Clusters' far-reaching influence of narrow-angle tail radio galaxies [2107.00449]

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1. What is a NAT?

NAT stands for **narrow-angle tail**, and is in reference to radio galaxies that have had their jets bent behind them such that the angle between their lobes is acute This is usually due to **ram pressure** exerted by the surrounding gas.

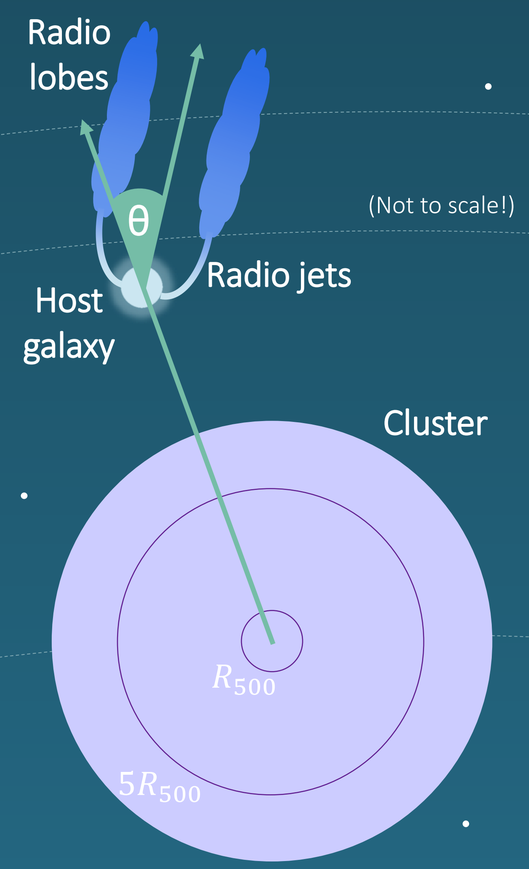
We use a sample of **208 NATs** identified by Mingo et al. (2019) from the **LOFAR Two-Metre Sky Survey (LoTSS) DR1**, and a cluster catalogue compiled by Wen et al. (2015) from the **Sloan Digital Sky Survey (SDSS) DR8 & DR12** to match NATs to clusters. This is the largest study of NATs in clusters to date.

LOFAR is the best tool for finding NATs, as the low frequency at which it detects radio sources allows the telescope to trace synchrotron emission from the electrons at the furthest tips of the source's lobes, thus imaging the NAT's larger tail structure.

2. So how do you calculate a NAT's orbit?

The offset of the radio lobes behind the NAT's host galaxy compared to the position of the cluster centre tell us which direction the galaxy is travelling on the plane of the sky, as shown in the diagram in the centre.

This results in NATs with tails pointing away from the cluster centre **(inbound)** having an **orbital angle of 0°**, and NATs with tails pointing towards the cluster centre (**outbound)** having an **orbital angle of 180°**.

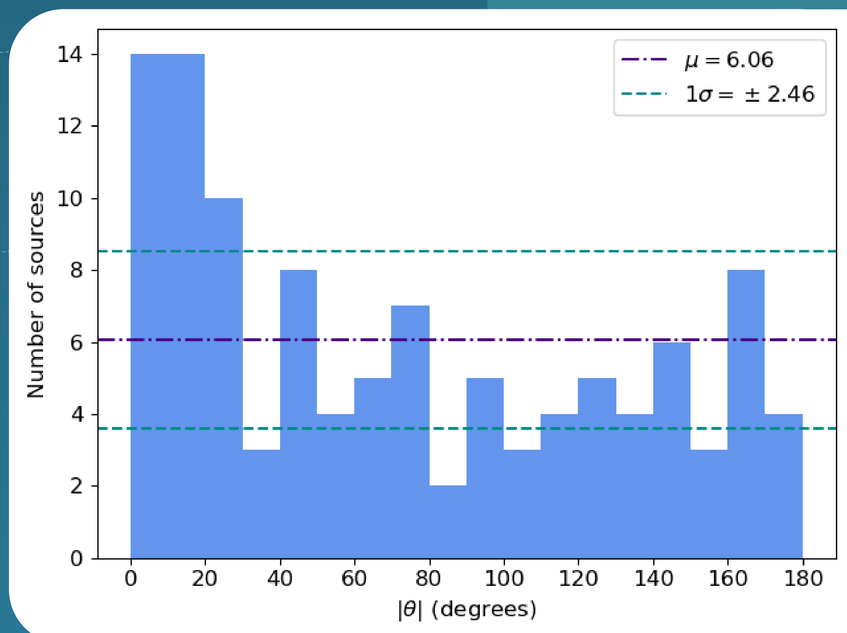


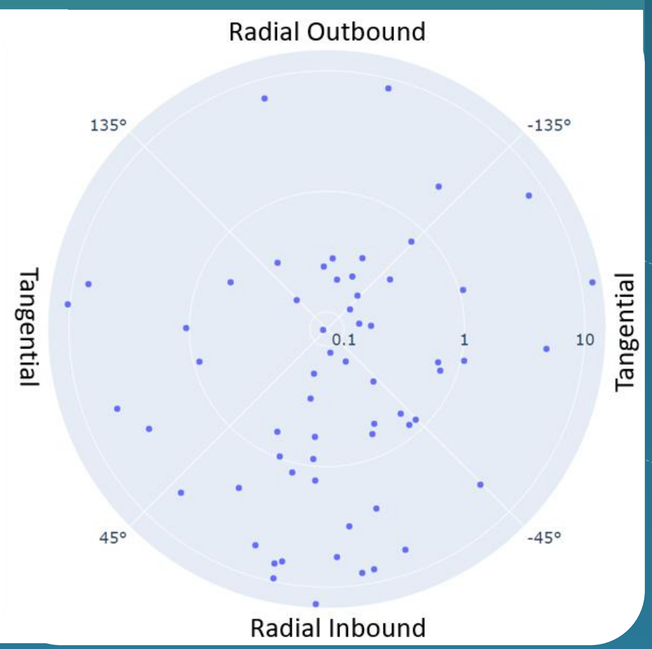
3. Results: radially infalling NATs in filaments

Producing a histogram from these orbital angles shows that NATs are primarily on **radially infalling** orbits, significant to the 99.99% confidence level. The histogram below contains non-BCG NATs out to $7R_{500}$, which is an unexpectedly high radius at which to see NATs travelling towards the cluster centre.

The polar plot below shows the orbital angle vs. R_{500} of NATs that are spectroscopically confirmed to be associated with the velocity dispersion of their matched cluster. NATs on radially inbound orbits still make up a large portion of this reduced sample, and can be seen to as far out as $10R_{500}$!

Since this is far past the **cluster outskirts**, and NATs have to be in a dense enough environment for their lobes to be bent behind them as they travel, we deduce that they must be falling through **filaments** towards the cluster centre. We aim to confirm this in future work.





• Mingo B., et al., 2019, MNRAS, 488, 2701 • Wen Z.L., Han J.L., 2015, ApJ, 807, 178 • de Vos K., et al., 2021, MNRAS, accepted for publication