

# Probing Faint Radio Activity in Radio-Quiet Quasars: Insights from the Quasar Feedback Survey (QFeeDS)

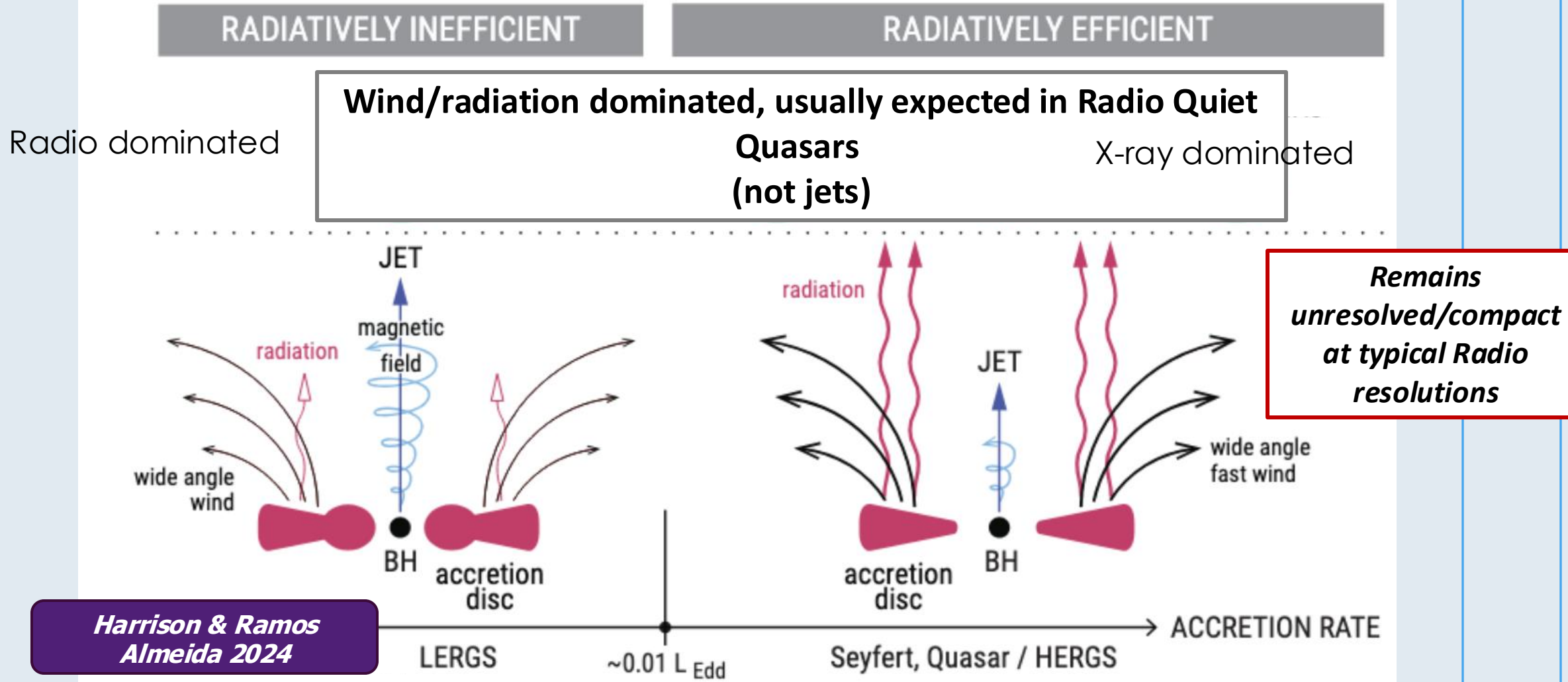
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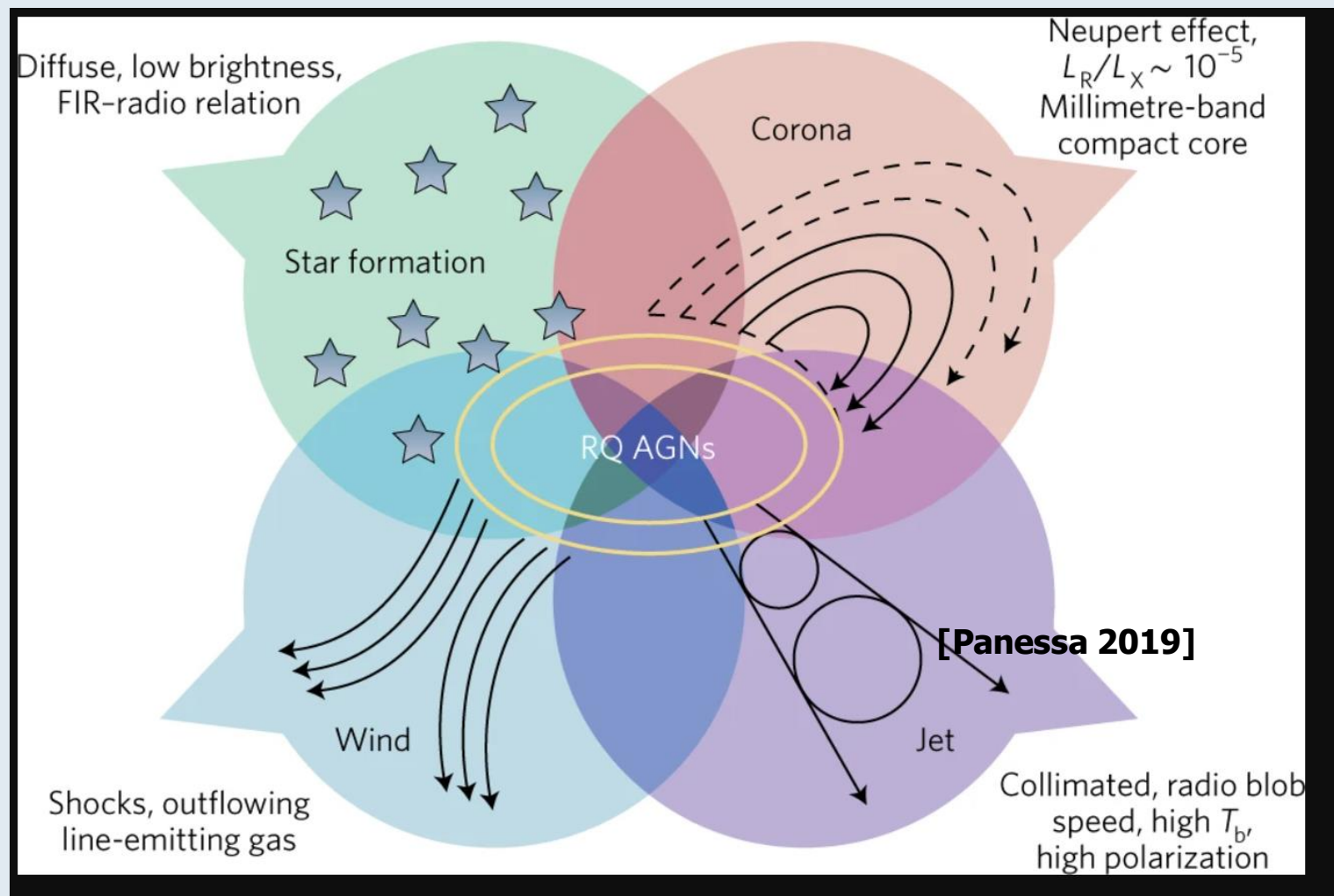
# Scientific Context and Motivation

**Do radio-quiet quasars host jets? What kind? Do/How they contribute to feedback?**



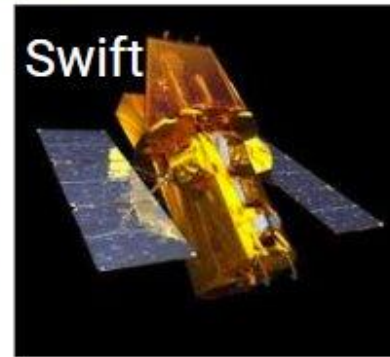
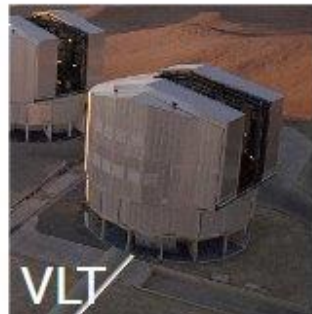
*Harrison & Ramos Almeida 2024*

## ❖ What's the origin of Radio emission in RQ-AGN?



# Quasar Feedback Survey (QFeedS)

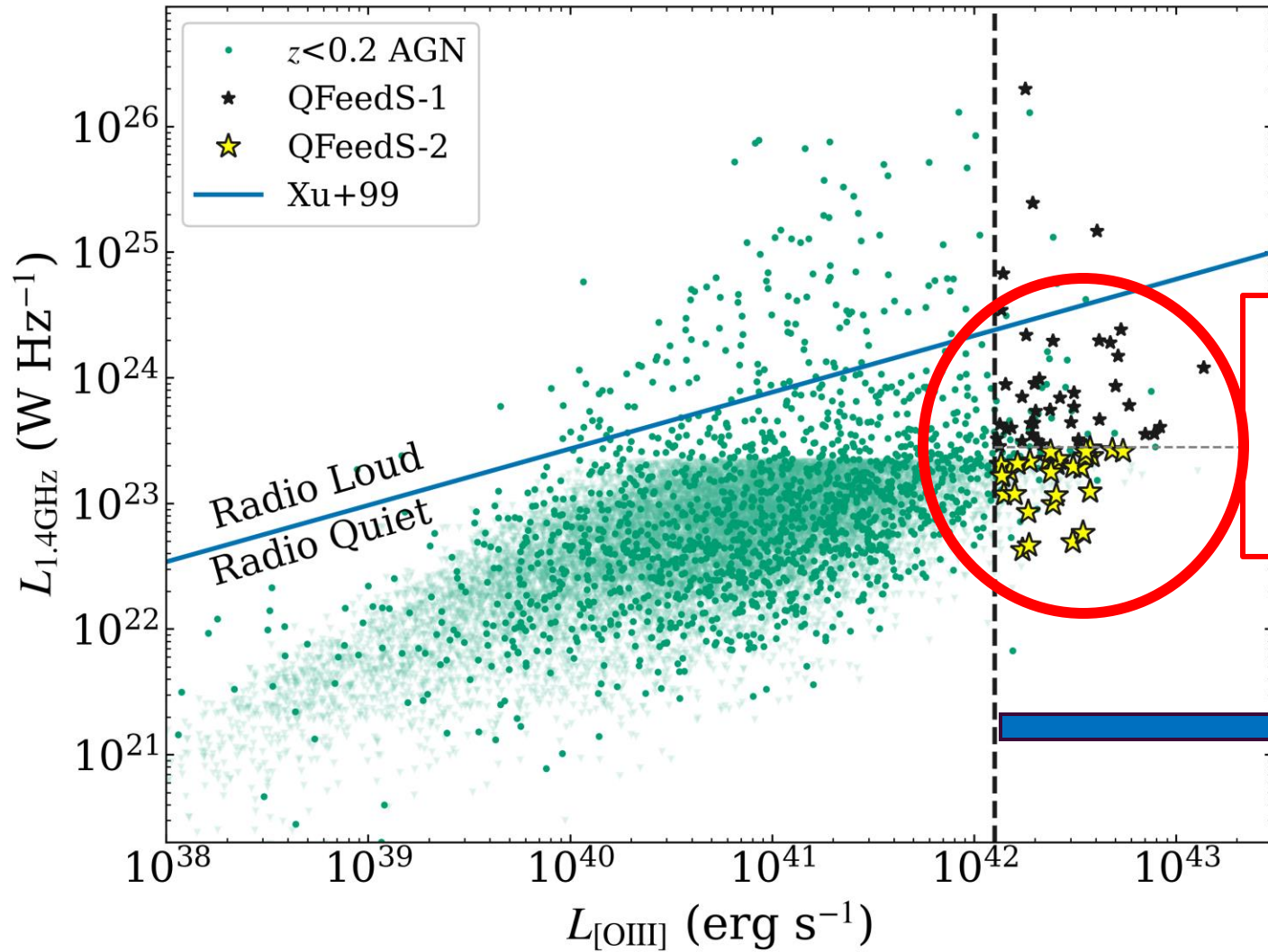
**71 quasars;  $z < 0.2$**   
**18 targets = Radio-loud**  
**54 targets = Radio-quiet *75%***



***Papers:***  
***Jarvis+19;***  
***Molyneux+19;***  
***Jarvis+21;***  
***Girdhar+22;***  
***Sipla+22;***  
***Girdhar+24;***  
***Molyneux+24;***  
***Njeri+25;***  
***Njeri+26***

# ❖ Sample Selection

Parent Sample of SDSS  $z < 0.2$  (green circles; Mullaney+13)



$Q\text{FeedS-1} == L_{1.4\text{GHz}} > 10^{23.45}$ ; 42 TARGETS

$Q\text{FeedS-2} == L_{1.4\text{GHz}} < 10^{23.45} \text{ W/Hz}$ ; 29 TARGETS

Radio Quiet quasars, usually expected to be wind/radiation dominated (not jets)

Our quasar luminosity threshold ( $L_{[\text{O III}]} > 10^{42.1} \text{ erg/s}$ ) for the total Quasar Feedback Survey sample selection

# Objectives of QFeedS:

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1. Investigate the origin of radio emission in RQ-AGN
2. Investigate the impact that quasars have on their host galaxies
  3. Study the properties of multiphase outflows
4. Measure the spectral indices, TBs of nuclear/compact radio emission
5. Quantify the relationship between radio properties and ionised gas kinematics.

# *Key Results*

## VLA & e-MERLIN revealed:

*VLA Imaging at 1.4 & 6 GHz, eMERLIN at 6 GHz: 0.3 - 3.0 kpc*

### ***Key results:***

- 1. Compact jet-like morphologies with steep spectrum**
- 2. Low-power jets influencing gas on sub-kpc scales**
- 3. Alignment between radio emission and gas outflows**

*Jarvis+2021; Girdhar+2024; Njeri+2025,2026*

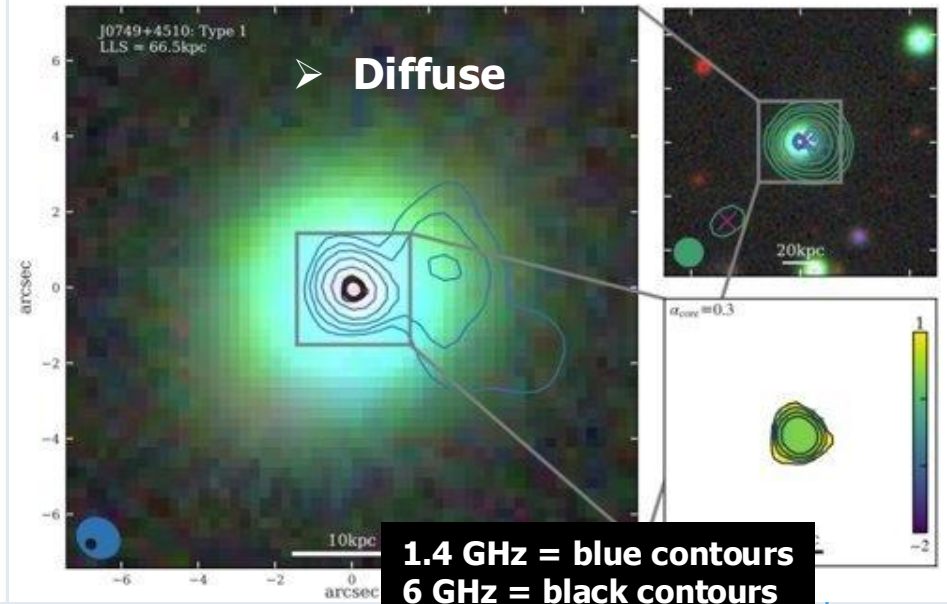
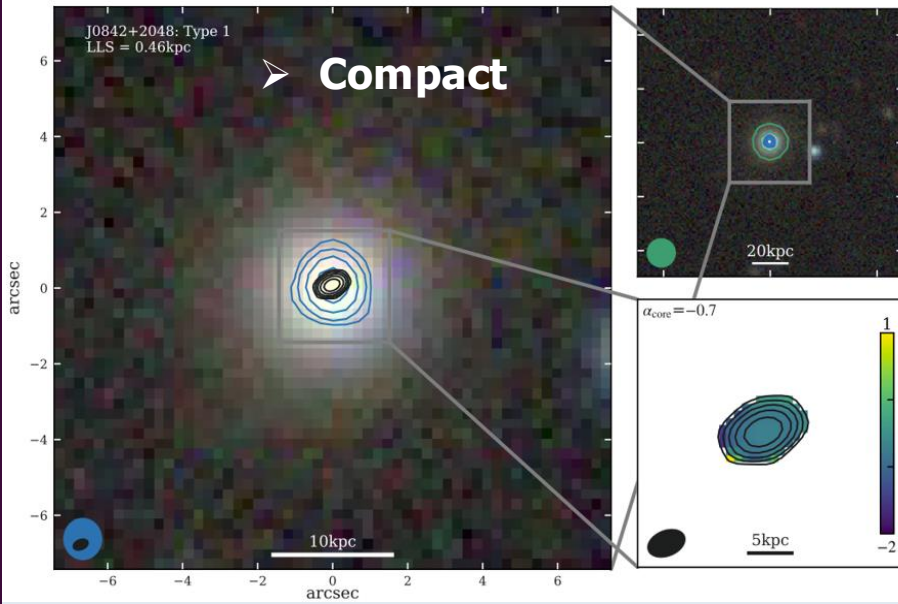
# VLA morphology:

**Diverse radio morphology & Multi-scale view:**

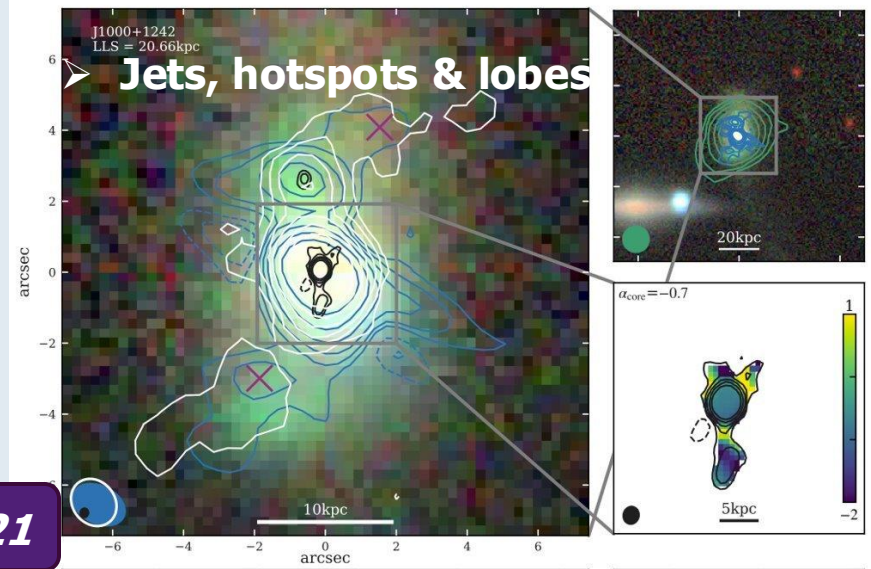
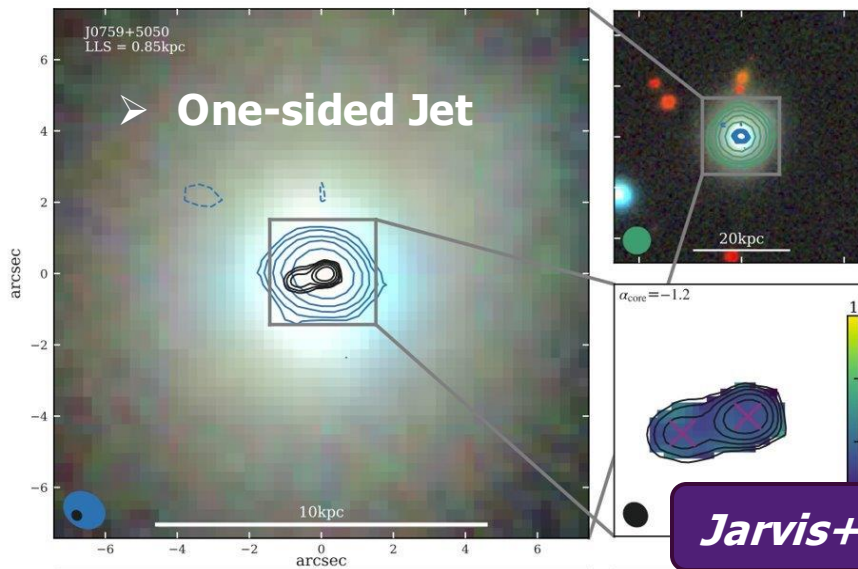
**FIRST: 36/42 == Compact**

**VLA 6 GHz: 18/42 == Compact**

**7/42 classified as 'Radio-AGN' origin**



**1.4 GHz = blue contours  
6 GHz = black contours**



***Multi-scale:  
2/3rds exhibit  
~1-60kpc scale  
radio structures***

**Jarvis+21**

# VLA & e-MERLIN revealed:

Spatial scales:  $\sim 0.3 \text{ kpc}$

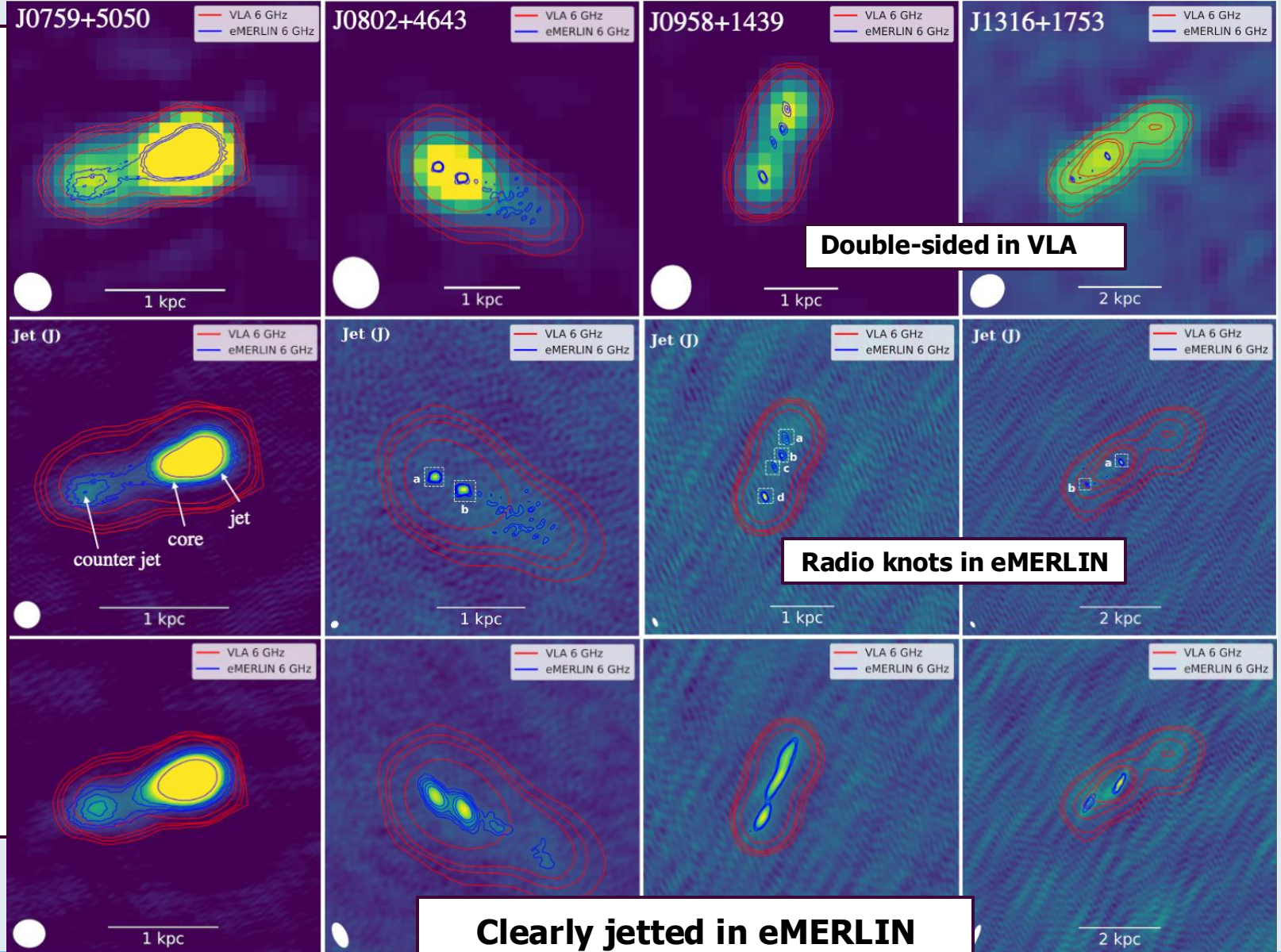
Diverse radio morphology:  
30 - 540 pc

Based on visual inspection:  
15/37 = Compact  
22/37 = jet-like

Contribute only  $\sim 40\%$  to the total emission

57% classified as 'Radio-AGN' origin!

*Njeri+25*



Double-sided in VLA

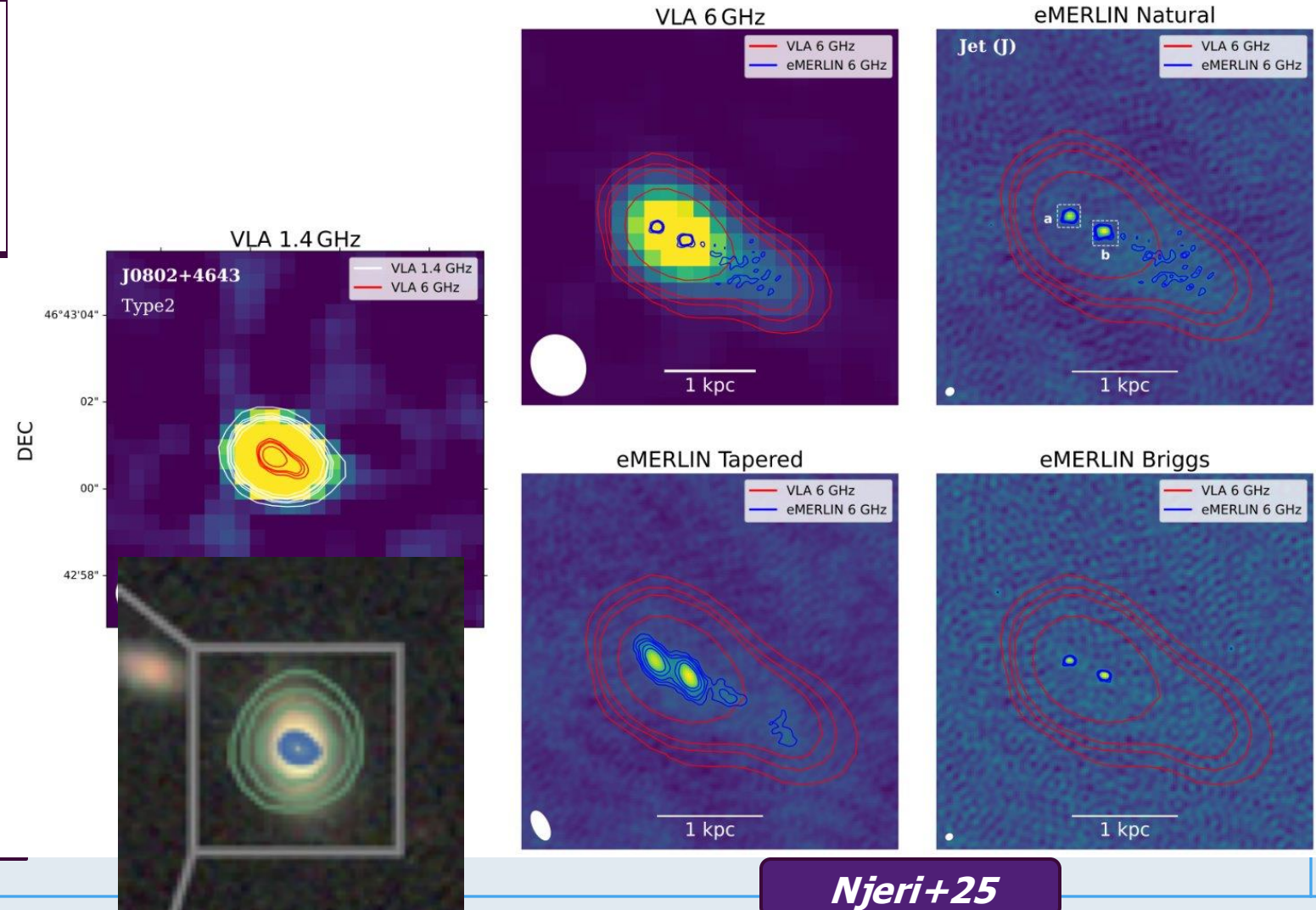
Radio knots in eMERLIN

Clearly jetted in eMERLIN

## VLA & e-MERLIN revealed:

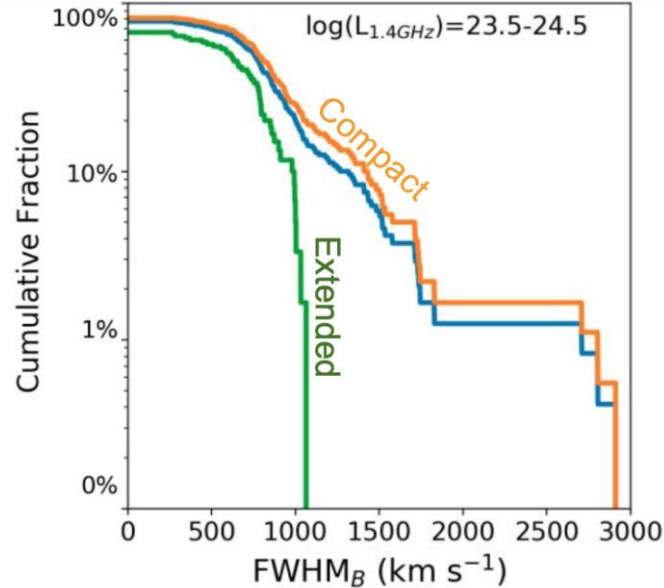
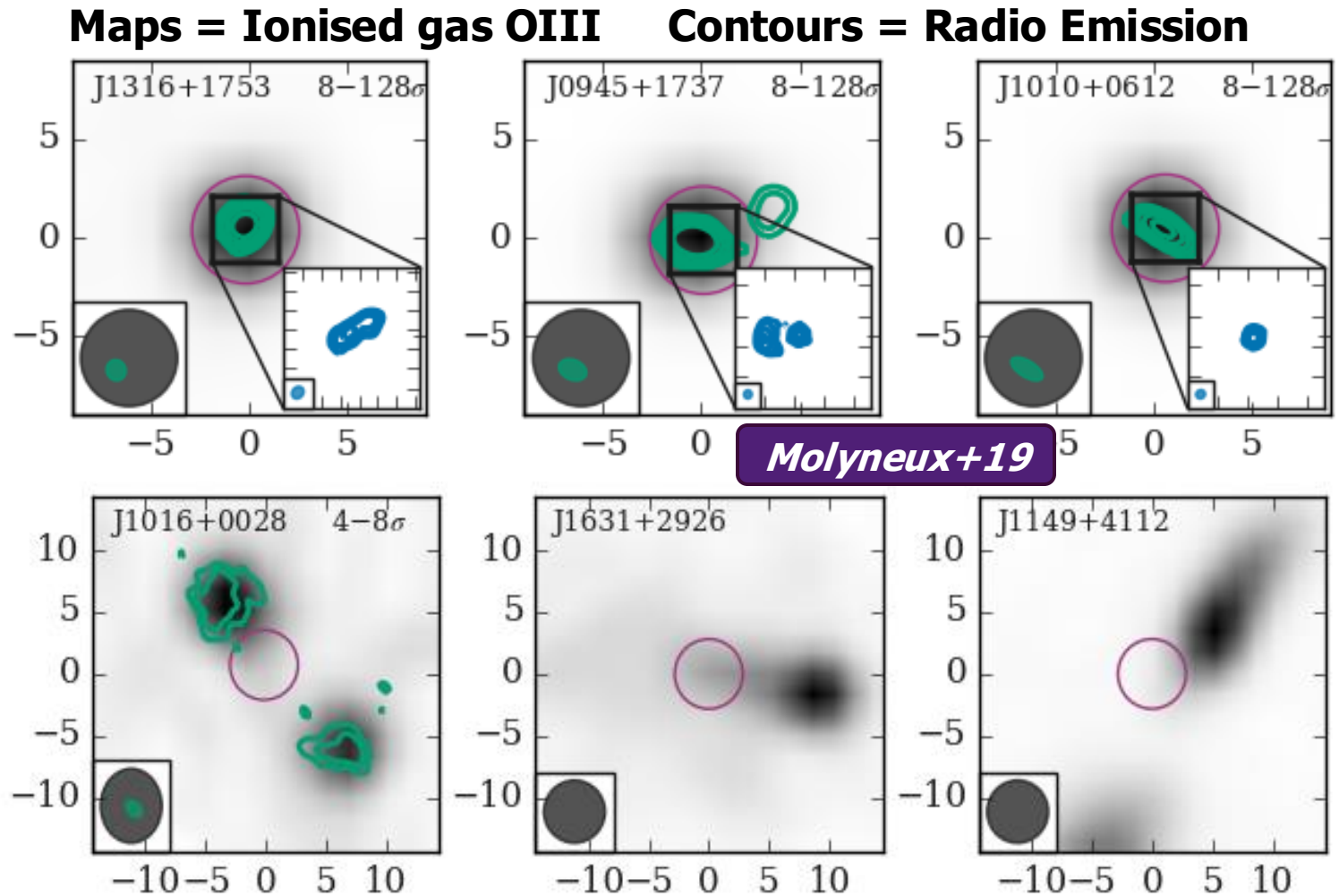
*2. Low-power jets influencing gas on sub-kpc scales*

- Possibly CSS/GPS
- Double-lobes at ~0.3 kpc
- Frustrated radio jet within the ISM



## VLA & e-MERLIN revealed:

Outflows are more prevalent when the radio emission is compact:  
Due to compact jets?



Compact

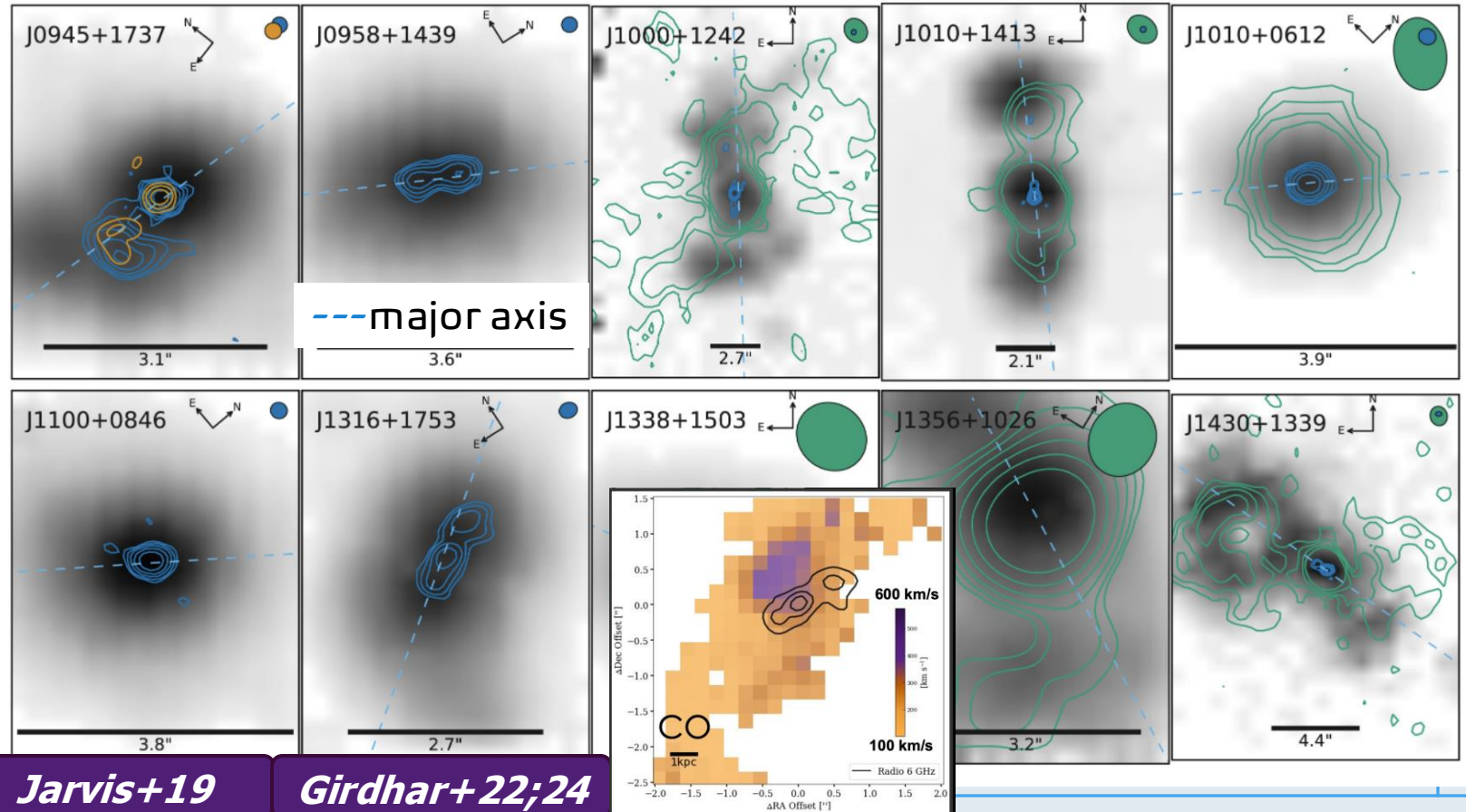
Extended

## VLA & e-MERLIN revealed:

**3. Alignment  
between radio  
emission and gas  
outflows**

**Common  
signatures of Jet-  
ISM interactions:  
enhanced  
ionised emission/increase  
d turbulent  
outflows/disturbed  
molecular CO gas at  
termini**

**Maps = Ionised gas OIII    Contours = Radio Emission**



**Jarvis+19    Girdhar+22;24**

## VLA 1.4 GHz & VLA 6 GHz reveal:

### *Njeri+2026*

- **Ultra-faint and compact:** L1.4GHz  $\sim 10^{22}$ – $10^{23}$  W/Hz
  - Spectral indices: 26/29 have SI < -0.5 (steep)
- Most sources unresolved at all frequencies (NVSS, FIRST, VLA, LOFAR)

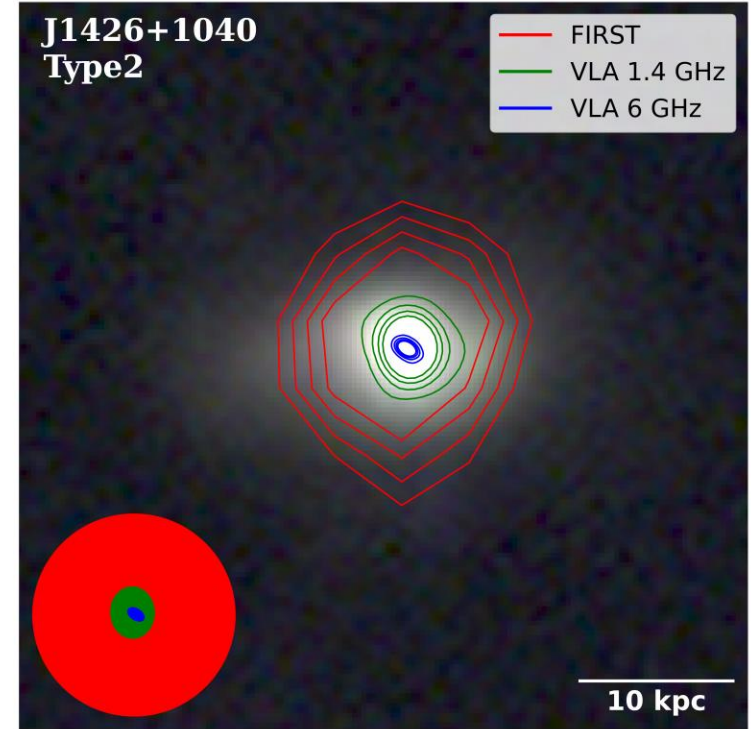
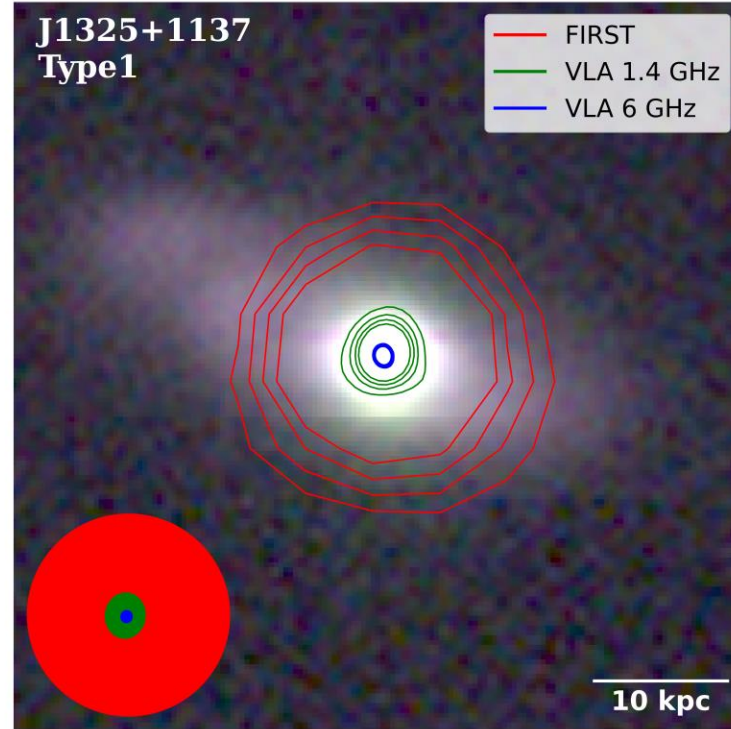
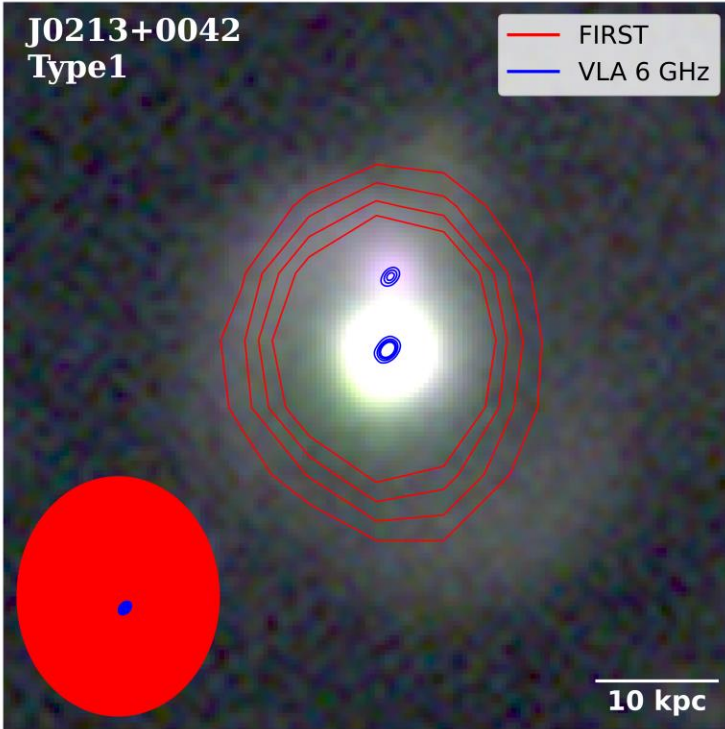
### • **Morphological Insights**

- ~30% show jet-like structure (elongated or multi-component)
- Remaining: compact, unresolved, possibly young or confined jets

### • **Multiwavelength Constraints**

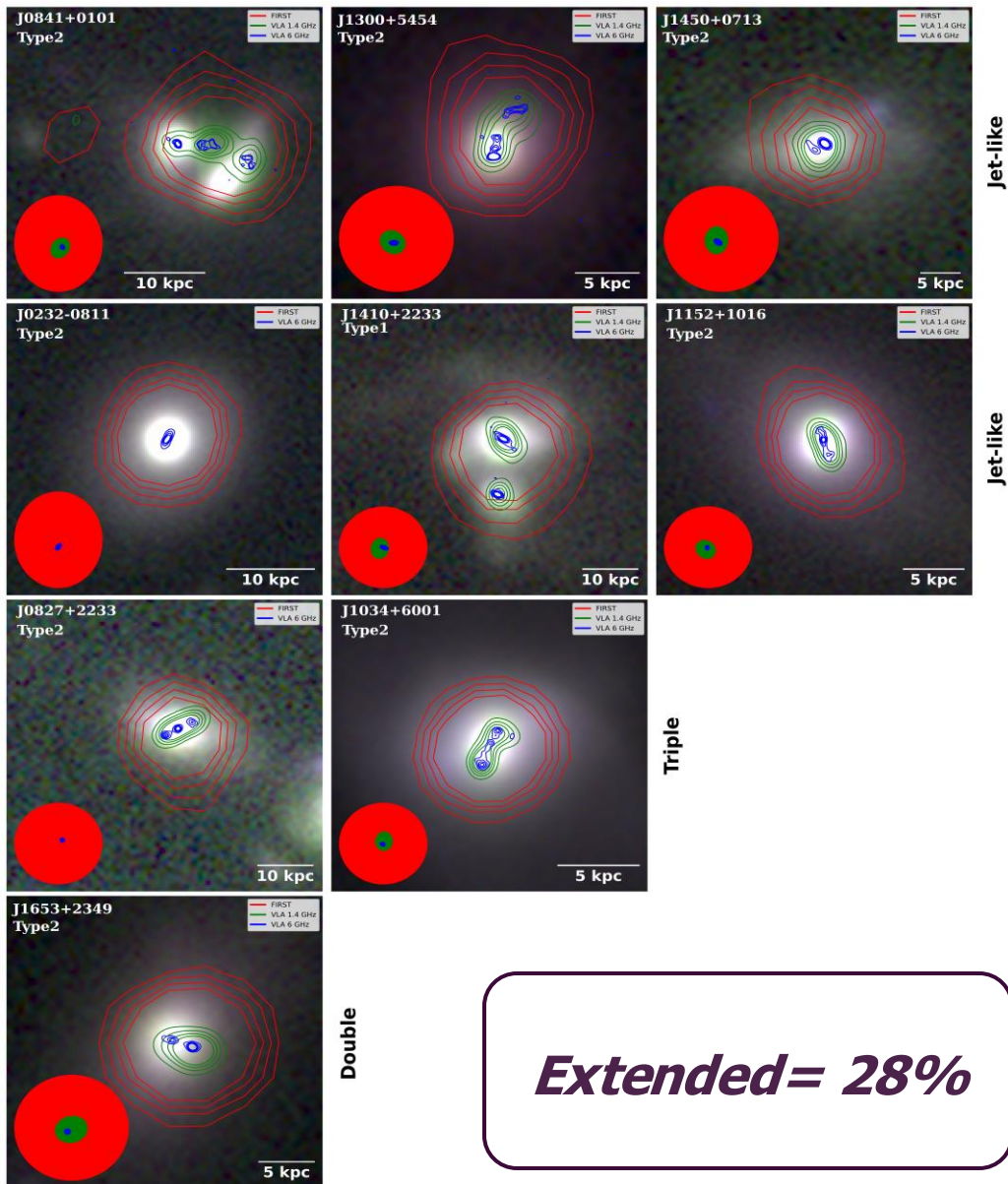
- [O III] luminosity weakly correlates with radio properties
  - Low SFRs: radio emission unlikely from star formation

# Radio Morphology:



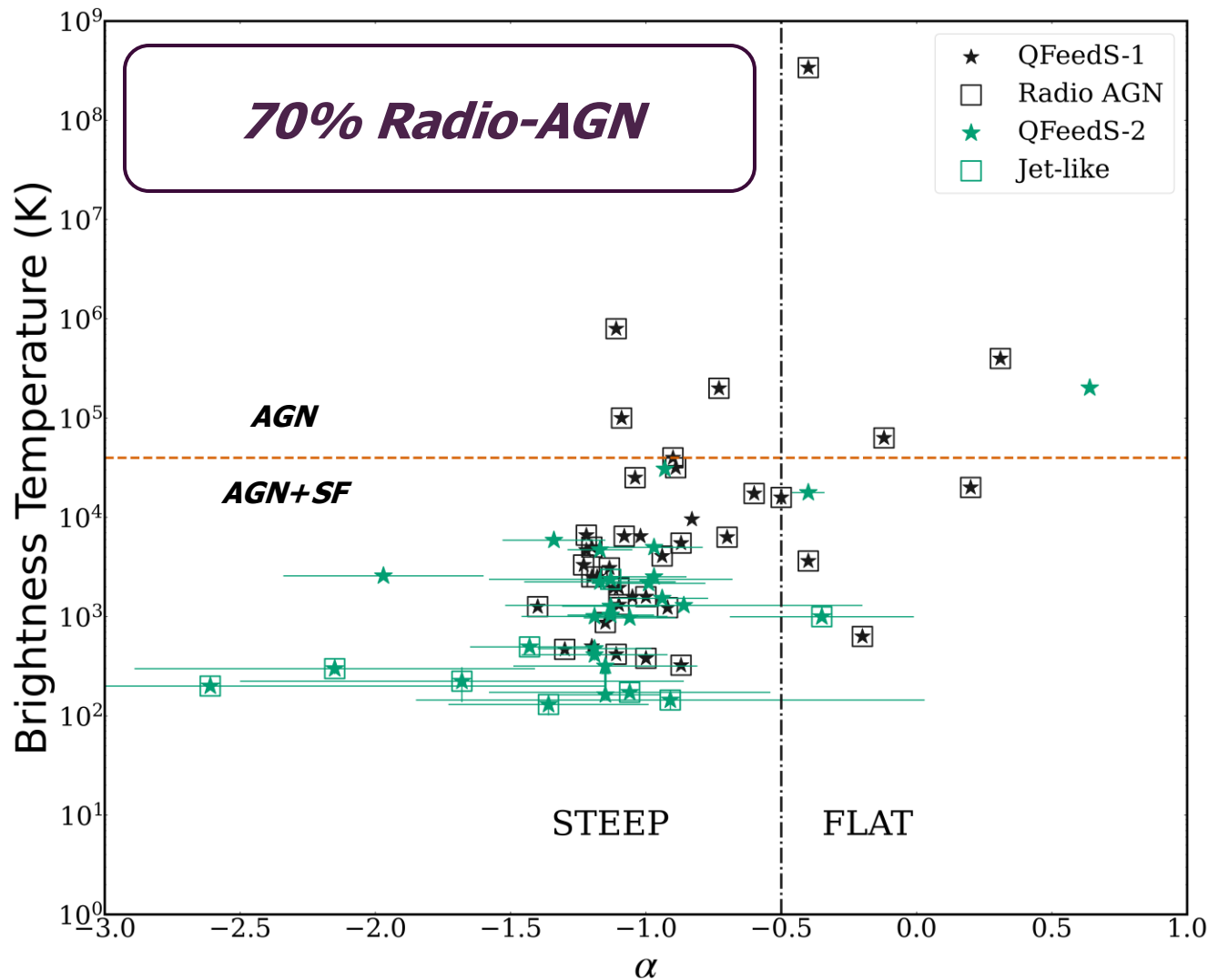
***Compact sources = 72%***

# Radio Morphology:



*Extended = 28%*

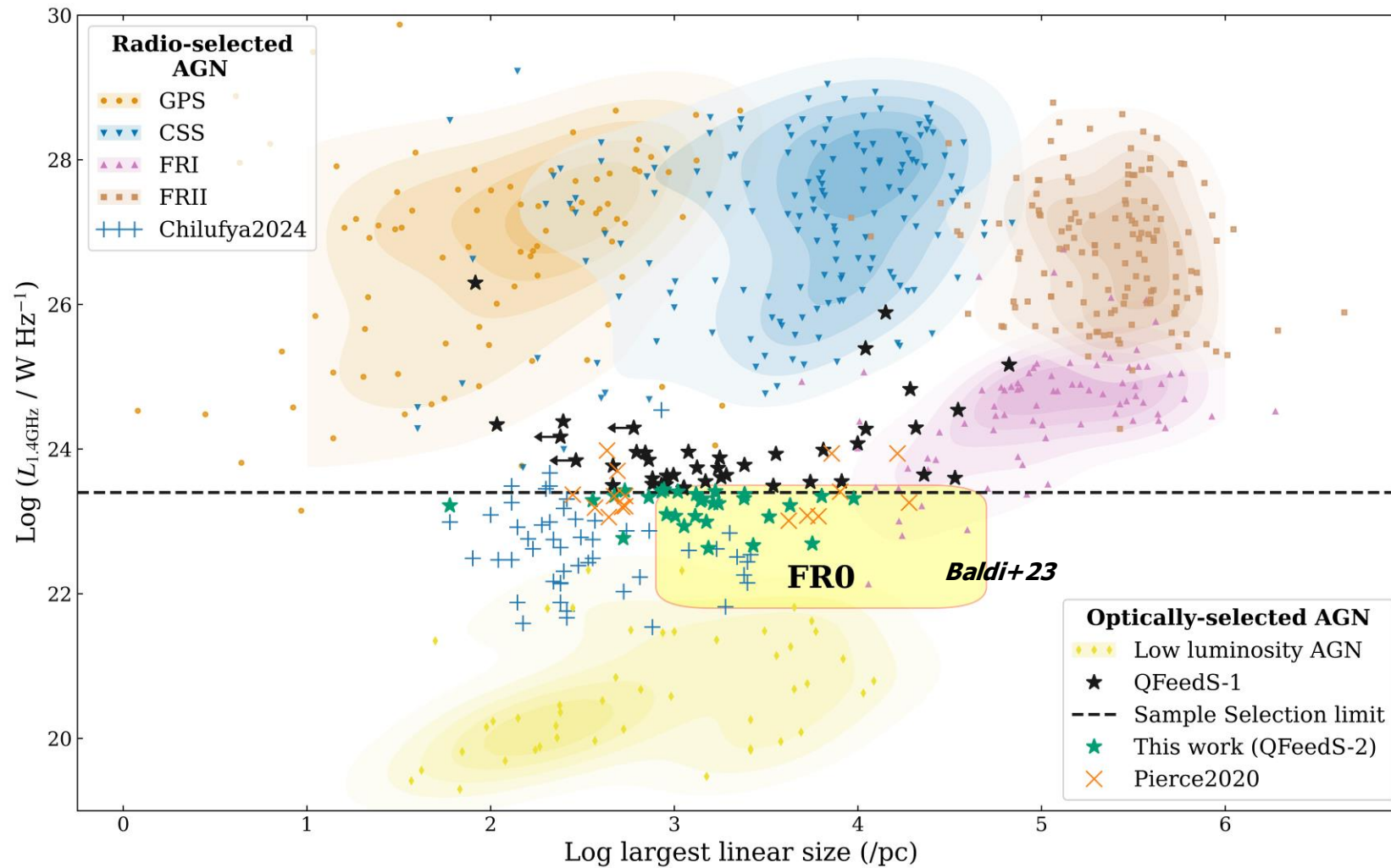
# Origin of radio emission:



- 1. Brightness temp
- 2. Spectral index
- 3. Radio morphology
- 4. Radio excess (QFeedS-2)

# Bigger picture? Low-Luminosity Objects:

18



**Njeri+26**

## ***Conclusion:***

**-RQQs can host AGN jets that may drive AGN Feedback at galactic scales**

**There is a strong connection between radio emission & galactic outflows in “radio quiet” quasars due to ~sub-kpc jets interacting with interstellar medium**

# Key takeaway + Future?:

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## Takeaway:

**Our findings support a scenario where low-power radio jets contribute to Maintenance/Radio-mode feedback in RQQs**

## Future:

**Largest sample of optical selected RQ 71  $z < 0.2$   
VLBI, ngVLA, IFU(MUSE/VLT), LOFAR**

## Question?

**With  $\sim 72\%$  QFeedS-2 (RQQs) lacking extended structure, showing steep spectra and sub-kpc confinement, do we redefine feedback not by absolute jet power, but by the local impact on the ISM?**

**Eg, Is there a threshold luminosity, jet power, or morphology below which feedback becomes ineffective?**

# AGN ON THE BEACH II

A multi-scale view of jetted AGN

21–25 September 2026  
Diani, Kenya

**Confirmed Invited Speakers**

Prof. Raffaella Morganti · RUG/ASTRON  
 Prof. James Chibueze · University of South Africa  
 Prof. Stas Shabala · University of Tasmania  
 Dr. Kristina Nyland · US Naval Observatory  
 Dr. Marisa Brienza · Istituto Nazionale di Astrofisica  
 Prof. Melvin Hoare · University of Leeds/DARA

**Local Organizing Committee**

Ann Njeri - Newcastle University - Chair  
 Isaac Mutie - Technical University of Kenya (TUK)  
 Paul Baki - TUK  
 Jack Radcliffe - University of Manchester  
 Dorcus Nthoki - TUK  
 Webber Chemonges - Kenya Space Agency  
 Shirley Aokoo - TUK  
 Winnie Wahome - University of Nairobi

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 Clive Tadhunter - University of Sheffield  
 Dipanjan Mukherjee - IUCAA  
 Ilaria Ruffa - INAF  
 Isaac Mutie - Technical University of Kenya  
 Isabella Prandoni - INAF  
 Leah Morabito - Durham University  
 Martin Bourne - University of Hertfordshire  
 Rob Beswick - University of Manchester  
 Sthabile Kolwa - University of South Africa

QR Code

Logos: DARA, Newcastle University, TUK, INAF, IUCAA, IANSA, Durham University, MANCHESTER, University of Hertfordshire, UH, The University of Sheffield

**Sept 21-25 2026**

**Diani Beach, Kenya**