Unveiling the Origin of Radio Emission in Nearby Low-Luminosity AGN with VLBI

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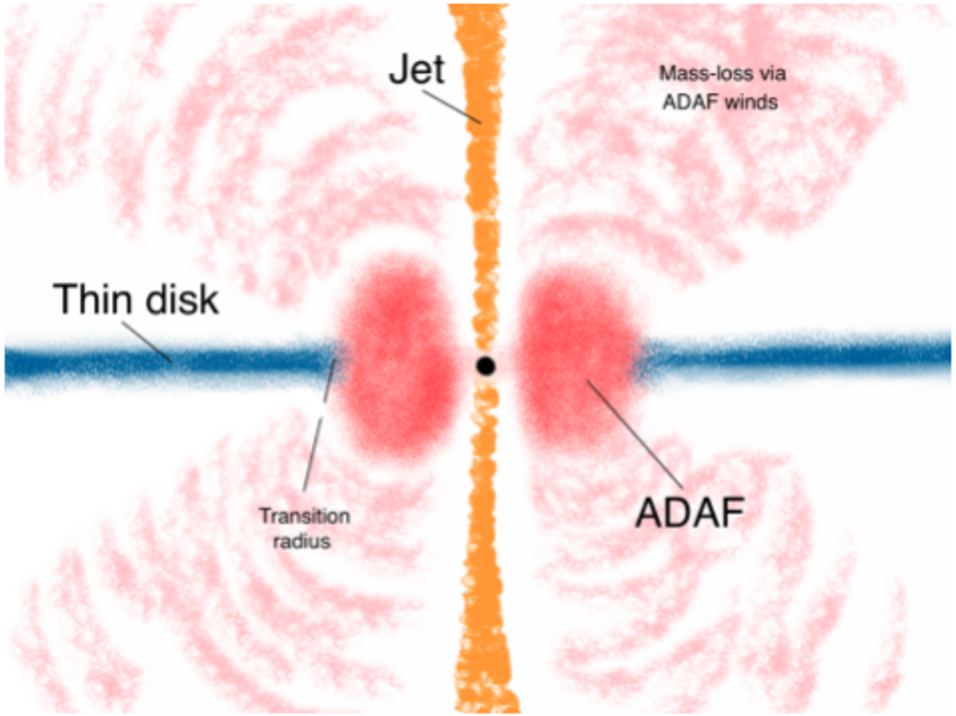
Low Luminosity AGN (LLAGN)

- $L_{bol} < 10^{42}$ ergs/s (Terashima+ 2000)
- $L_{H\alpha} < 10^{40}$ ergs/s (Ho+ 1997)
- 1/3 of nearby galaxies are LLAGN (Ho et al. 2000)
- Seyfert galaxies
- Low Ionization Nuclear Emission-line Regions (LINERs) - spectra like Seyferts but low ionisation lines
- “Transition” sources - spectra between LINER/HII regions

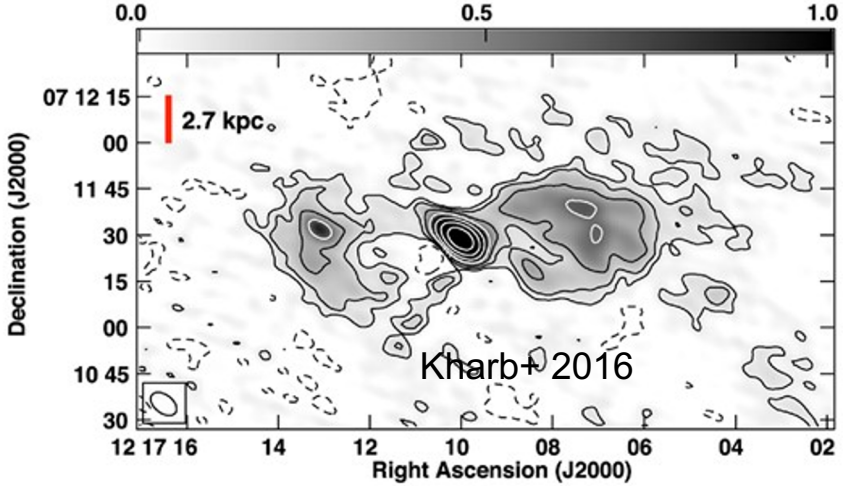
The Central Engine of LLAGNs

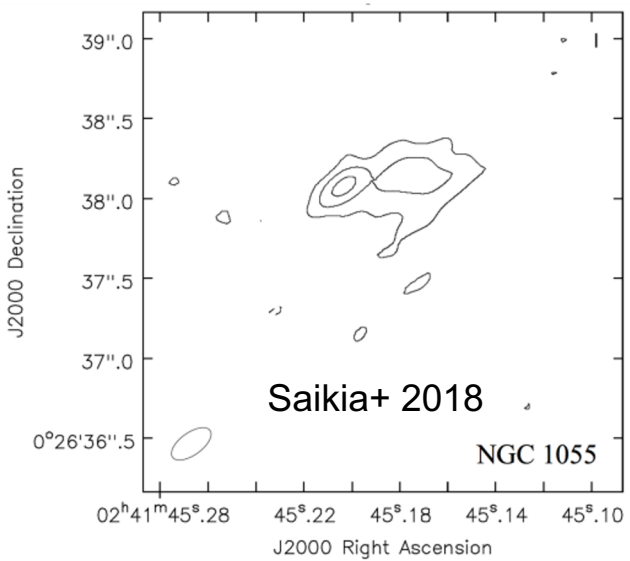
- Radiatively inefficient accretion flow (become advection dominated: ADAFs, BDAFs, ...)
- Truncated thin disk
- What about Jet/outflow?



(Nemmen et al. 2014, MNRAS)

Kiloparsec-scale radio structures

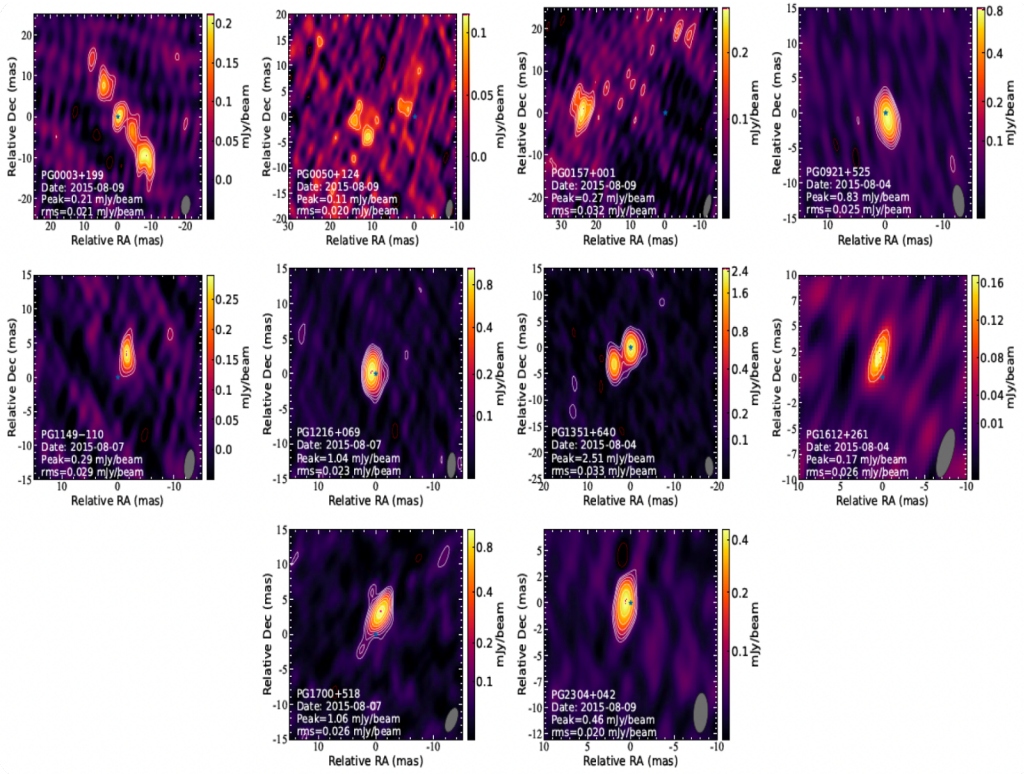




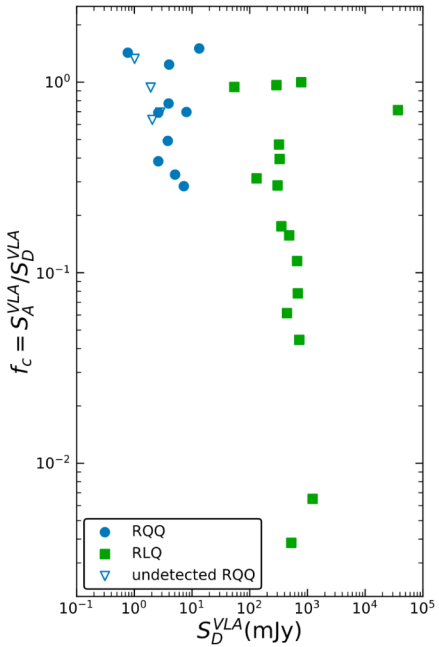
- 37% (18/48) galaxies detected with the VLA at 15 GHz. (Nagar+ 2000)
- 44% (19/43) show extended radio structures >1 kpc at 5 GHz with the VLA (Gallimore+ 2006))
- 60% (45/76) show pc/kpc structures at 15 GHz with the VLA (Saikia+ 2018)
- …

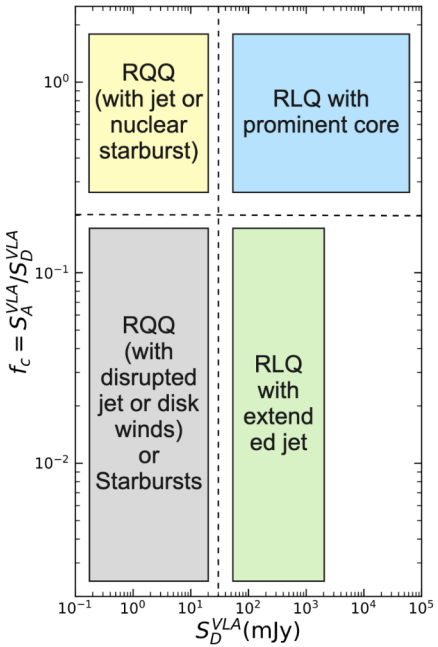
PG quasars with VLBI

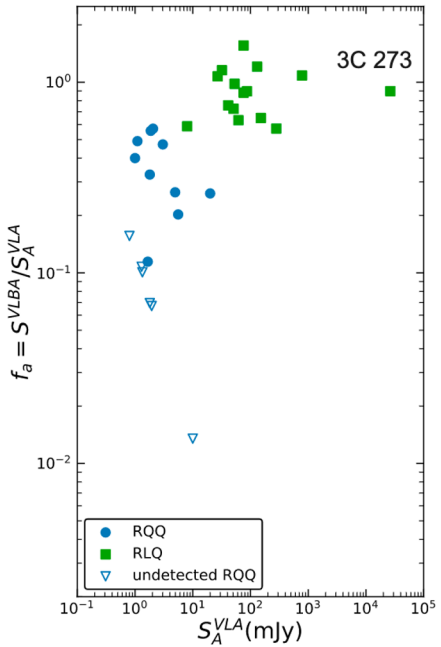
- 20 low-redshift (z<0.5) Palomar-Green (PG) quasars
- A single core or a 'core + one-sided jet' structure was revealed in all radio-loud PG quasars.
- Compact radio components are detected in 10 of the 16 RQQs, with a detection rate of 62.5%.

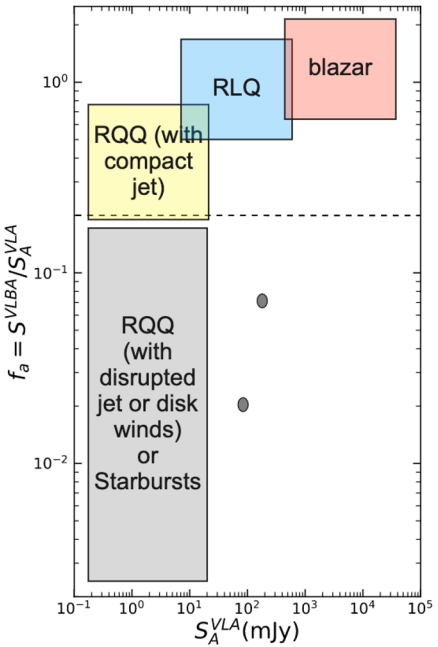


PG quasars with VLBI



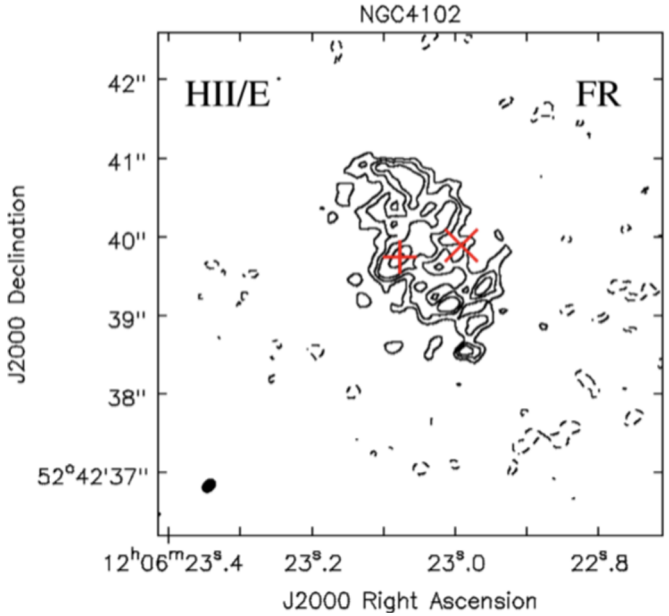


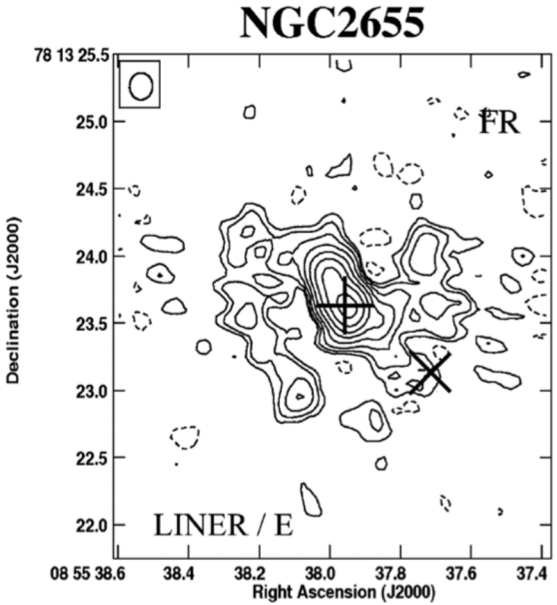




Wang+ 2022, in prep.

Radio structures with e-MERLIN (LeMMINGs)



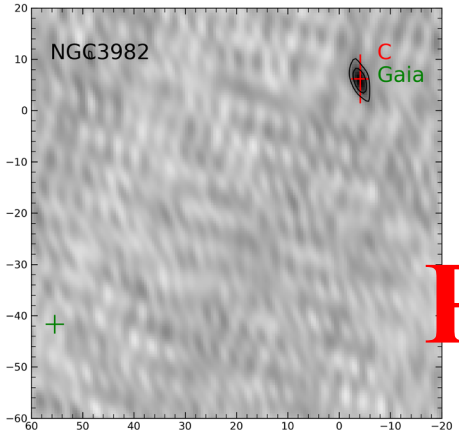


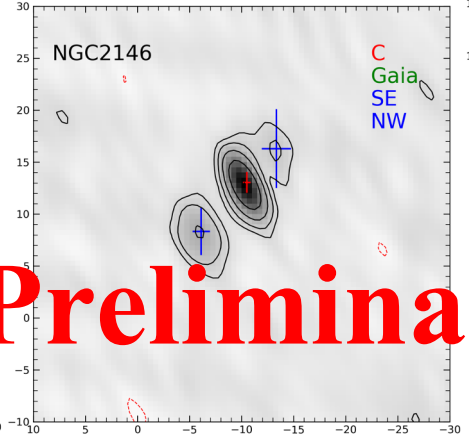
- 44.6% (125/280) galaxies detected at 1.5 GHz with the e-MERLIN (Baldi+ 2018,2021)
- 106 sources identified the core; 11 sources are jet dominated
- 47 HII galaxies detected , some shows jetted structures

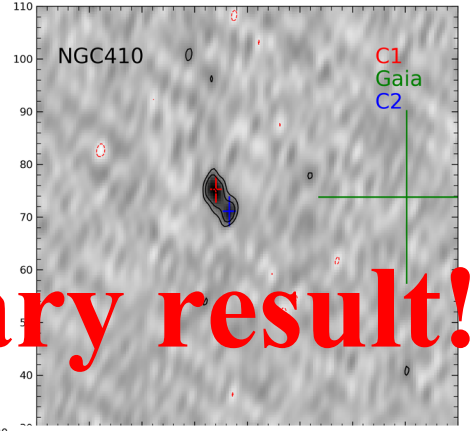
LeMMINGs with VLBI

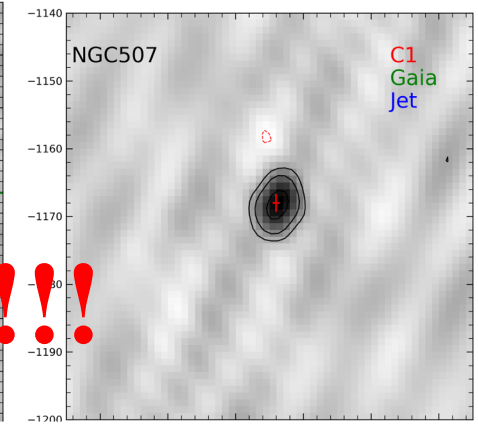
- 48 sources (flux density > 1 mJy, core identificated) selected from the LeMMINGs sample (125 sources)
- 36 sources (detected with e-MERLIN at 5 GHz) selected from the 48 sources
- 18 brighter sources observed at 5 GHz with the VLBA
- 18 weak sources observed at 5 GHz with e-EVN+ e-MERLIN
- 31/36 sources already observed (5 EVN sources left)
- 61% (19/31) sources detected at pc scales.

LeMMINGs with VLBI

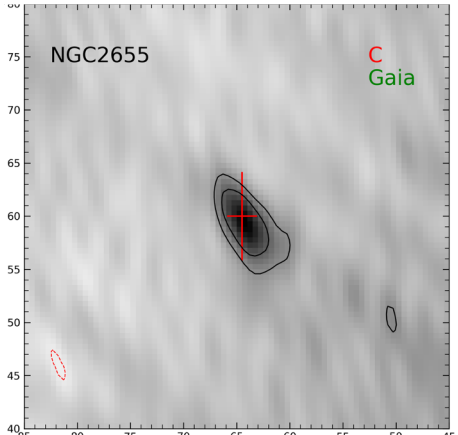


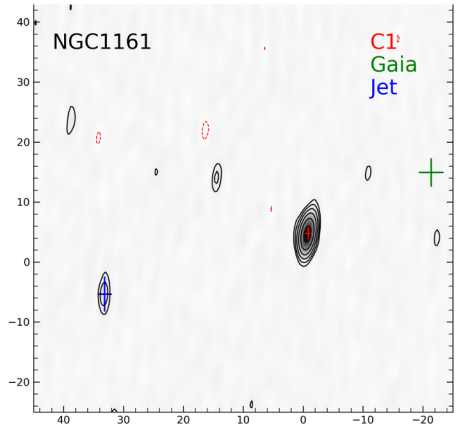


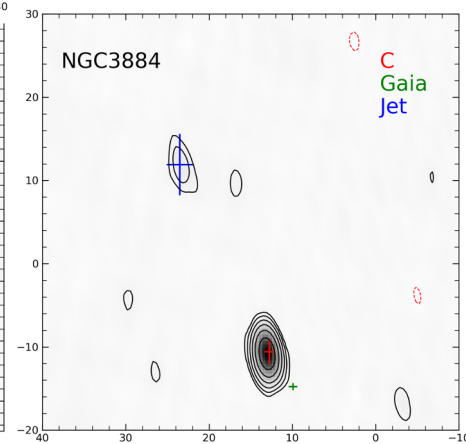


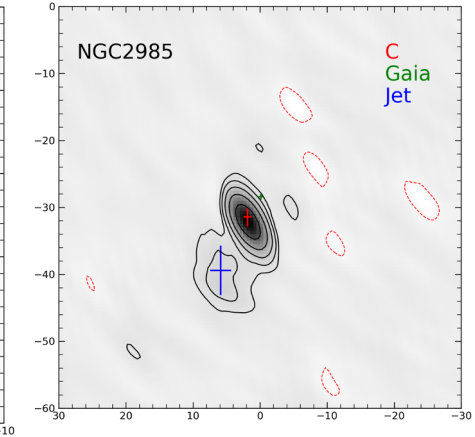


Preliminary result!!!



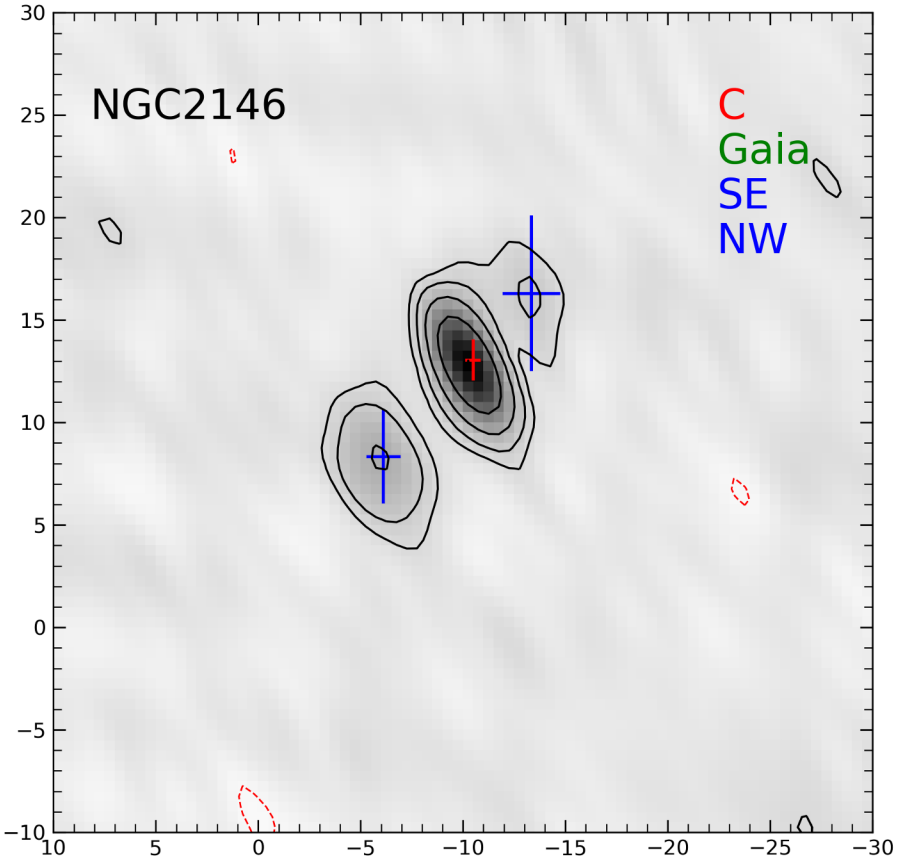






NGC 2146

- Only HII galaxy detected in VLBI
- Two-sided jet?
- $T_{b,core} = 4.2 \times 10^7$ K
- $S_{tot} = 1.73$ mJy



Future work

- Observe the remaining 5 sources.
- Data analyse: Model fitting, …
- Locate the positions at sub-milliarcsecond precision.
- Investigate the relationship between radio emission and other wavelengths.
- Sample to lower flux densities is needed.