Tenth International Fermi Symposium

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Multi-wavelength Study of Radio Galaxies in MeerKAT fields

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Overview

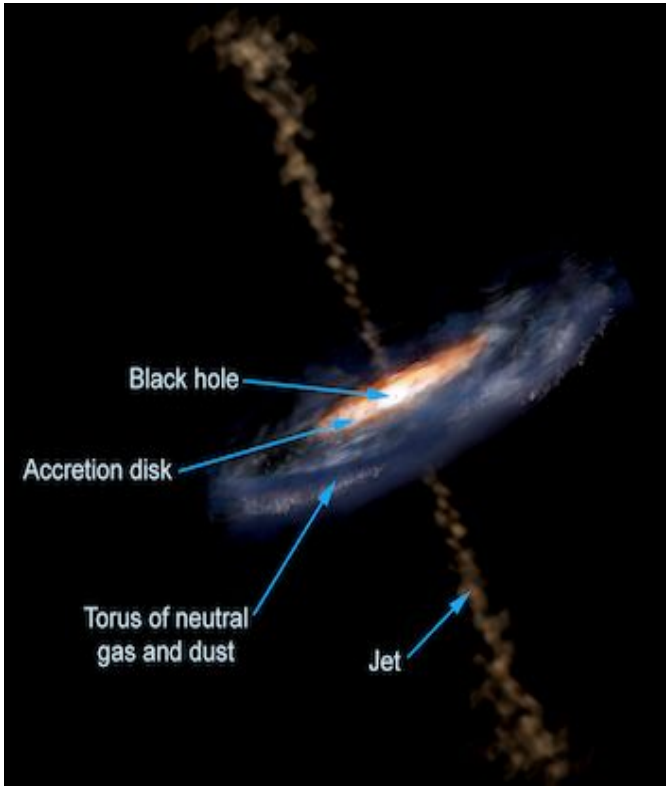
- Background Information
- Aims of the project
- Observation and Data reduction
- Results
- Conclusion

Introduction

❖ Radio galaxies are galaxies with an active nucleus (AGN = active galactic nucleus), harboring a supermassive black hole, powering relativistic beams (jets) of particles that extend over thousands of light years into intergalactic space.

Properties of radio galaxies (**Active Galaxies**):

- have a bright nucleus.
- are very luminous at radio wavelengths.
- are absolutely massive.
- emit synchrotron radiation.
- have gigantic jets pointing out of the galaxy.



Credit: Aurore Simonnet, Sonoma State University

Aims of the project

(a) identify potentially interesting objects within the available MeerKAT fields for further study, based primarily on their radio morphology;

(b) assemble available archival multi-wavelength data, including infrared, optical, and X-ray surveys as well as data from the Fermi Gamma-Ray Space Telescope;

(c) build multi-wavelengths spectral energy distributions (SED) for those sources with sufficient multi-wavelength coverage; and

(d) interpret them in the framework of AGN jet emission models to diagnose the physical properties of the jets and their environments.

Observation and Data reduction

- 64-dishes radio interferometer of 13.5 m-diameter each.
- Operational in UHF-band (0.58 – 1.0 GHz), L-band (0.9 – 1.67 GHz), S-band (1.73 – 3.5 GHz) see Jonas & MeerKAT team (2016).
- ~7” of resolution.
- MeerKAT’s shortest baseline is 29 m and longest baseline is 8 km.

Observation and Data reduction cont...

- The observation for this project were done MeerKAT's L-band receiver configuration.
- Which has a bandwidth of 856 MHz and a central frequency of 1.28 GHz.
- Used the oxkat v1.0 software (Heywood 2020) to reduce and process the data on ilifu cluster.
- oxkat is a semi-automated Python-based reduction pipeline for MeerKAT data, currently optimised for L-band continuum observations.
- Steps which were followed in ilifu cluster are:
  - ➔ First generation calibration (1GC): Cross-calibration and initial imaging
  - ➔ FLAG: Flagging
  - ➔ Second generation calibration (2GC): Self-calibration

Observation and Data reduction cont...

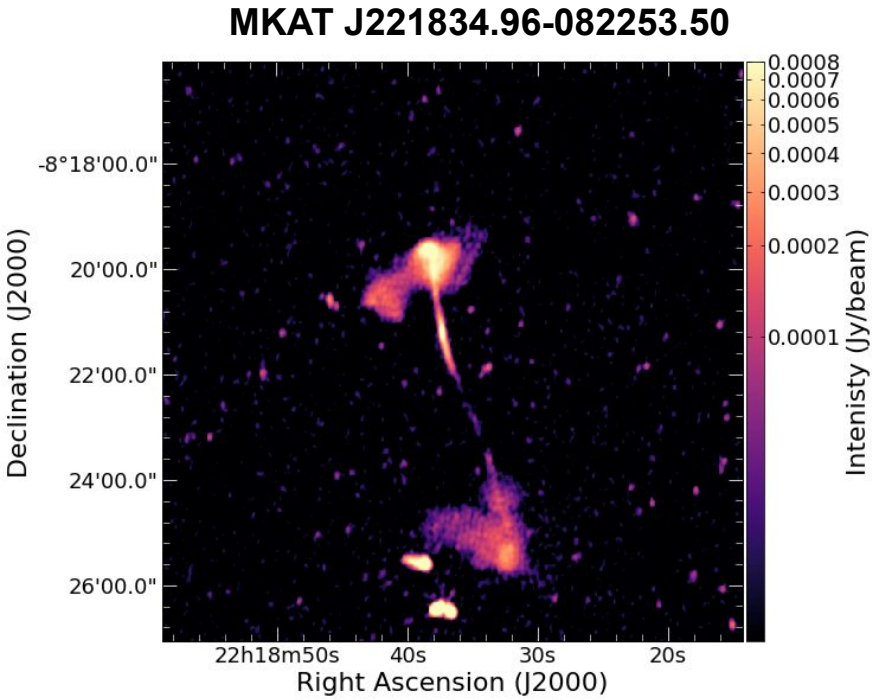
Field name	Observation date	Synthesized beam	rms (μJybeam−1)
FRB 20171019A	18 October 2019	6″.8 x 5″.0	5.2
FRB 20190711A	09 September 2019	12″.5 x 4″.9	4.6
FRB 20190714A	28 September 2019	6″.5 x 5″.1	5.8

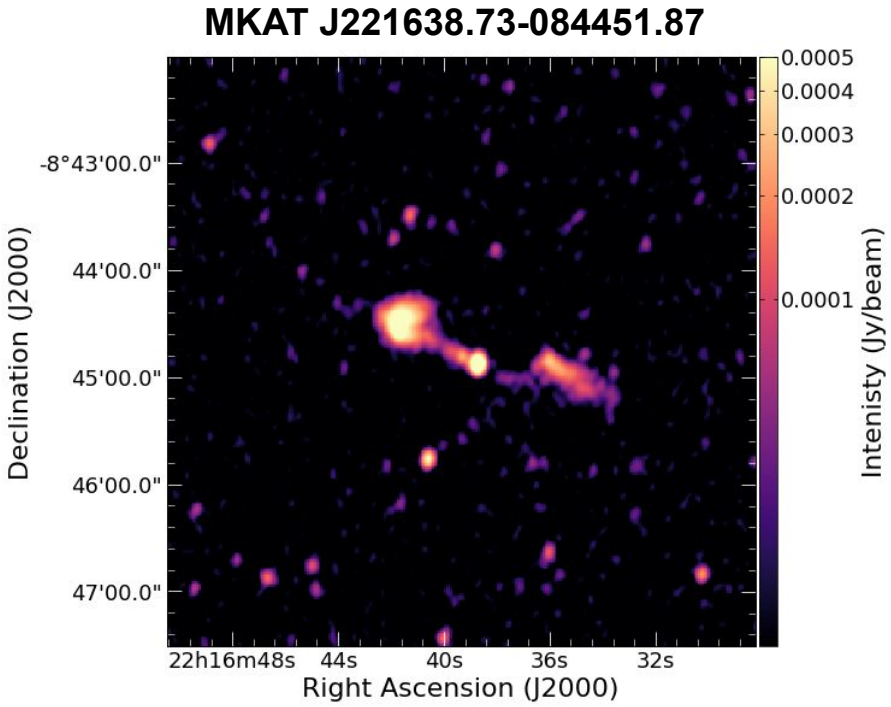
Table 1: Observations summary of the FRB fields from MeerKAT.

Results

- 86 radio galaxies were identified from all the three fields.

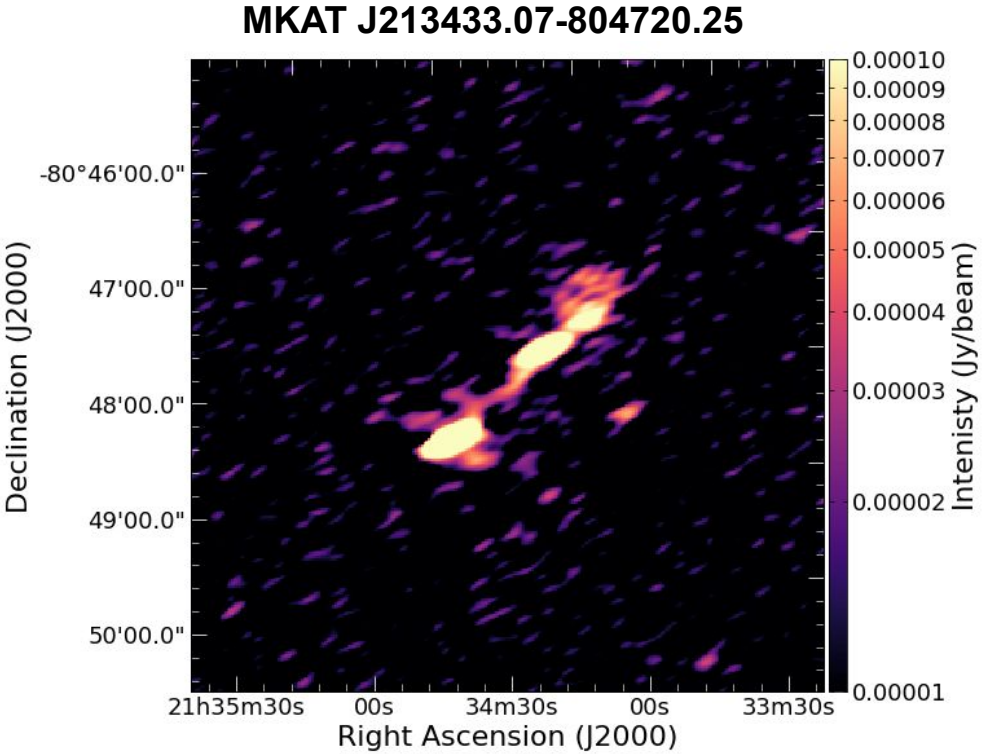
FRB 20171019A

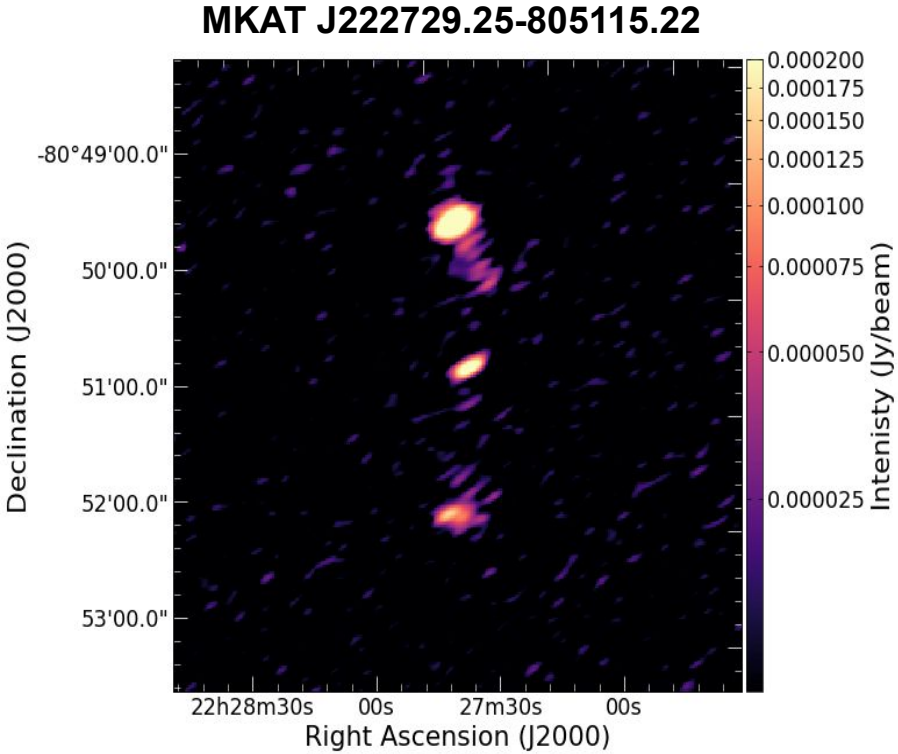




Results cont...

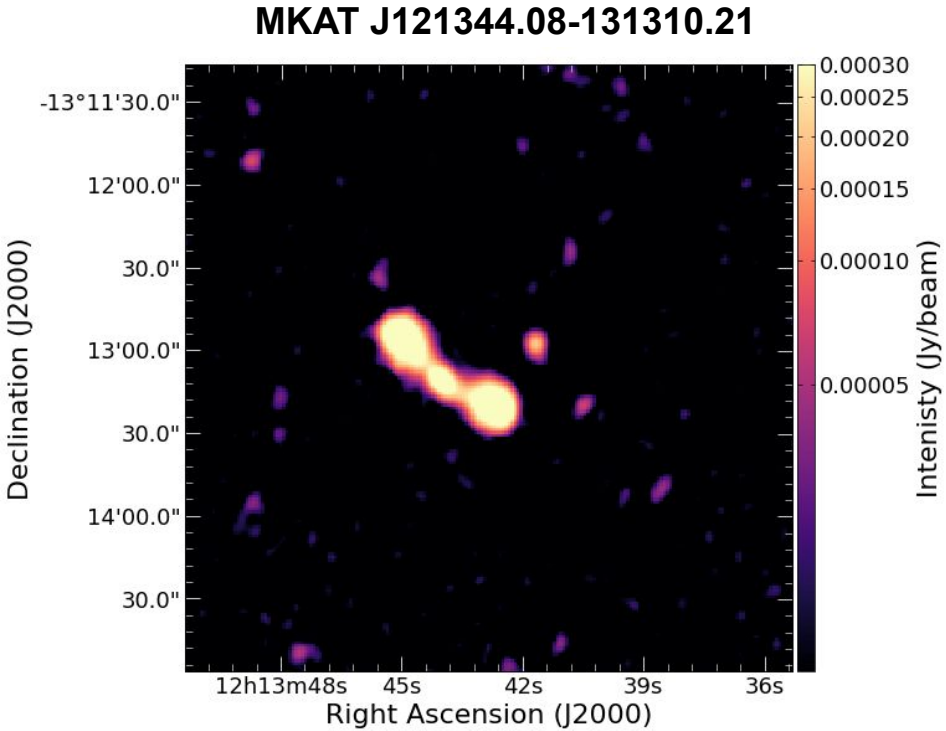
FRB 20190711A

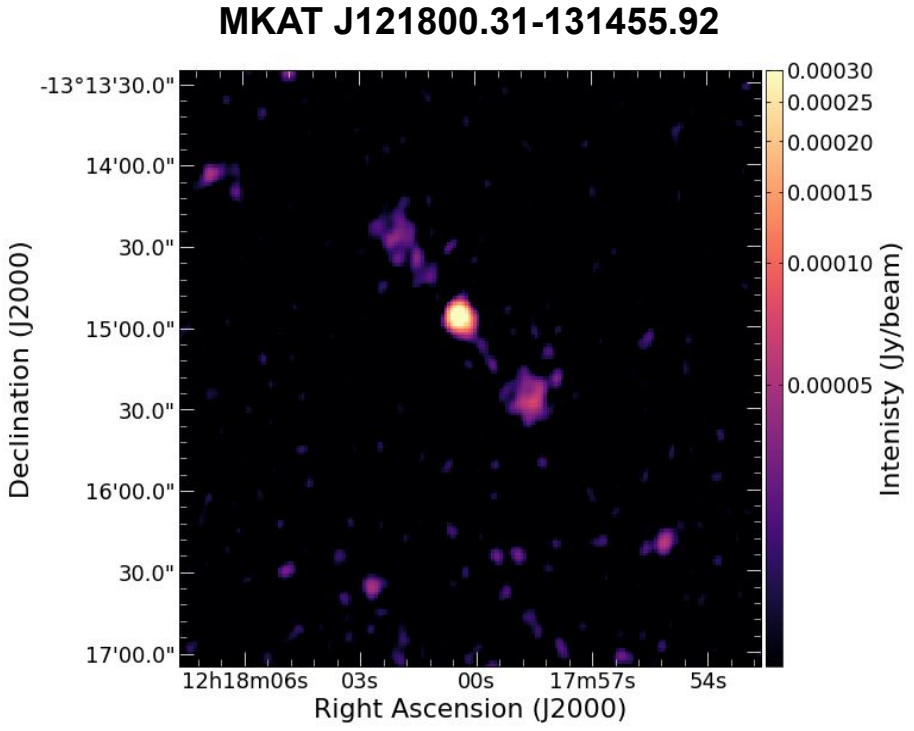




Results cont...

FRB 20190714A





Results cont...

- The interesting object identified is MKAT J221834.96-082253.50 from the FRB 20171019A field.

MKAT J221834.96-082253.50

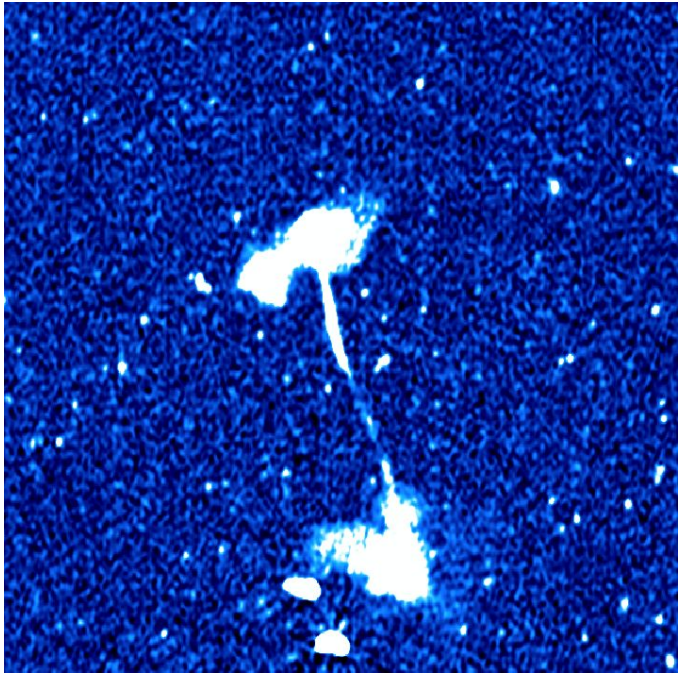
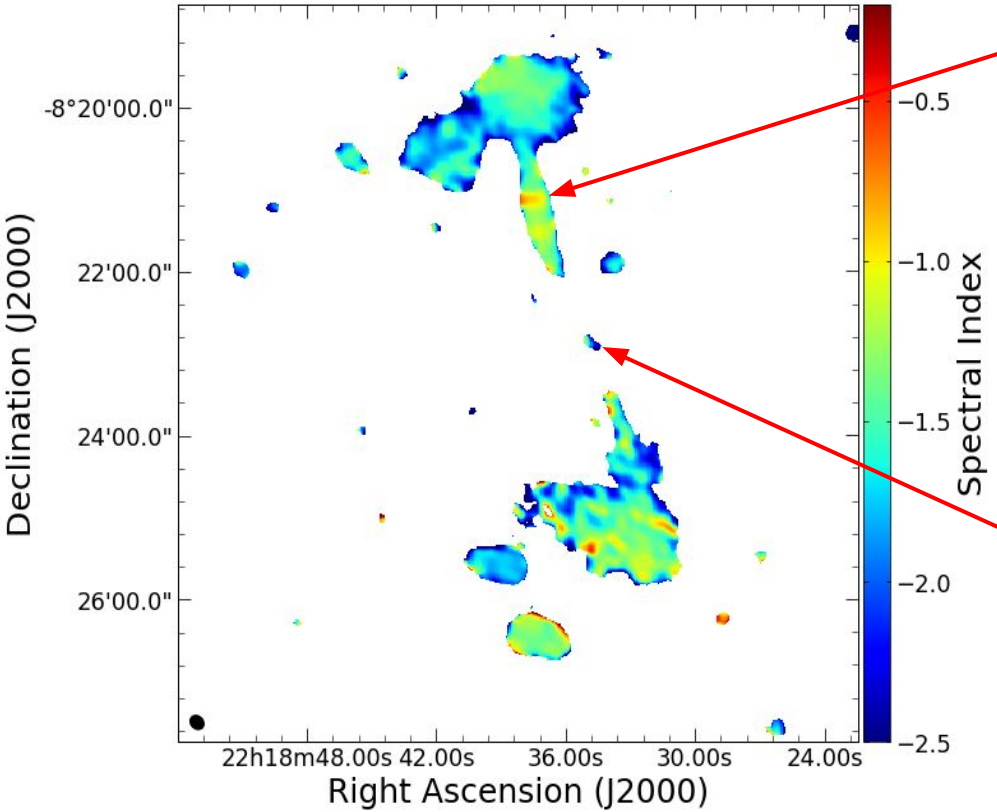


Table 2: Counterparts

FRB 20171019A					
Source name	Position (~)		Counterparts		
	WCS (FK5)		Infrared	Optical	High Energy
	α	δ	2MASS	SDSS	2XMMi
AGN1	22:18:34	-08:22:53	5	28	3

Results cont...

Spectral index map



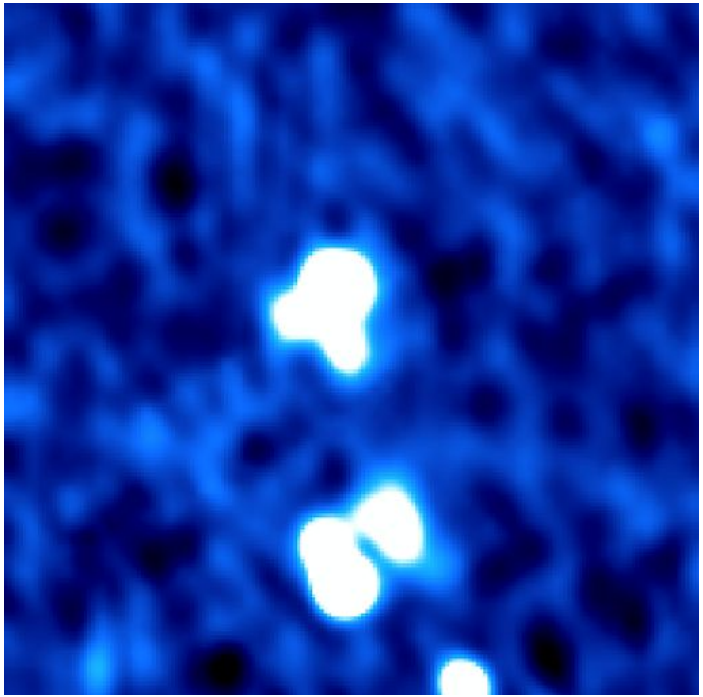
- Hot-spot [22:18:37.5 -8:21:08.3]
- Core [22:18:34.1 -8:22:53.5]

Results cont...

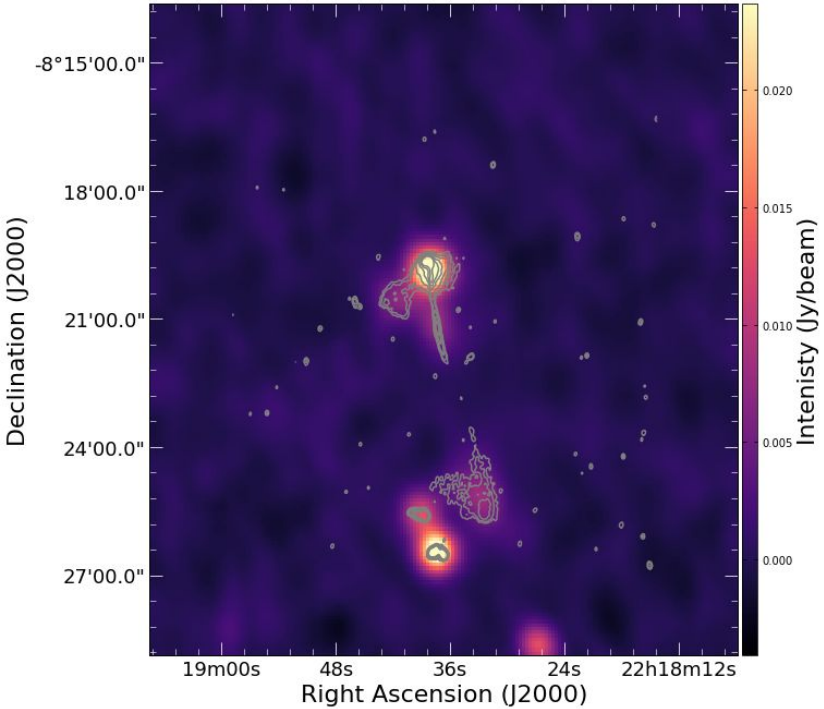
Archival multi-wavelength FITS image

Radio band (VLA Catalog data)

NVSS 221836-082120

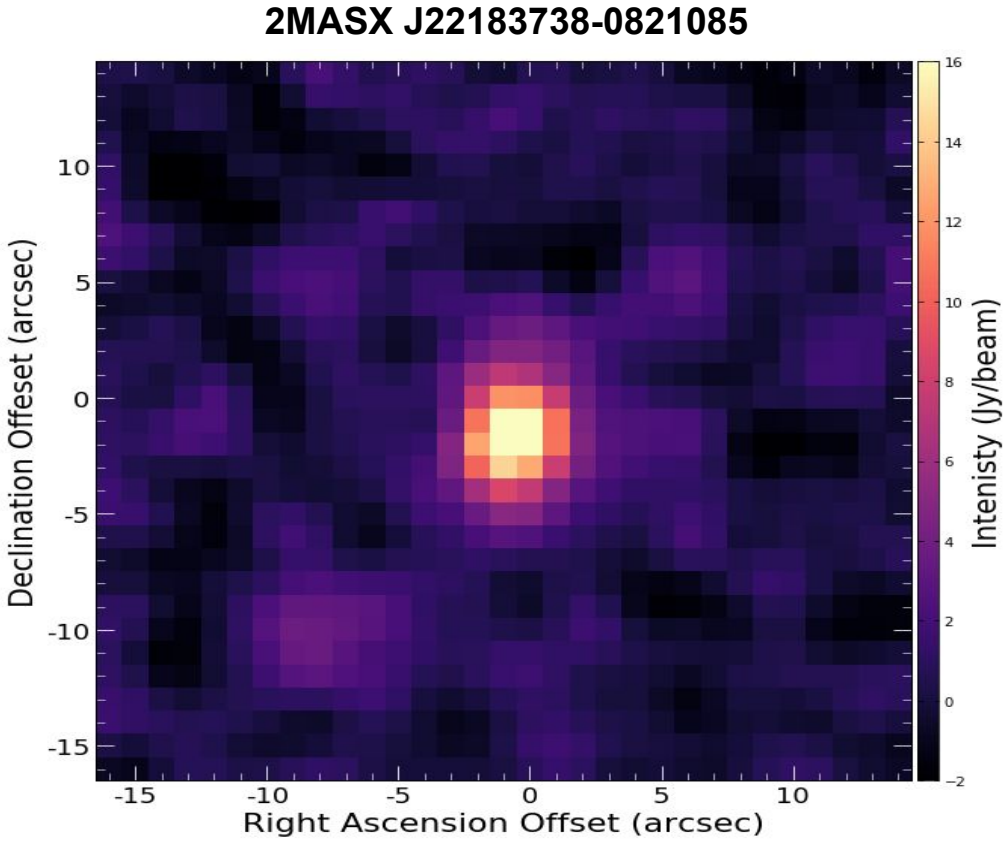


Contour map with VLA data

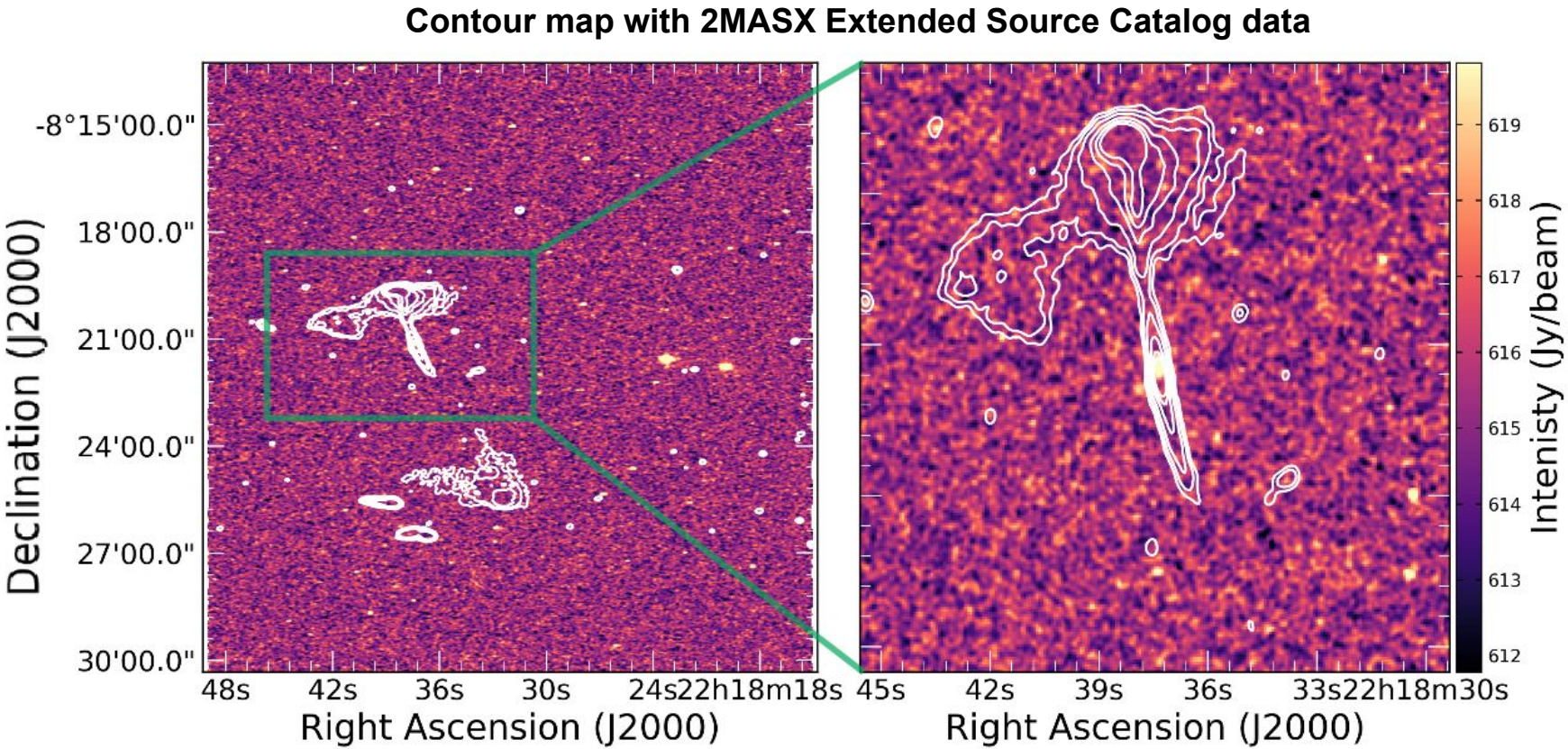


Results cont...

Infrared band (2MASX Extended Source Catalog data)



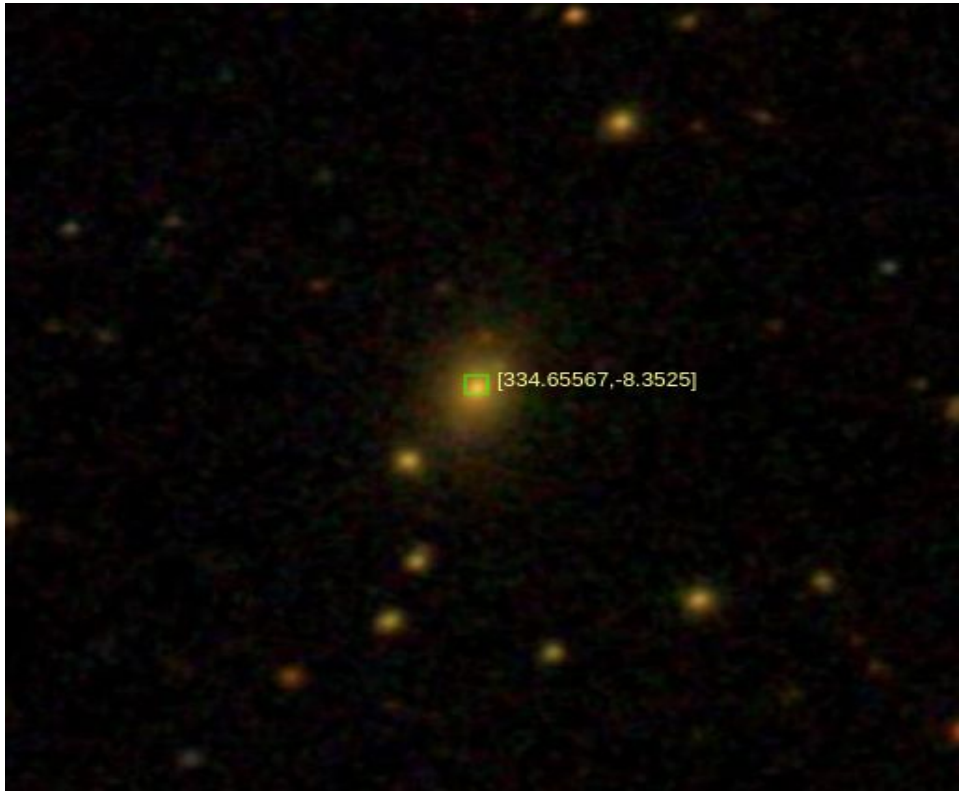
Results cont...



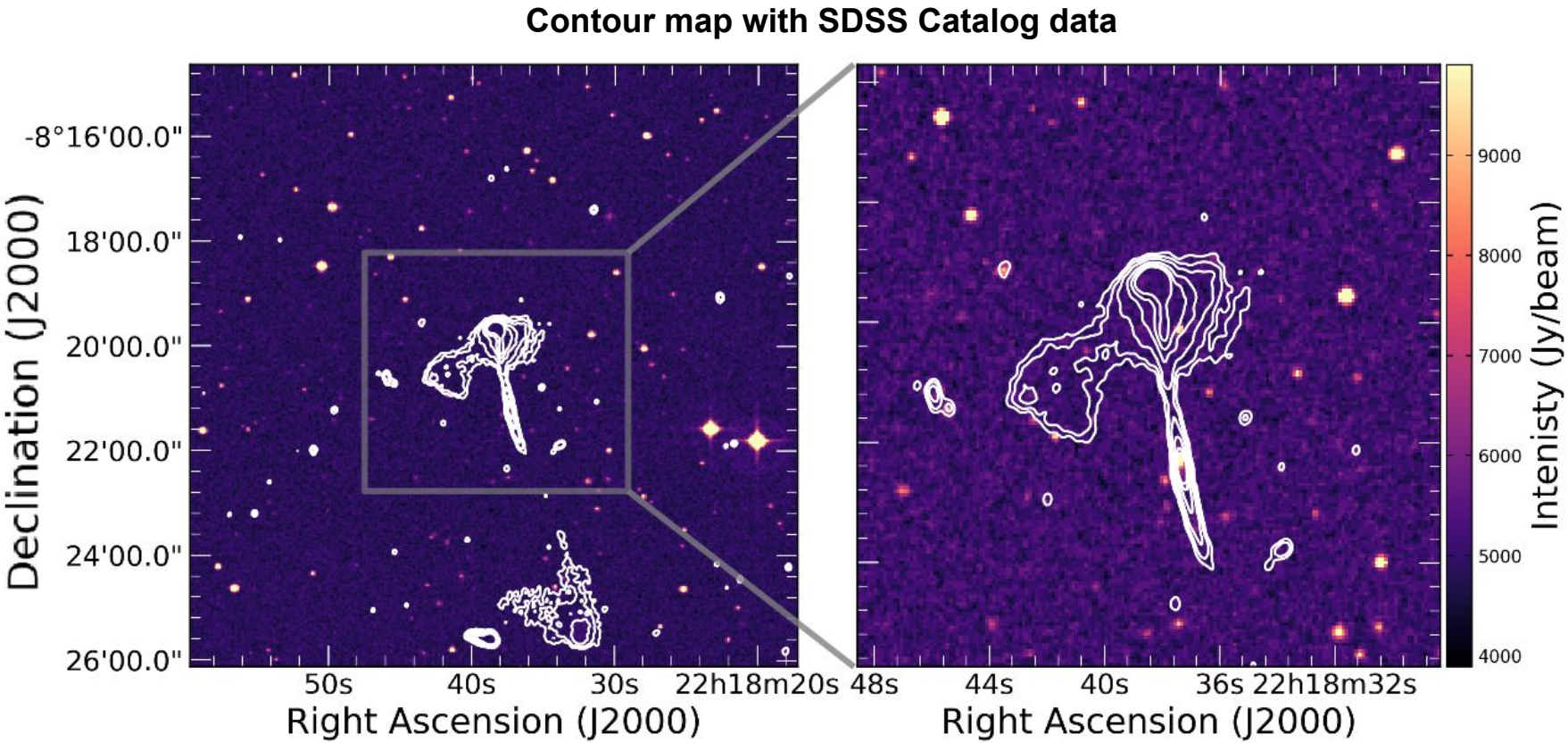
Results cont...

Optical band (SDSS Catalog data)

SDSS J221837.35-082109.1



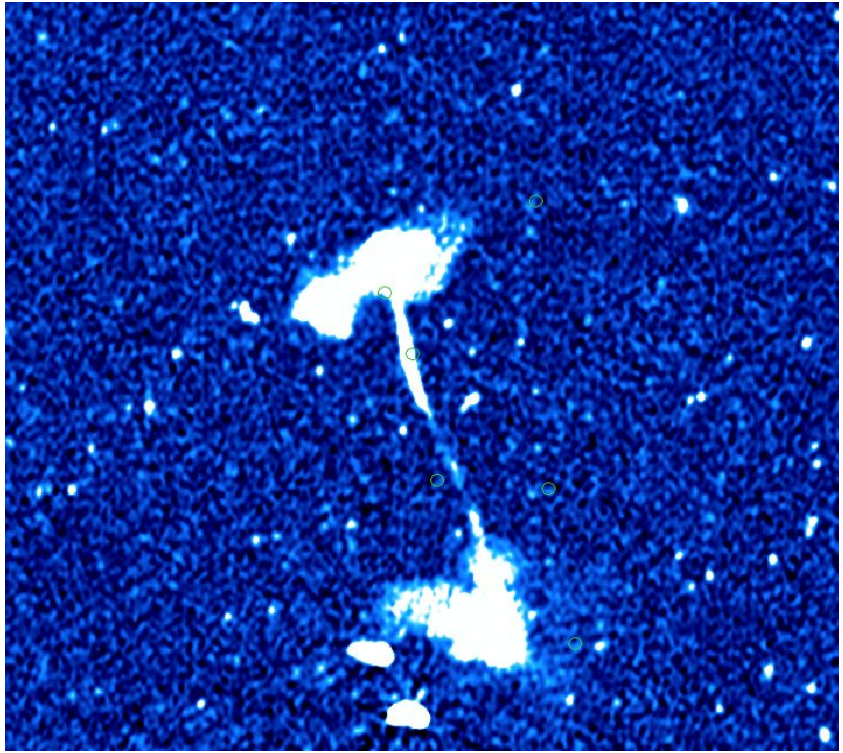
Results cont...



Results cont...

High Energy band (2XMMi source data and 4FGL Fermi-LAT catalog)

MKAT J221834.96-082253.50



- MKAT J221834.96-082253.50 with the X-ray counterparts from 2XMMi source catalog (green circles).
- There was no FITS file/image found in the X-ray band.
- There was no counterparts found in 4FGL Fermi-LAT catalog.

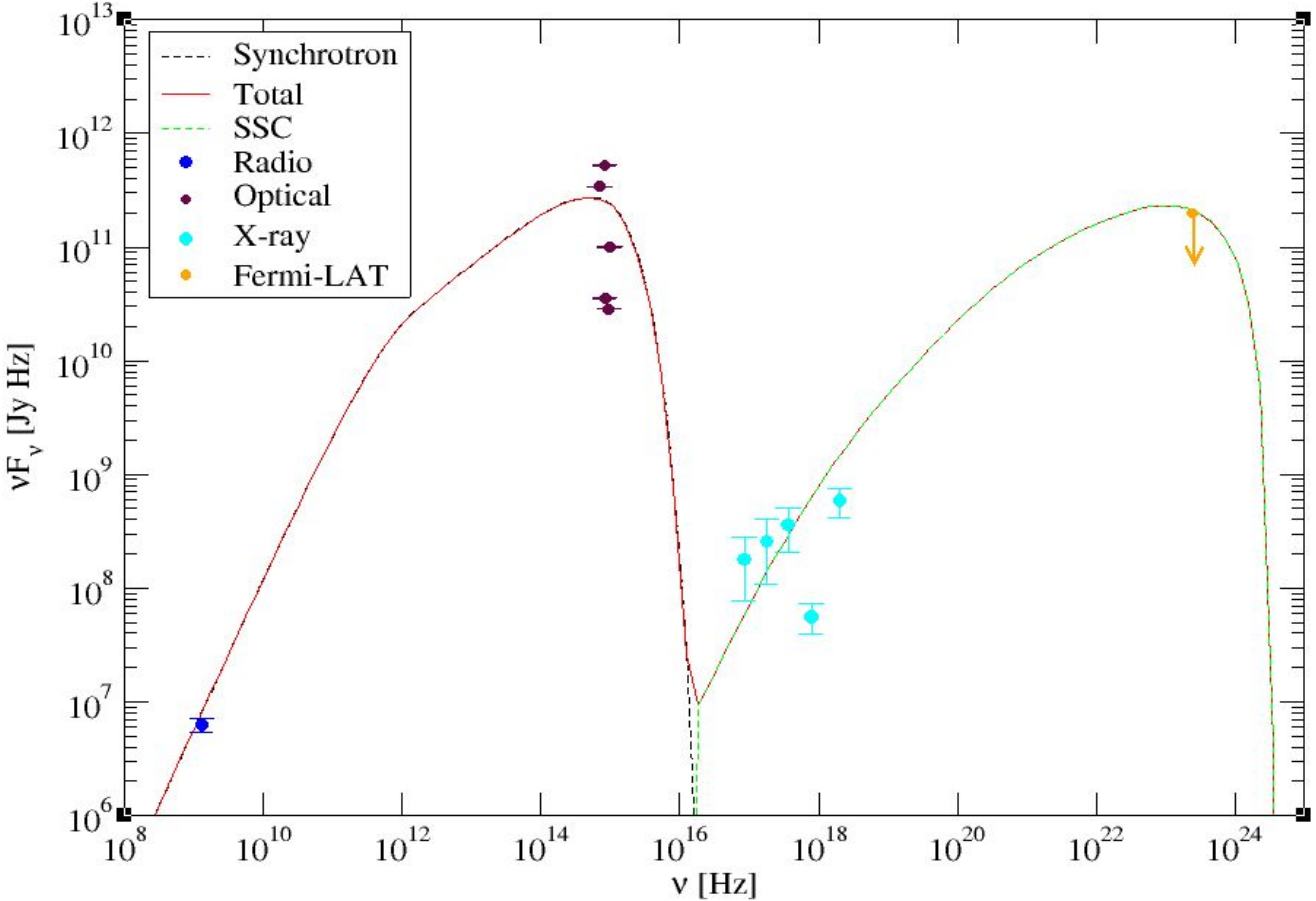
Results cont...

Spectral Energy Distributions (SED)

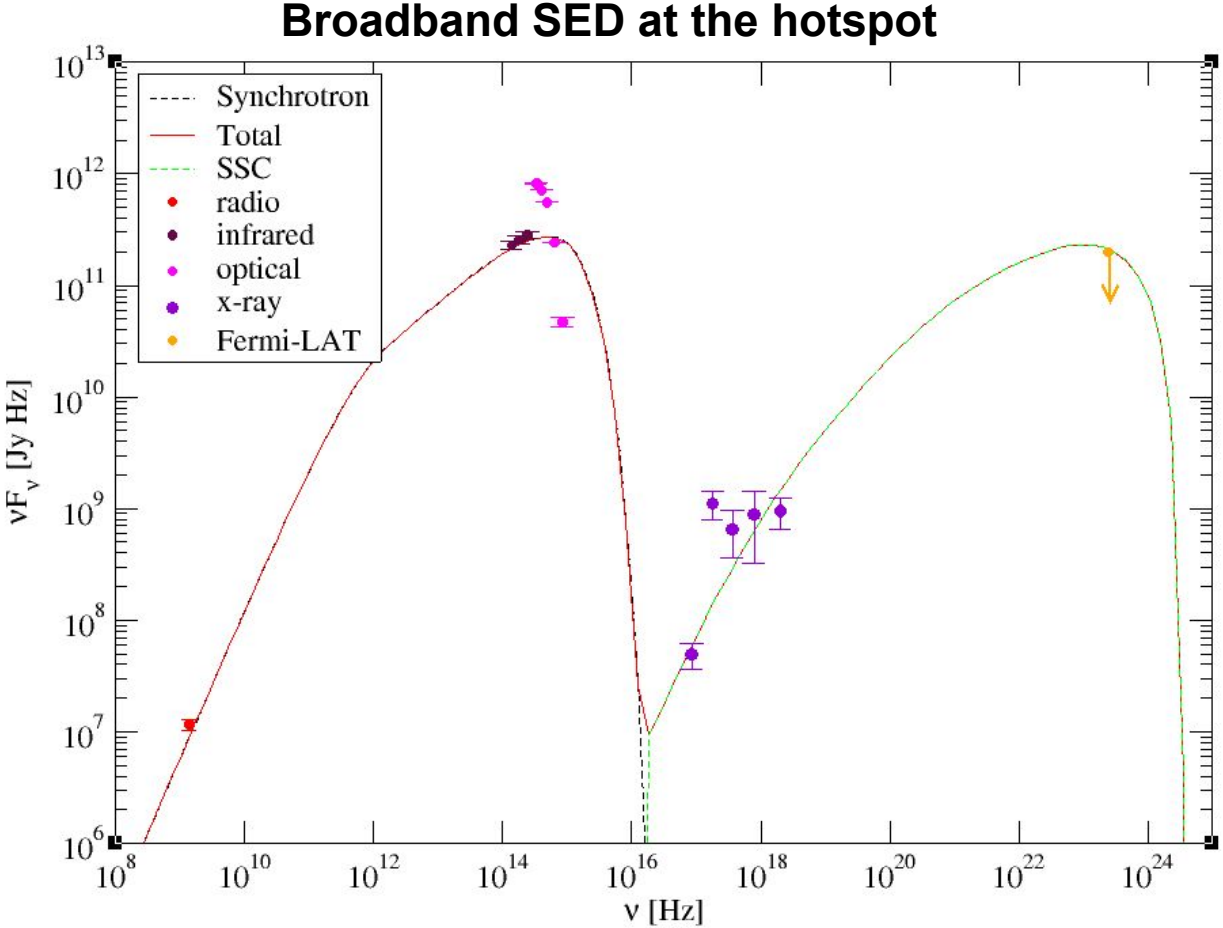
- Used the blazar code of Boettcher et al. (2013).
- Input parameters:
  - ➔ Injection luminosity [erg/s] = 2.5e44
  - ➔ Gamma_min = 2.5e4
  - ➔ Gamma_max = 3.8e4
  - ➔ Escape time parameter (t_esc = eta*R/c) eta_esc = 0.25
  - ➔ Magnetic field at z_0 [G] = 0.25
  - ➔ Blob radius [cm] = 1.2e18
  - ➔ Observing angle [degrees] theta_obs = 90
  - ➔ Redshift z = 0.168

Results cont...

Broadband SED at the core



Results cont...



Conclusion

- One radio galaxy was selected.
- Assembled available multi-wavelength data.
- Finding the Archival multi-wavelength FITS image.
- Built multi-wavelength spectral energy distributions (SED) for the core and hot-spot.

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Thank you for your attention!

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