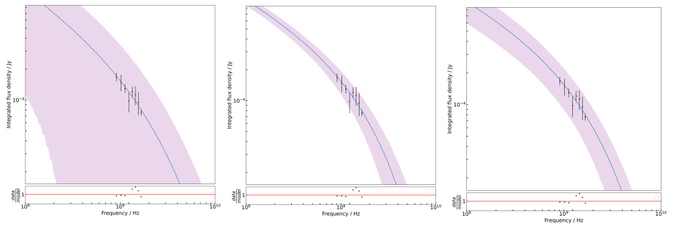
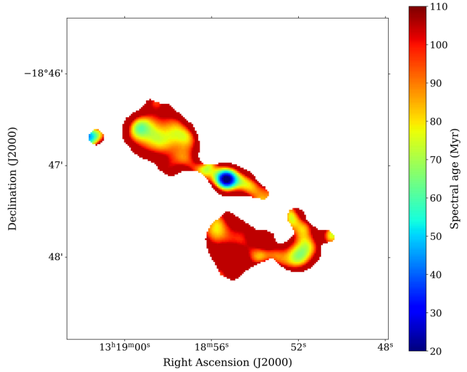


Fig 4: Top: Model fitting made by synchrofit using CI, JP, and KP models. Bottom: spectral ageing map using JP model (BRATS).



Results:

- We found 26 radio galaxies and 14 double lobes AGN in our FRB field (fig 1).
- MKAT J131855.02-184708.00 is an FR I WAT with an Ω-shaped morphology (fig 2), showing asymmetry between a double-bent SE jet and a simple bent NW tail.
- Tail bending is mainly caused by ram pressure [1,2] and backflow interactions [7], while the SE jet's double bending is due to an oblique shock [3,4].
- The spectral index map (fig 3) shows a flat core and steep jets. The flatness in the hotspots suggest ongoing particle reaccelerations.
- Hotspot asymmetry indicates different acceleration mechanisms, with the NW region dominated by shock compression and turbulence [2,5,6], and the SE region shaped by oblique shocks and KH instabilities [3].
- BRATS [8] and Synchrofit [9] models show increasing tail ages, youngest plasma near core, spectral age [10] ~ 74.84 Myr.

Conclusions:

This study demonstrates how ram pressure, backflow, and shocks combine to shape the morphology of Ω-tail radio galaxies. The observed asymmetries in jet bending and spectral ageing patterns highlight the dominant influence of the environment on particle acceleration and tail evolution. It also demonstrates MeerKAT MeerKAT's capability to detect faint diffuse emission, providing valuable insights into the interplay between galaxy dynamics and extragalactic radio structures.

References: **[1]** O'Donoghue et al., 1993, ApJ, 408 **[2]** Sudheesh et al., 2025, MNRAS, 543 **[3]** Kurahara et al., 2026, PASJ, 78 **[4]** Ohmura et al., 2023, ApJ, 951 **[5]** Muller et al., 2021, MNRAS, 508 **[6]** Lusetti et al., 2024, MNRAS, 528 **[7]** Miller, 1985, MNRAS, 215 **[8]** Harwood et al., 2013, MNRAS, 435 **[9]** Quici et al., 2022, MNRAS, 514 **[10]** van Weeren et al., 2019, SSRv, 215

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