

The life and times of

3C 236

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Motivation

3C 236 largest (in projection) GRG for decades
(lobes discovered by Willis 1974)

Re-started source (CSS core), possible sign for multiple activity on larger
scales (Barthel+1985)

Host galaxy ($z=0.1$) shows multiple starburst episodes
(Martel+1999, O'Dea+2001, Tremblay+2010, Labiano+2013)

Investigate source morphology at low frequencies

Trace older (low energy) particle population(s), infer activity history

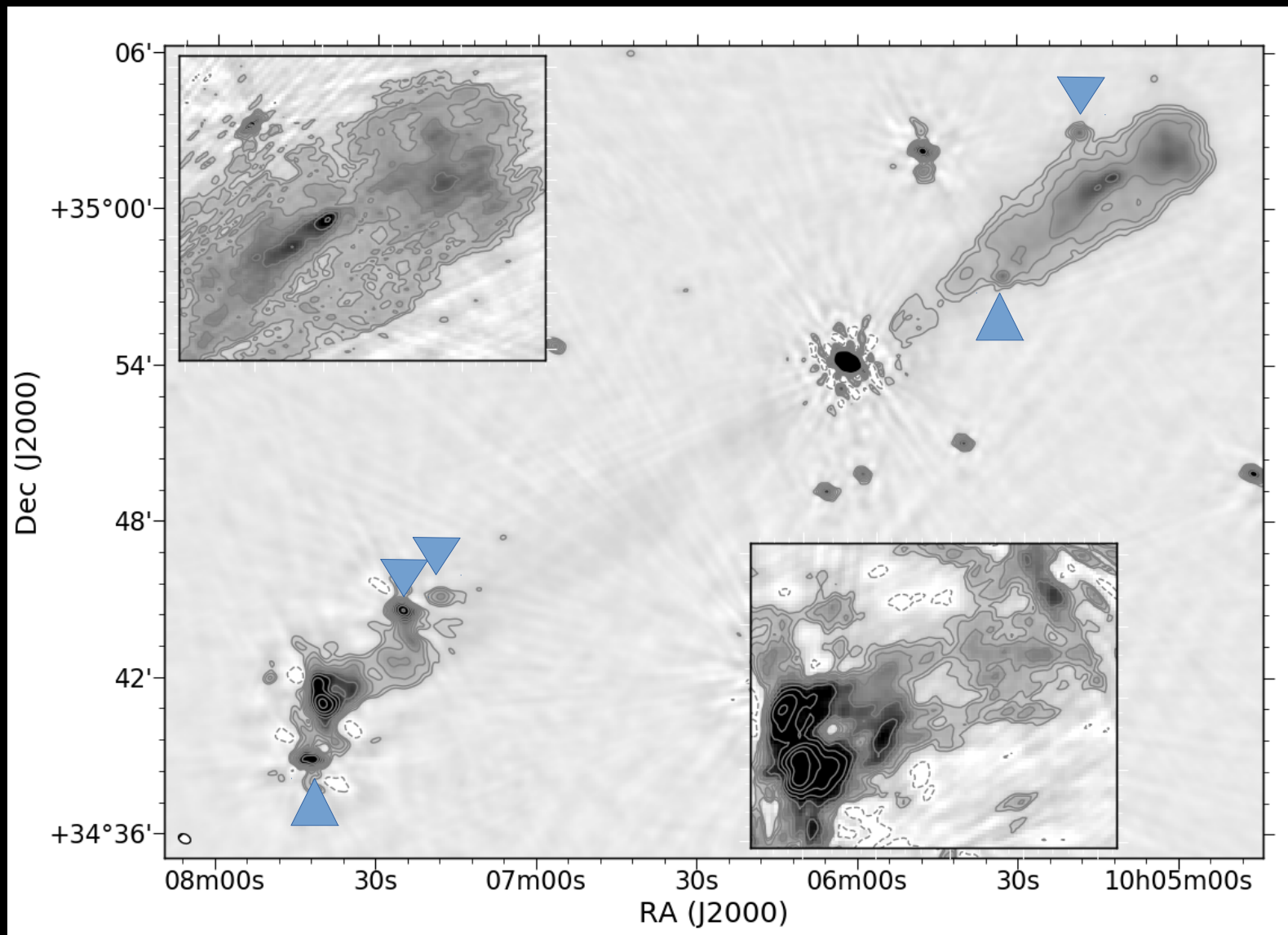
Data

LOFAR: 7.5h on target (interleaved mode, March 2014)
(3.5 hours left due to bad ionosphere), 143 MHz

WSRT map, Mack+1997, 609 MHz

NVSS map, 1400 MHz

143 MHz LOFAR

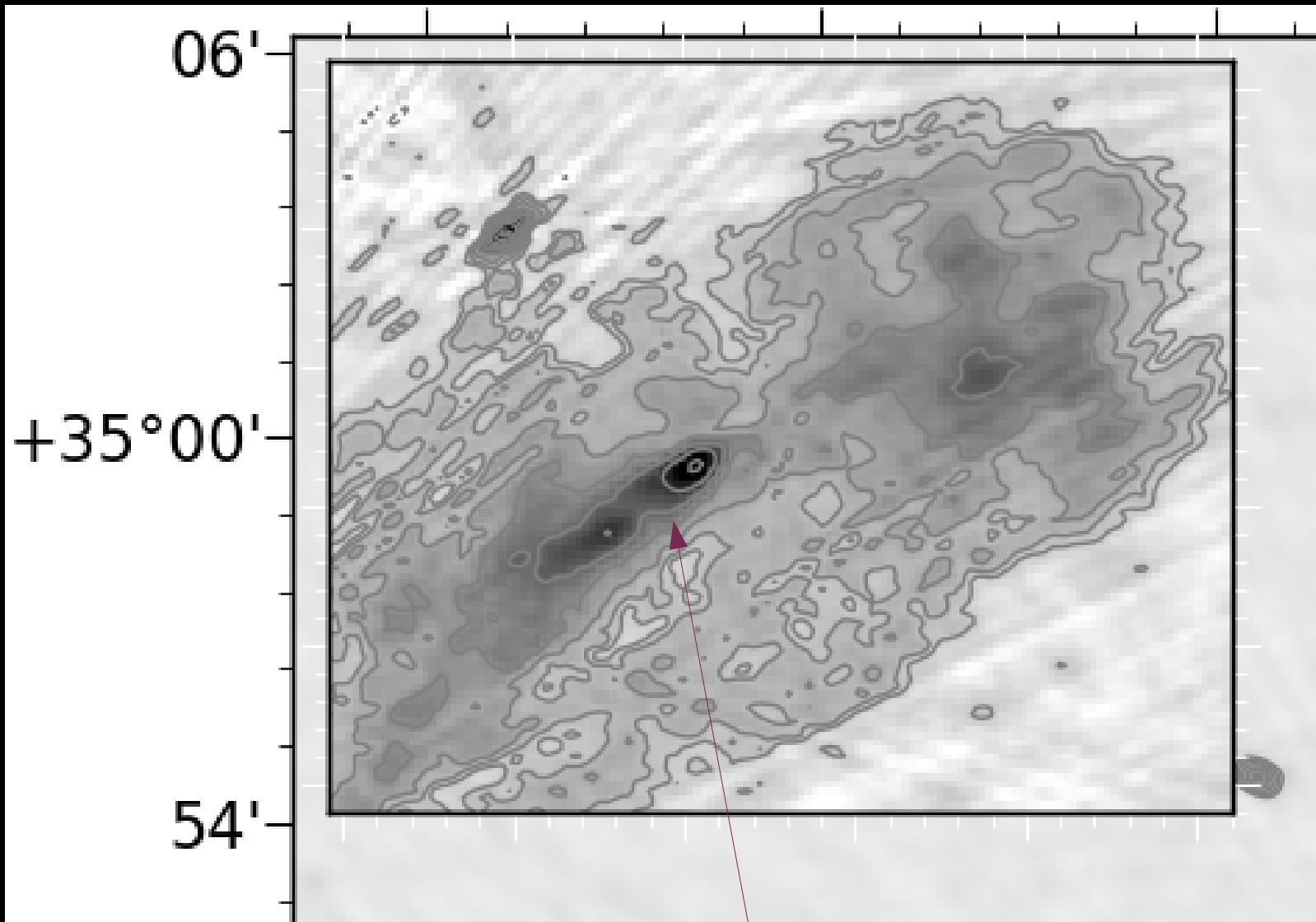


30" x 21" PSF, 1.3 mJy/PSF r.m.s. noise (inset: 7" PSF)

Point sources beyond the target located in the lobes marked by ▼

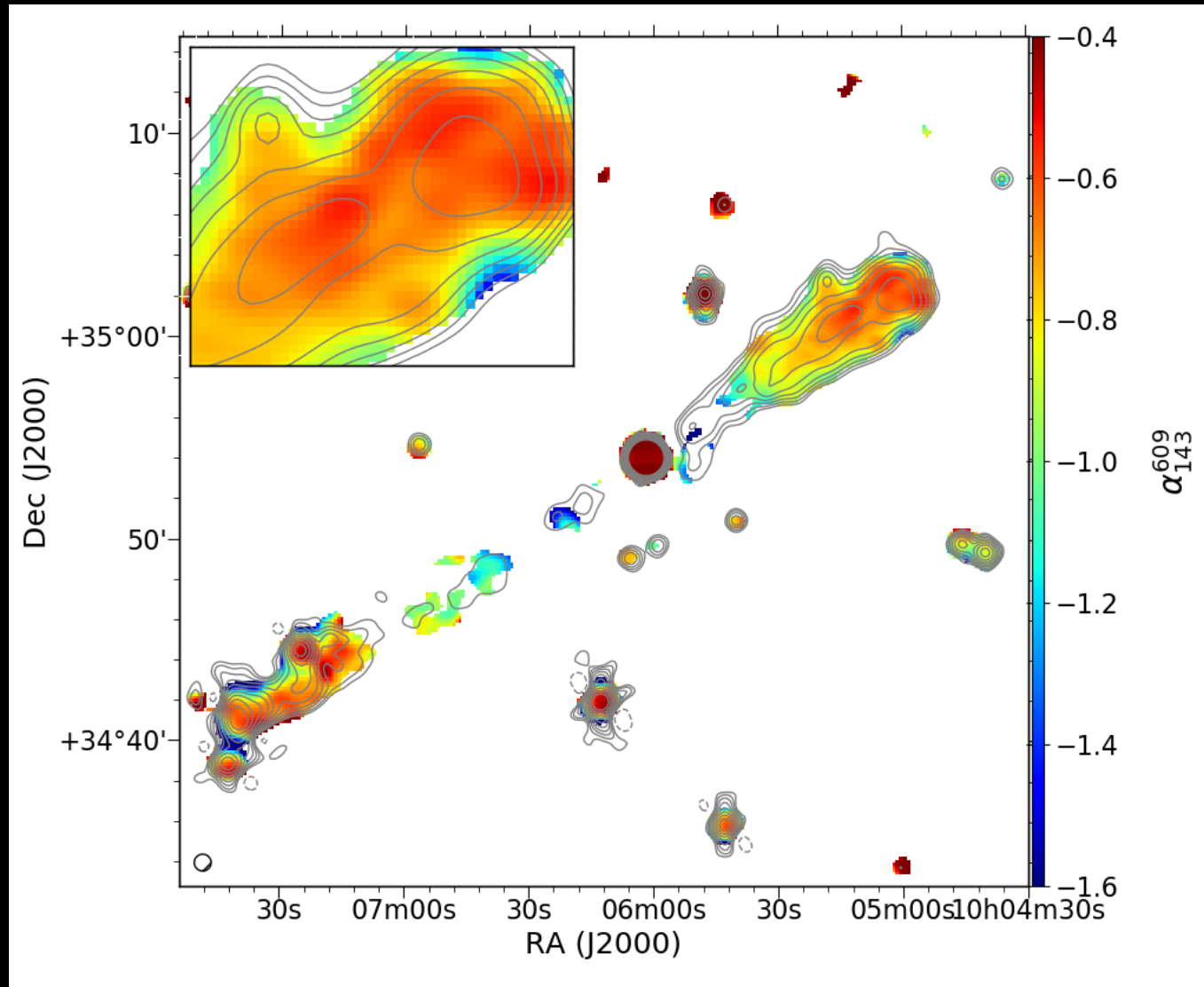
Note lobe asymmetry.

143 MHz LOFAR



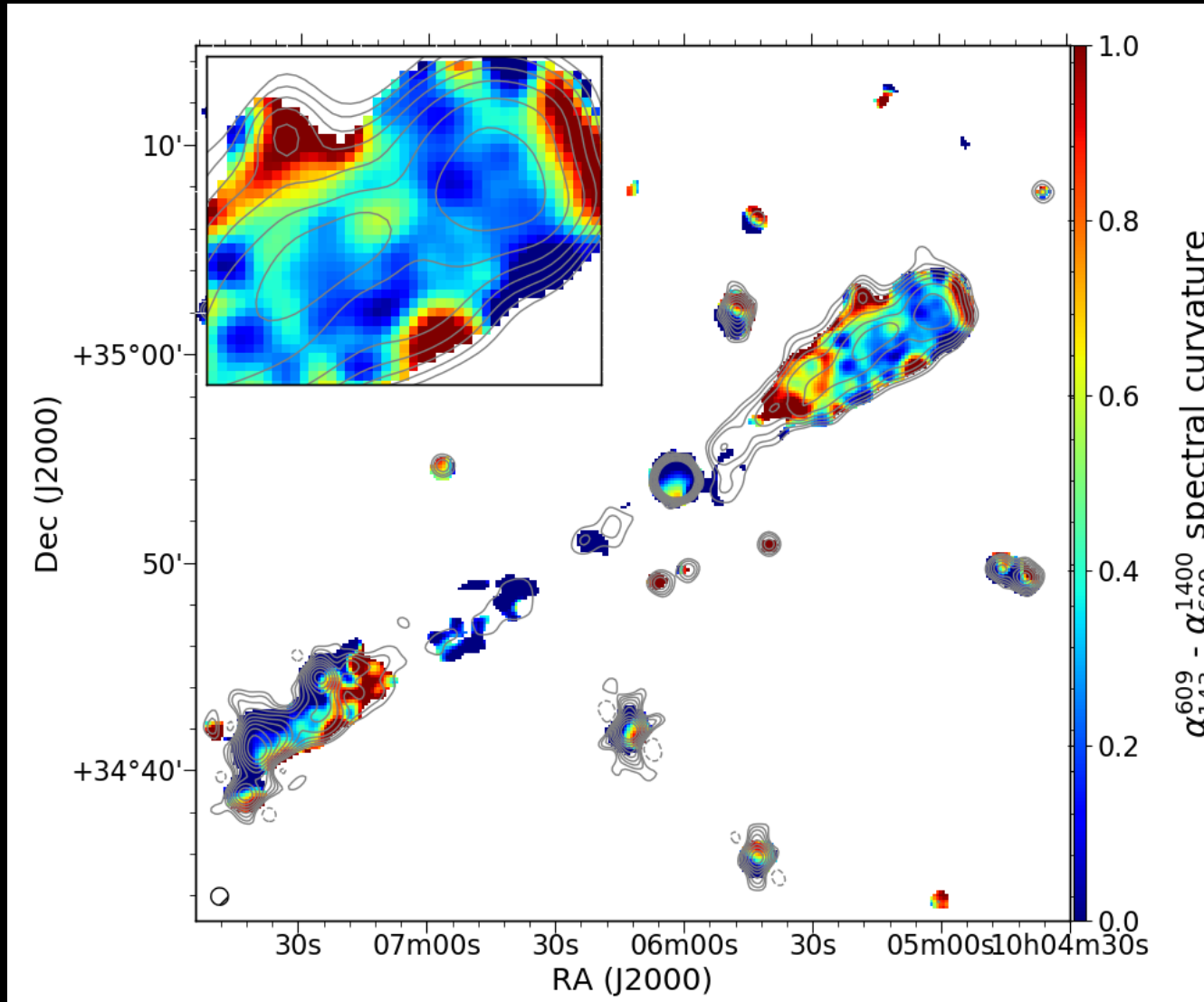
The “ridge” is now decomposed into hotspot(s). The NW lobe outer region is diffuse.

143 - 609 MHz spectral index map



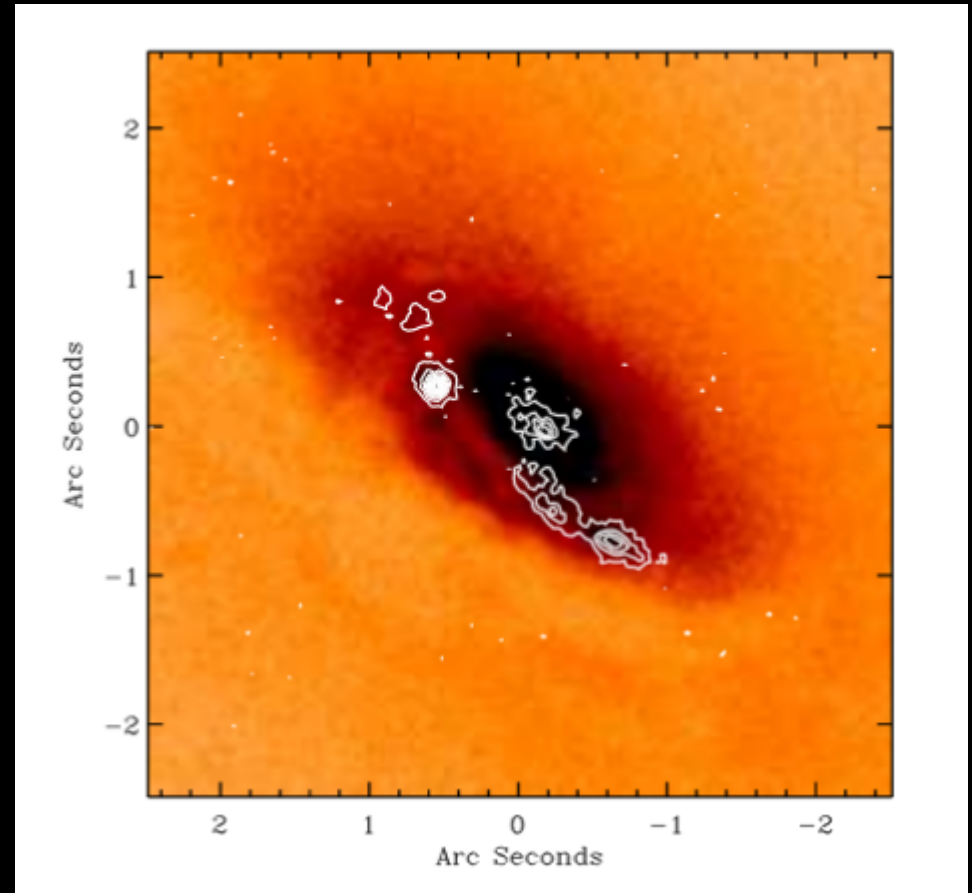
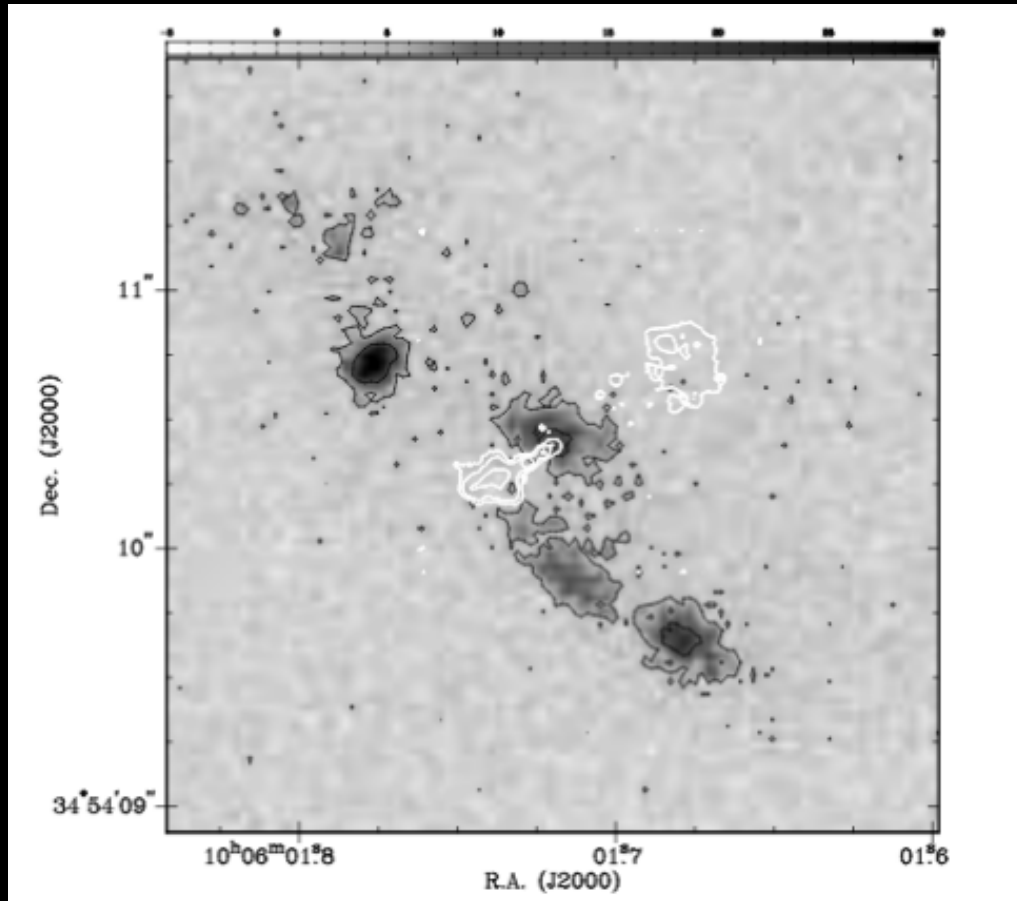
50" PSF, highest resolution so far extending to 144 MHz. Pixels above 5 sigma shown, LOFAR map contours. Inner hotspot visible (inset). Spectral steepening towards lobe edges, most prominent at SE lobe. Indication of different environmental conditions (expansion energy losses dominant)?

143 – 609 – 1400 MHz spectral curvature map



50" PSF, lower values indicate locations where the spectral index at higher frequencies has the same value as that at low frequencies. Core and hotspots remain flat, while lobe edges show spectrum steepens at high frequencies.

CSS core



Left: VLBI (Schilizzi+2001) overlay on HST STIS NUV (O'Dea+2001) Right: HRC V band and NUV contours from Tremblay+2010
CSS source aligned with large scale radio emission. Star formation in the nucleus supports at least two episodes of AGN activity.

Conclusions

Ridges of enhanced surface brightness connected to hotspots prominent in both lobes. These ridges are observable at low frequencies.

Inter-lobe morphological differences indicate possible environmental differences, NW lobe contained, SE lobe expanding in lower density environment.

NW lobe has an inner hotspot, evidence for 3 activity episodes, significant for a
GRG

Spectral mapping reveals ridges and hotspots show indication of spectral flattening, possible indication of older particle population, still retaining injection spectral index values. Energy losses towards core and lobe edges.

Spectral curvature indicative of very low energy particle lobe envelope, especially at SE lobe.

More maps at various frequencies needed to determine source ages and AGN duty cycle.