THE HIGH RADIO FREQUENCY VARIABILITY OF BRIGHTEST CLUSTER GALAXIES

With OVRO, KVN, NIKA2, SCUBA2 and ALMA

Tom Rose

with Alastair Edge, Sebastian Kiehlmann, Junhyun Baek, Aeree Chung and Jae-Woo Kim

Question: how variable are the cores of brightest cluster galaxies at high radio frequencies, where in they past they’ve not been observed in enough detail?
NGC 1275, BCG of the Perseus Cluster

- Archetype of a brightest cluster galaxy in a cool-core
- Gamma-ray detected radio galaxy
- BLLac/AGN hybrid

High radio frequency variability has been observed for ~60 years.

At 2mm, the core radio source has varied by a factor of ~15 over the last 60 years.
NGC 1275 varied by a factor of 15 at 5 GHz between ~1983 and 2003
Higher frequency monitoring of NGC1275 monitoring (from 2002 to 2012, Dutson+ 2014)
LINKING SPECTRAL INDEX CHANGES TO VARIABILITY

- Spectral index changes of the core relate to the variability
- Fading periods have a steeper spectral indices than outbursts
NGC 1275 varied by a factor of 15 at 5 GHz between ~1983 and 2003
MONITORING A LARGER SAMPLE OF BGCs

- NGC 1275’s core clearly varies a lot, but it’s an exception in having been observed over such a long period

- Is the variability of its radio core typical for a large galaxy?

- Is the variability related to the spectral index properties?
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- NGC 1275’s core clearly varies a lot, but it’s an exception in having been observed over such a long period.

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- Is the variability related to the spectral index properties?

SOLUTION:

- An OVRO 40m campaign from 2009 to the present day monitoring the 15 GHz variability of 20 X-ray selected BCGs.

- Combined with NIKA2, SCUBA2 (353 GHz), ALMA (100-200 GHz), and KVN (22 and 43 GHz) observations to monitor spectral index changes.
15 GHz LIGHTCURVES OF COOL CORE BCGs – LOTS OF VARIABILITY

Fluxes:
- OVRO 15 GHz
- KVN 22 GHz
- OVRO 15 GHz vs. SCUBA2 353 GHz
- KVN 22 GHz vs. KVN 43 GHz
- OVRO 15 GHz vs. NIKA2 150 GHz
- OVRO 15 GHz vs. ALMA ≈ 100 GHz

Spectral indices:
- OVRO 15 GHz
- OVRO 15 GHz vs. SCUBA2 353 GHz
- KVN 22 GHz vs. KVN 43 GHz
- OVRO 15 GHz vs. NIKA2 150 GHz
- OVRO 15 GHz vs. ALMA ≈ 100 GHz

Graphs showing variability in flux and spectral indices for various BCGs over time from Jan '09 to Jan '21.
All 20 BCGs show 20% variability on 3 year timescales

At least a third vary by 60% on 3 year timescales.

Variability is a universal feature, even for 'flat' spectrum sources.

In SZ calculations, it’s dangerous to assume any BCG point source to be constant.
Sources rising the most have flatter spectral indices.

For SZ studies requiring the subtraction of a continuum source, extrapolating from a lower frequency flux density made a few years earlier could involve a significant error due to variability *and* associated spectral index changes.
CONCLUSIONS

- All 20 BCGs show 20% variability on 3 year timescales
- At least a third vary by 60% over several years
- Variability is a universal feature, even for ‘flat’ spectrum sources.
- In SZ calculations, it’s dangerous to assume any BCG point source to be constant

Sources rising the most have flatter spectral indices...

... so making spectral index estimates is very unreliable when flux measurements are separated by a few years, even in ‘flat’ spectrum sources