



AGN radio relics in the LOFAR sky

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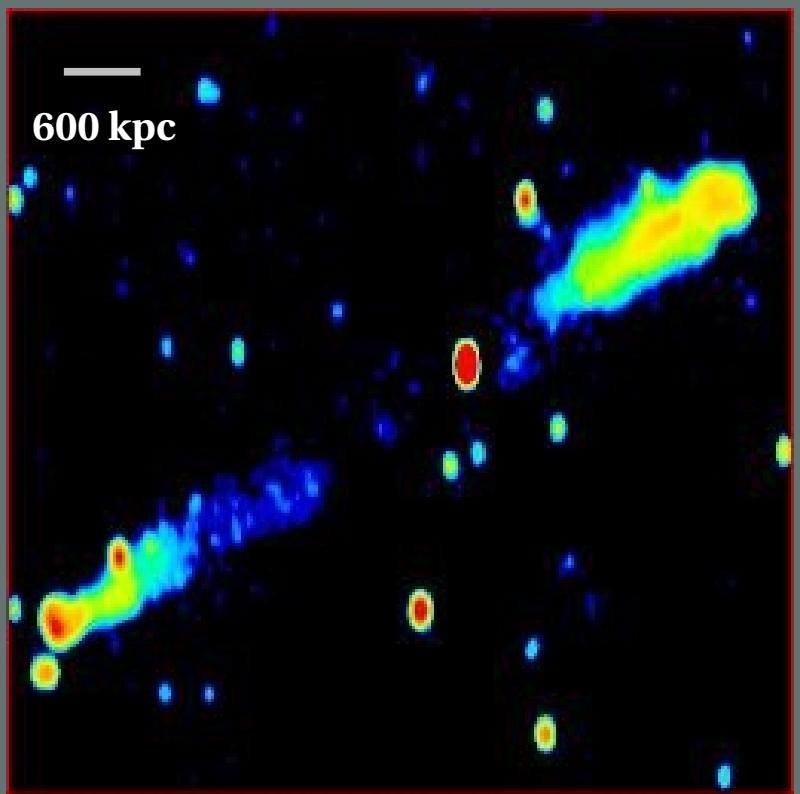
+ the LOFAR commissioning team

Ger-feest, Groningen, November 03–07, 2013

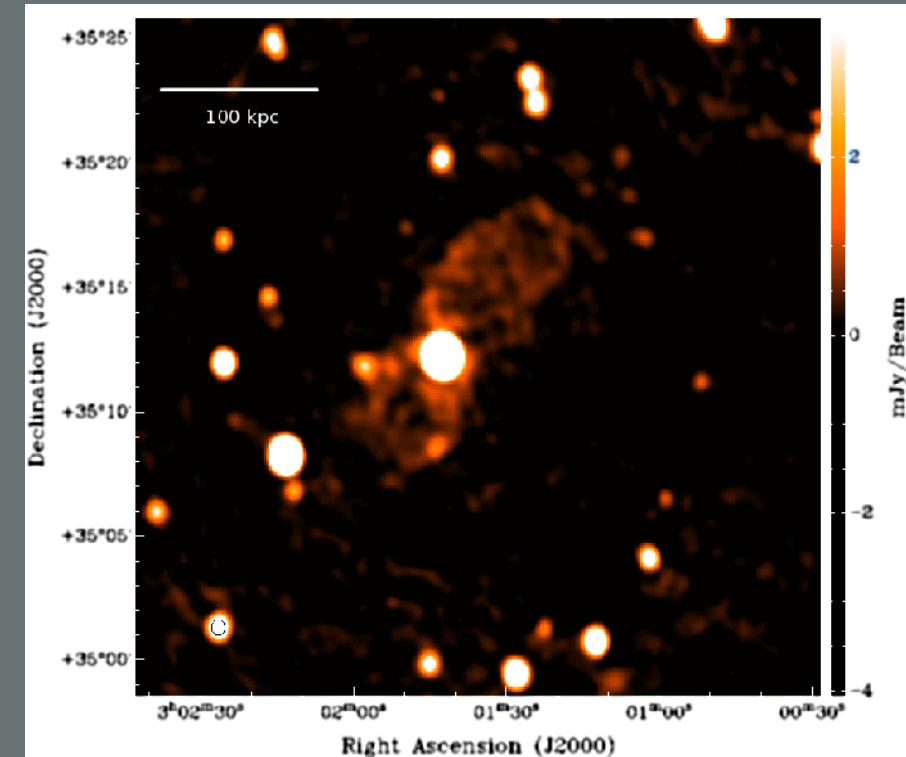


What are AGN radio relics?

- The only observable tracer of past AGN activity.

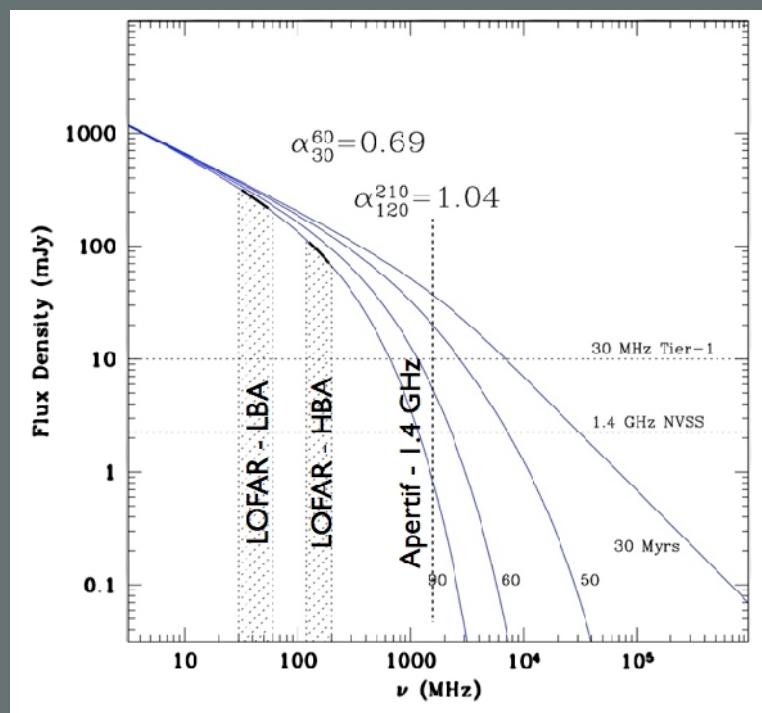


3C236 – 608 MHz, Mack+1996

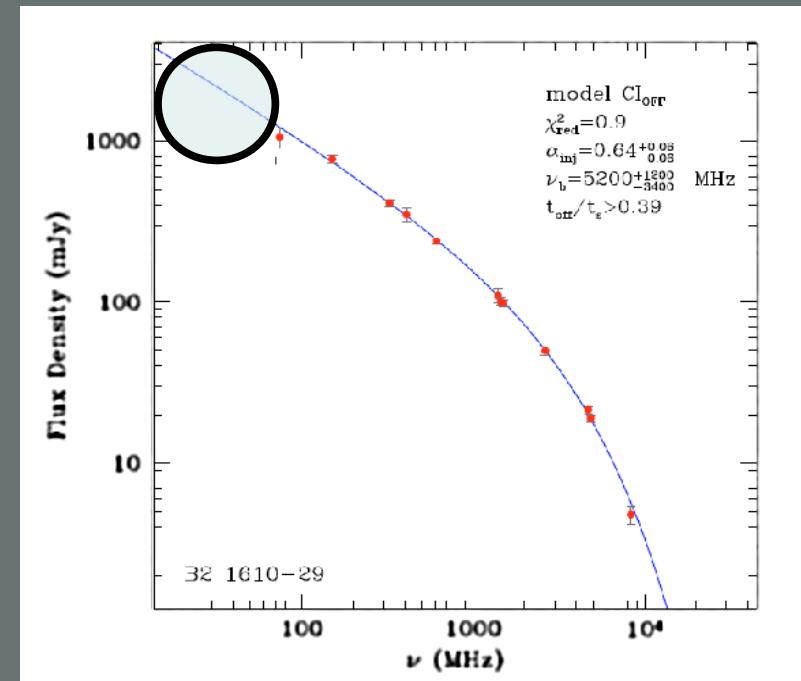


Radio relic around B2 0258+35 WSRT 1.4 GHz
Shulevski+ 2012

- We can determine their age through spectral index studies.



Spectral aging for synchrotron emitting plasma
- current and future surveys .

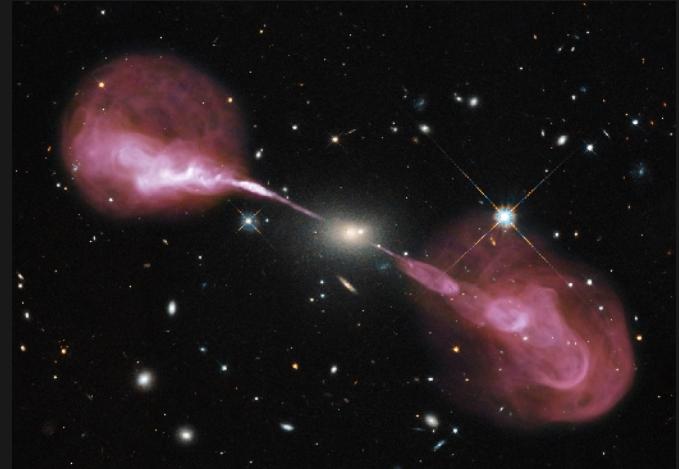


Spectrum of a radio relic showing age related curvature.
With LOFAR we can constrain the spectra at even lower frequencies.



Why are we studying AGN relics?

- Ascertain the duty cycle of the active nucleus.
(time between active epochs)

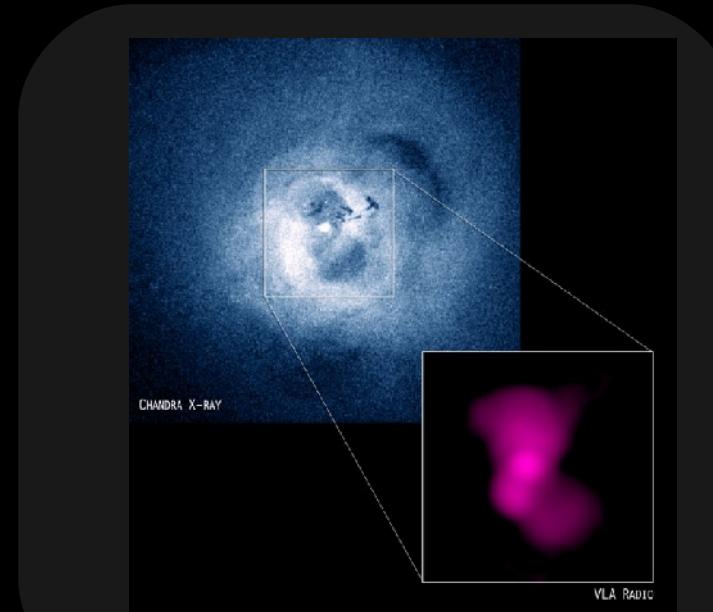


3C348 (Her A) JVLA + HST

- Impacts on AGN feedback:

Total energy / momentum
deposited over cosmic timescales in:

ISM -> interrupt / quench star formation.



IGM -> heating, impact on galaxy evolution.

Per A (X-ray + radio)



Case study 1: 4C35.06

LOFAR 61 MHz
new detections

Abell 407
Core: UGC 2489
 $z = 0.047099$

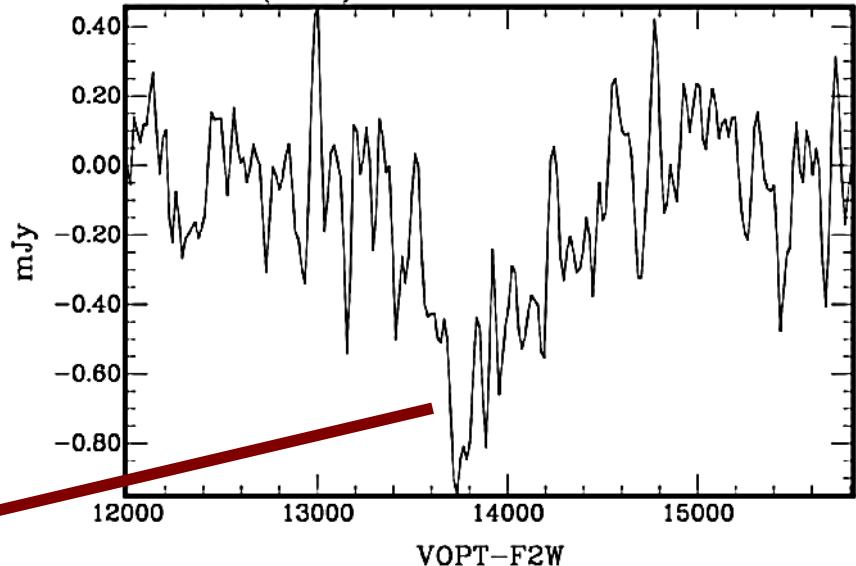
2 - 3 epochs of AGN
activity observed.

WSRT 1.4 GHz
VLA 4.89 GHz – contours



- HI in absorption detected
more in young and re-started
AGN
(Chandola +2010, Saikia+ 2009,
Morganti+2005, 2012).

Ra: 03^h 01^m 51.95^s (J2000)
Dec: 35° 50' 21.00" (J2000)



HI absorption profile observed
near the AGN host.

- Halo gas cooling and fueling
the AGN?

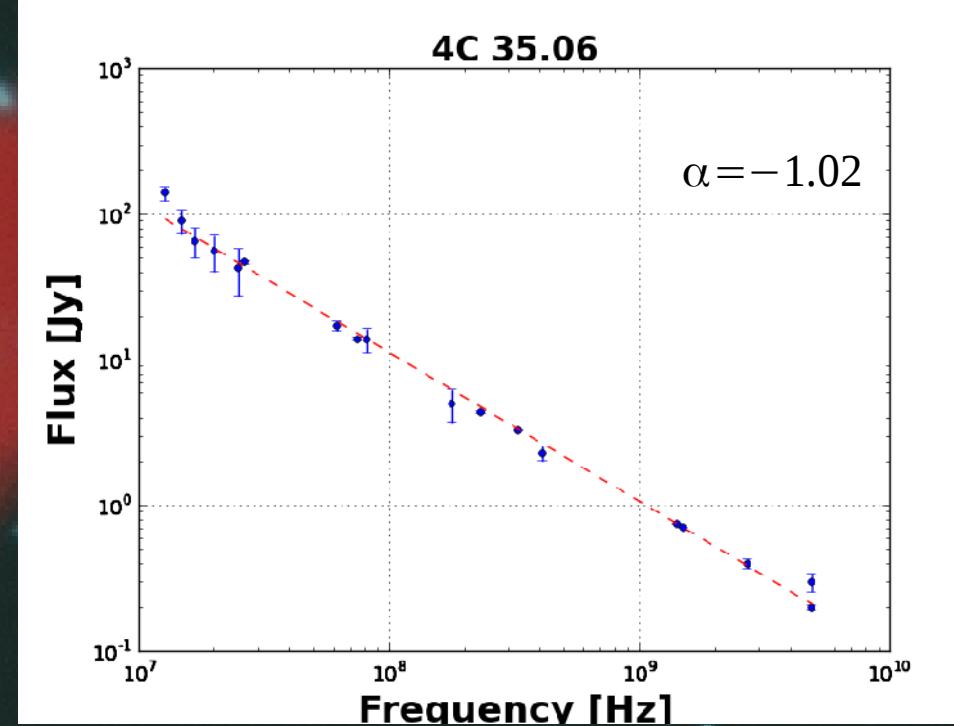


- We're seeing multiple AGN activity episodes.

- Emission alignment suggests one active AGN.

- Multiple epochs of activity of one AGN?

- Multiple AGNs active?



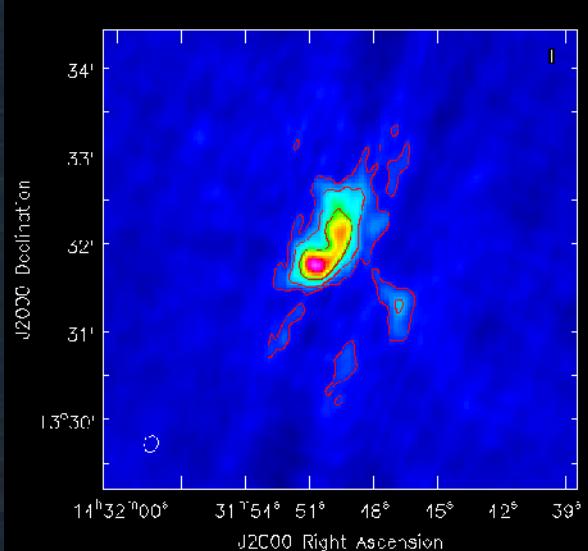
Integrated flux spectrum of 4C35.06



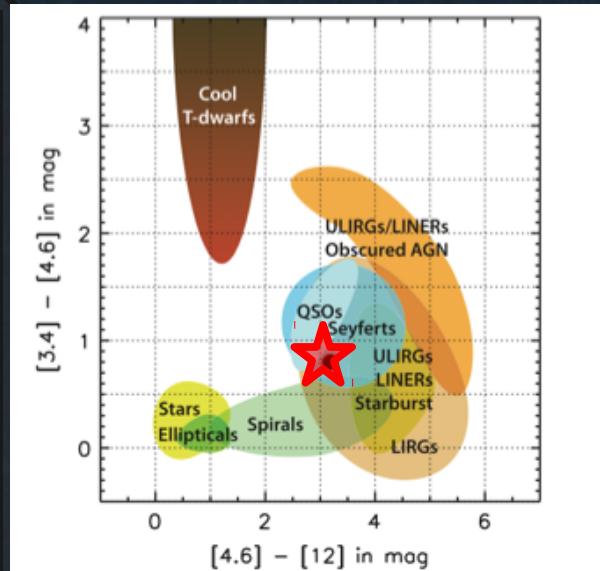
Case study 2: J1431+1331

Hosted by a cD galaxy
in a MACS cluster at $z = 0.1599$

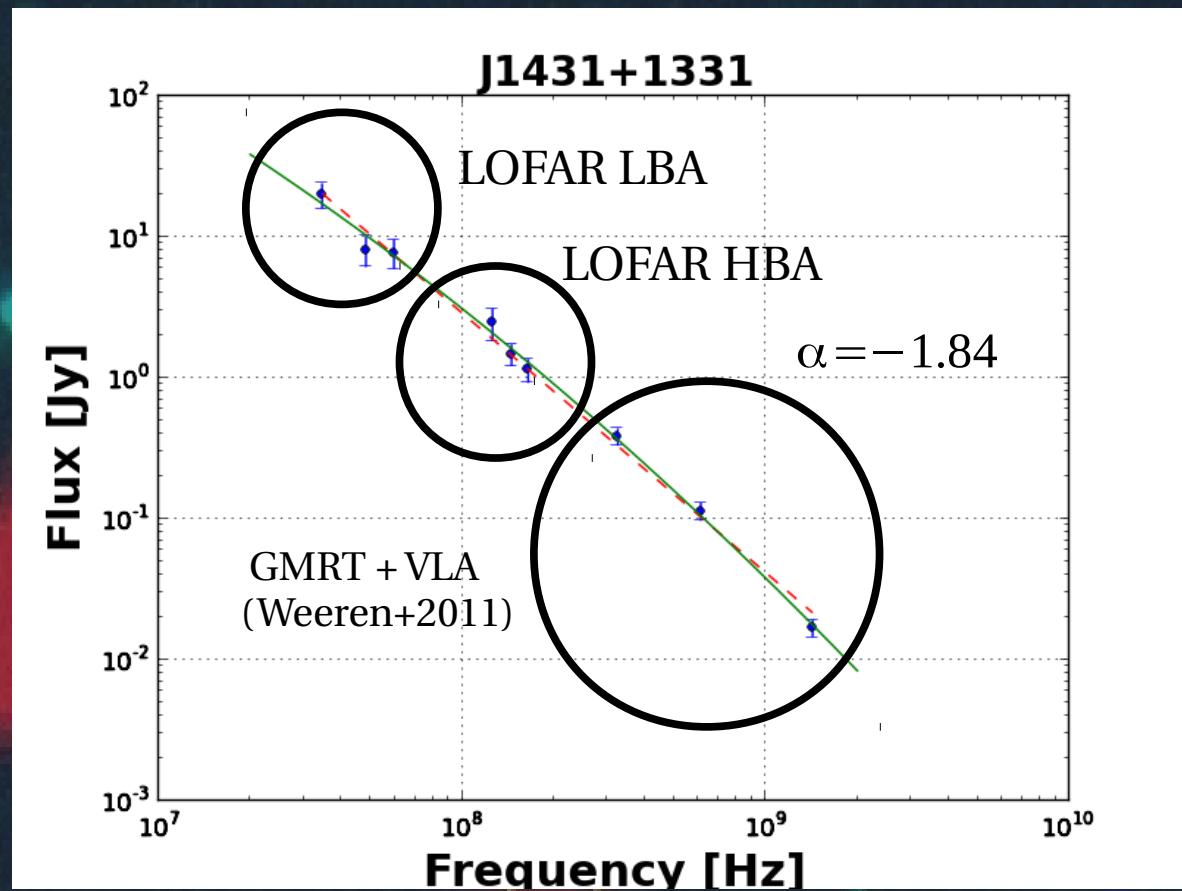
Steep spectrum – Weeren+2011
Shock rejuvenation? - Ogrean+2013
Active core visible in VLA maps.



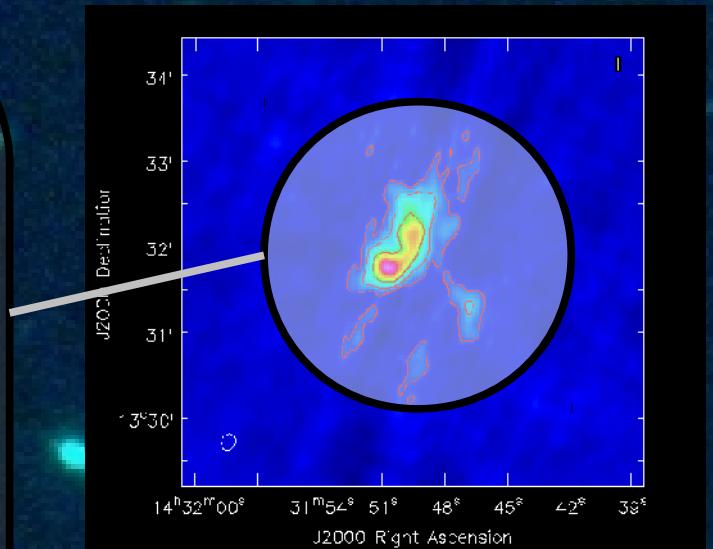
LOFAR 150 MHz.



Host WISE color suggests
an AGN.



Integrated flux spectrum of J1431+1331



- Goal: use data constraints to extract plasma age from a model (KP, JP).

- Future work: do plasma aging analysis over the resolved source at lowest frequencies using LOFAR.



Conclusions:

- Cycle 0 and 1 observations show LOFAR is able to detect new, diffuse emission with resolution below 10" at 140 MHz.
- Accurate flux measurements in LOFAR images still an issue.
- Sensitivity is improving as is higher resolution imaging at longer baselines.
- Will allow for blind searches for relics in the near future; ages can be constrained and more precise duty cycle measurements will follow.
- Synergy with HI studies to investigate AGN triggering mechanisms.