AGN feedback from radio galaxies
when surveys and cosmological simulations meet

Leah K. Morabito[1]
C. Laigle[1], M. Jarvis[1], A. Slyz[1]

Introduction

It is widely accepted that active galactic nuclei (AGN) feedback is necessary in cosmological simulations to reproduce observable properties of galaxies in the local Universe, but the details of the physical processes are difficult to isolate. Powerful radio galaxies are clear candidates for providing AGN feedback, and observations from new, deep radio surveys offer a unique method to study how the evolution of some of the most massive galaxies is impacted by the presence or absence of large-scale radio jets. By comparing these observations with the most advanced cosmological simulations, we hope to advance our theoretical understanding of AGN feedback in these powerful radio galaxies.

Powerful radio galaxies

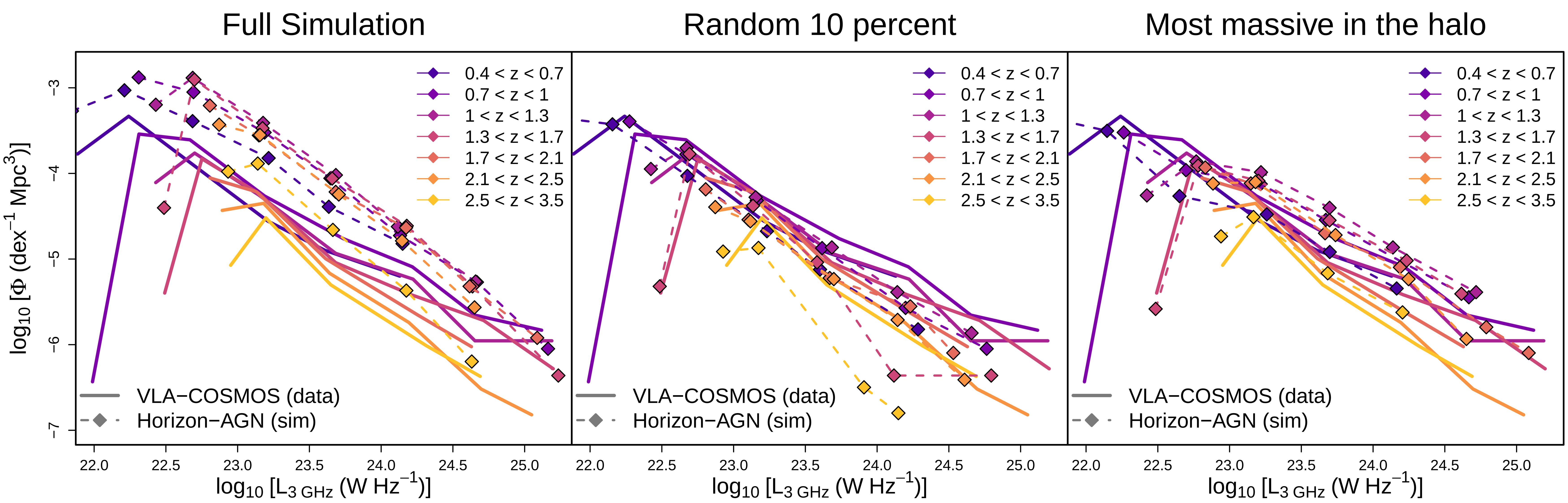
About 10 percent of all AGN produde relativistic jets of plasma that can reach sizes of hundreds of kpc. These jets emit synchrotron radiation, which we observe at radio wavelengths. Radio jets can interact with both their local (e.g., Morganti et al. 2016) and extended (e.g., Carilli et al. 1994) environments, and can be aligned with star forming regions (e.g., Chambers et al. 1987). The radio jets of Cygnus A (left, red) support bubbles in the X-ray emitting gas surrounding it (blue). These interactions can help shape galaxy evolution directly by changing local conditions; or by changing conditions in the IGM, affecting surrouding galaxies.

The Simulation: Horizon-AGN

Horizon-AGN is a cosmological hydrodynamical simulation (Dubois et al. 2014) enclosing a cube with sides of $L = 100\,\mathrm{Mpc\,h^{-1}}$. Horizon-AGN is one of the first simulations to include radio emission, which is modelled using analagous relations between accretion rate and radio emission in X-ray binaries (see Slyz et al. 2015 for details). We use a light cone of 1 deg^2 extracted from Horizon-AGN (Laigle et al., 2018) to create a mock catalogue matching the properties of the observations.

The Observations: VLA-COSMOS

The VLA-COSMOS 3 GHz Large Project (Smolčić et al. 2017) covers 2.6 deg^2 to a depth of 2.3 $\mu\mathrm{Jy\,bm^{-1}}$ with 0.75″resolution. Ninety-three percent of the radio sources are successfully cross-matched with optical, near-infrared, and mid-infrared counterparts. This deep ancillary data provides redshifts and enables the division of the sample into star-forming galaxies, radio AGN with jets, and radio-quiet AGN.



Results + Ongoing Work

In the figure above we test different methods of selecting which AGN have radio jets, and compare observed and simulated radio luminosity functions. On the left is the full Horizon-AGN simulation, where all AGN are labelled as having radio jets if their accretion efficiency is $\chi > 0.01$. In the middle we select a random 10 percent of AGN with $\chi > 0.01$ as having radio jets. On the right is a more physically meaningful AGN selection: only the most massive AGN in the top 10 percent of most massive halos are radio-jetted AGN. The final selection method was based on observational trends (e.g., Best et al. 2005), and matches the luminosity functions fairly well. Ongoing work includes comparison with a new, multi-band radio survey of XMM-LSS (Very Large Array at 1.5 GHz and the Low Frequency Array at 150 MHz). In the near future, Square Kilometre Array pathfinders like MeerKAT will provide deeper radio data to push down to the radio-faint AGN population.

References Best et al., 2005, MNRAS, 362, 25; Carilli et al., 1994, MNRAS, 270, 173; Chambers et al., 1987, Nature, 329, 604; Dubois et al., 2014, MNRAS, 444, 1453; Laigle et al., 2018, MNRAS, 474, 5437; Morganti et al., 2016, AN, 337, 199; Slyz et al., 2015, EXTRA-RADSUR2015, 52;

[1]University of Oxford

Questions? Comments? Let us know!
leah.morabito@physics.ox.ac.uk