The curious case of X-shaped radio galaxies: Back-flow Model

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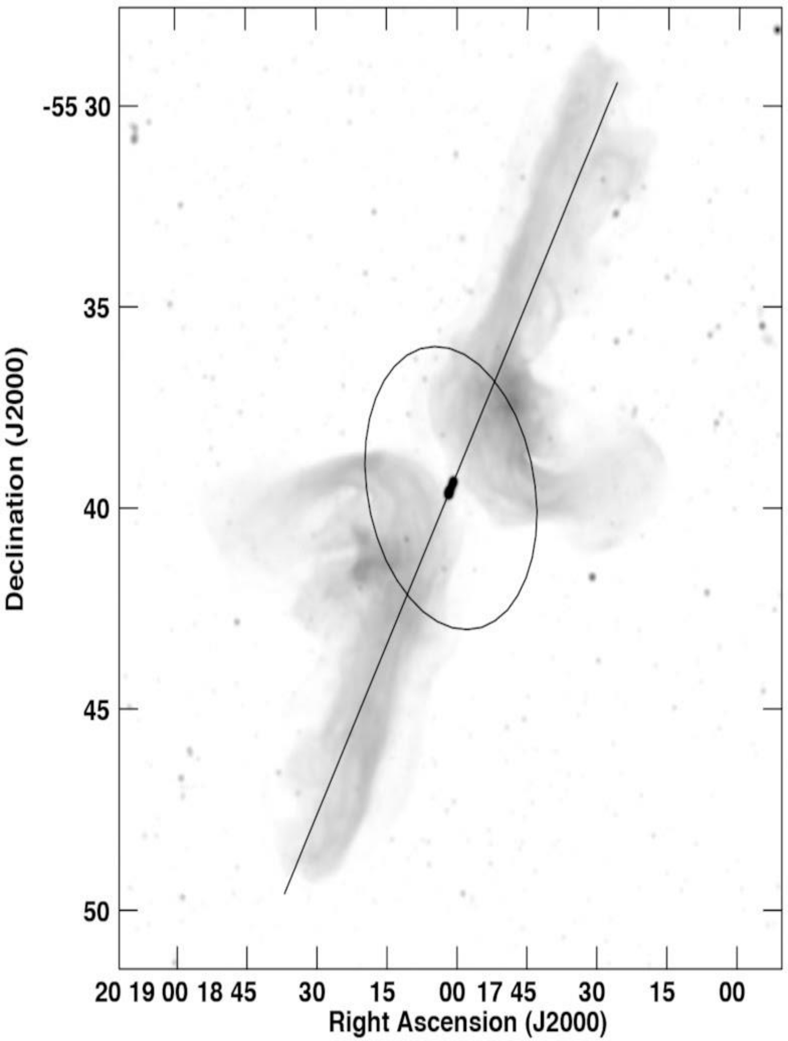
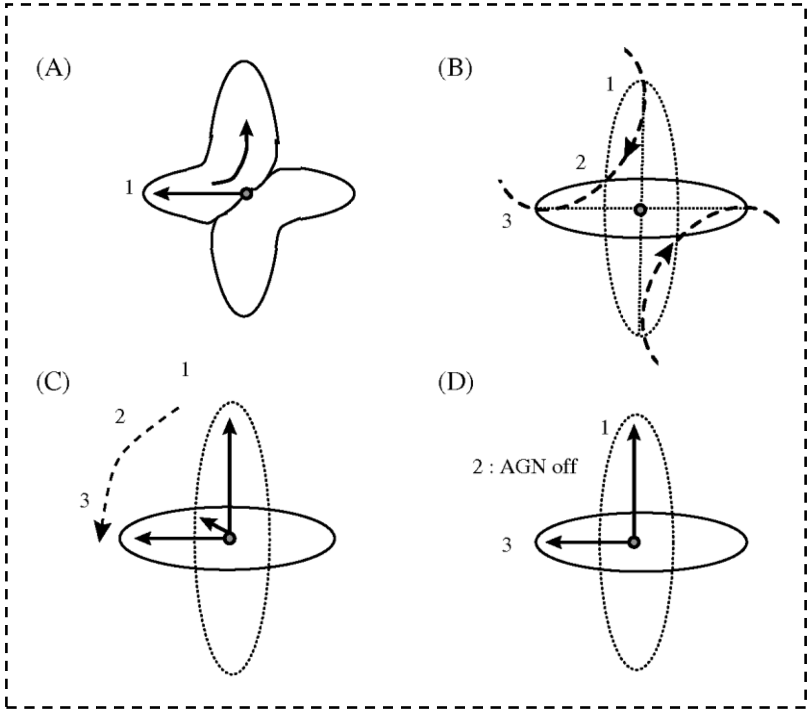
X-shaped radio galaxies



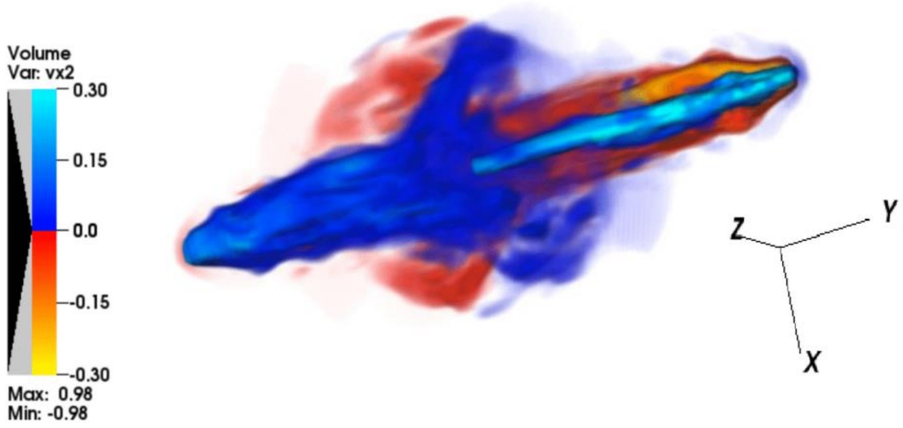
- Image of **PKS 2014-55**, an X-shaped radio galaxy, observed at a frequency of 1.28 GHz with the size of it's host galaxy overlaid on it, providing a strong evidence for the Back-flow model (Cotton et al. 2020).



- **Back-flow model** (Capetti et al. 2002)
- **Jet precision** (Dennett-Thorpe et al. 2002)
- **Jet reorientation** (Hodges-Kluck et al. 2010)
- **Dual AGN** (Lal & Rao 2007)

- Our goal is to study the formation and evolution of these galaxies due to the Back-flow model using numerical simulation where we have focused on both the **dynamical** and **emission** perspective of it. These simulations are executed using the relativistic-MHD module of PLUTO code (Mignone et al. 2007).

Results: 3D



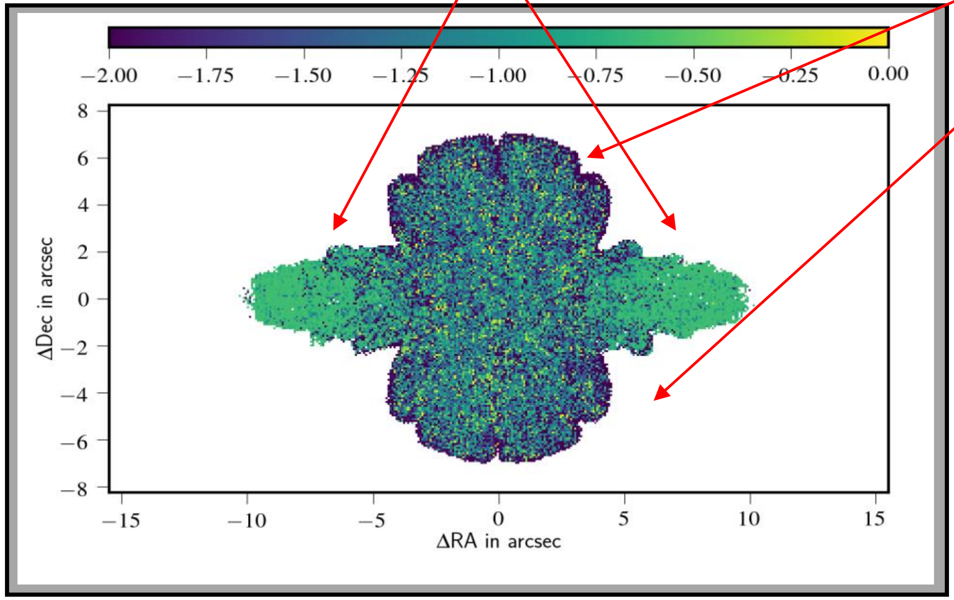
- **The top panel** demonstrates the velocity distribution (v_y) for our 3D case, viewed from an angle to the jet ejection axis (Y). It shows the formation of the back-flowing jet materials at the jet head and their accumulation in the wing (Rossi et al. 2017).

- **The bottom panel** demonstrates the spectral index (α) map of the galaxy constructed using frequencies (*ν*) 144 MHz and 5GHz indicating that the wings consist of steep spectral index values.

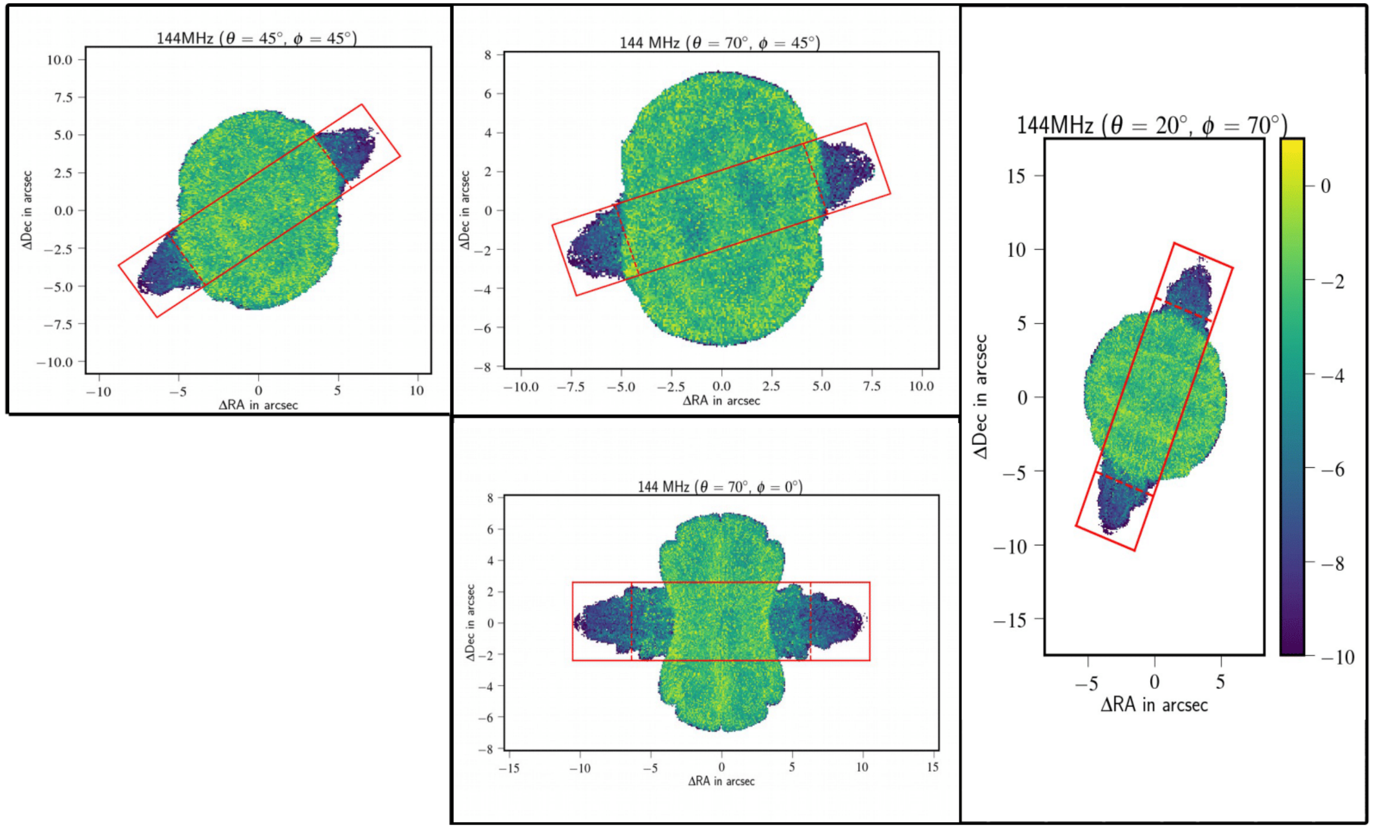
Hybrid framework of
PLUTO CODE
(Vaidya et al. 2018)
(flux density ∝ ν^{α})

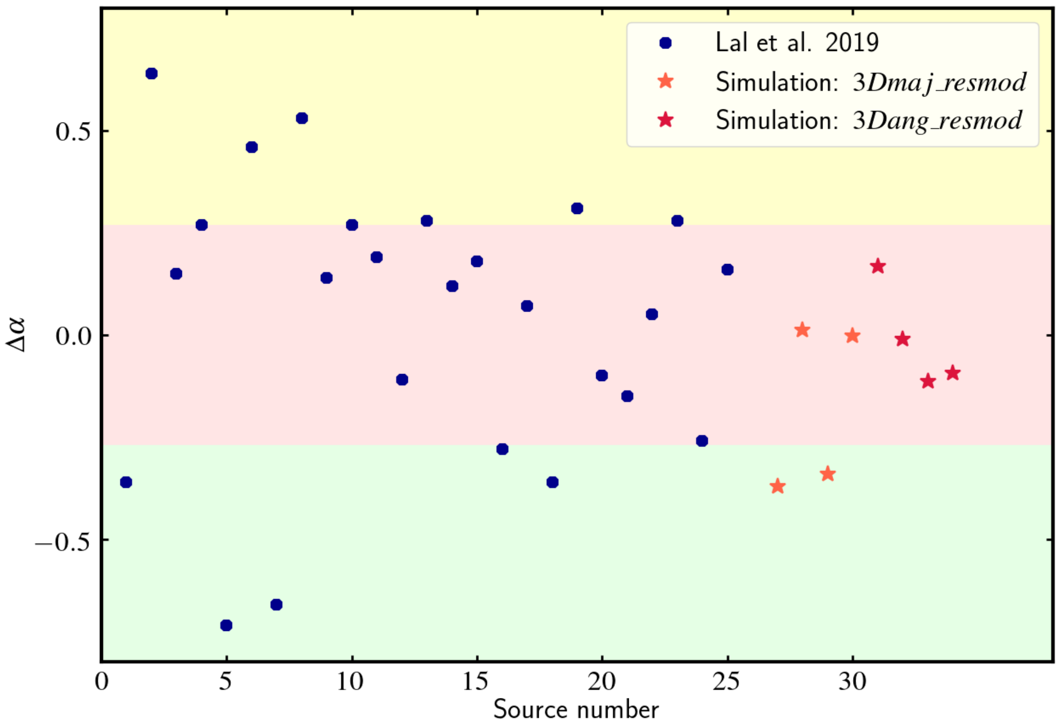
New particles
Flat spectral index

Older particles
Steep spectral index



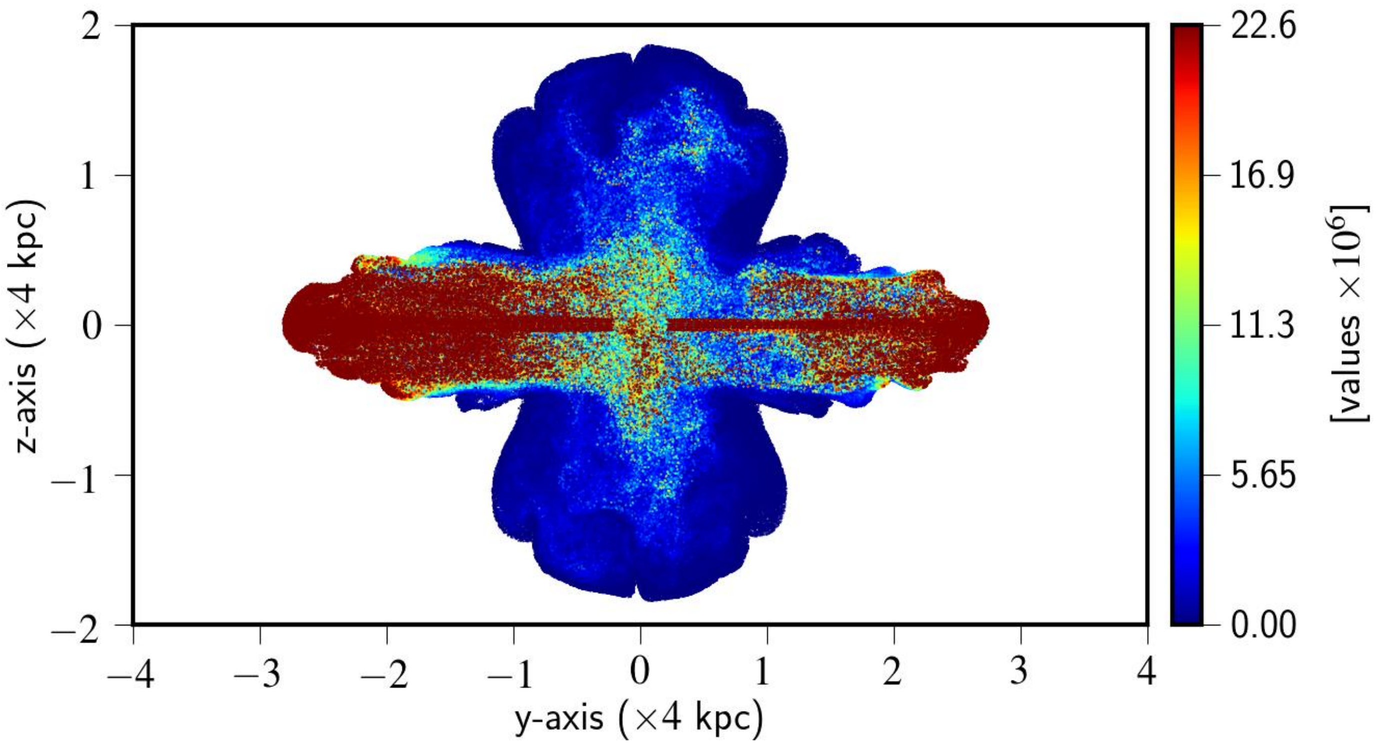
Results: 3D

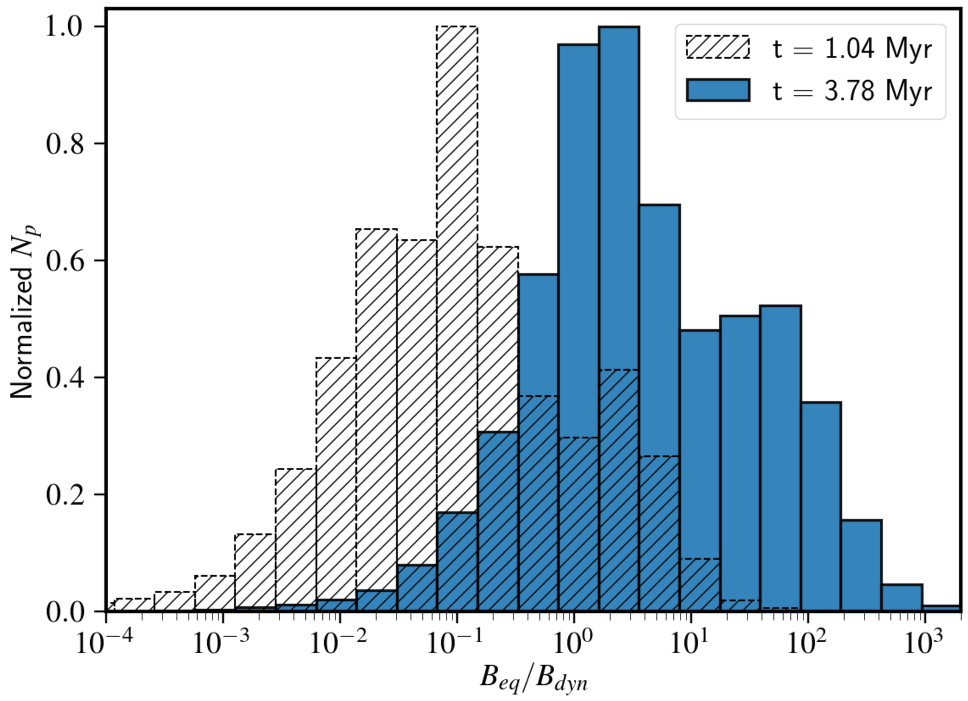




- Appearance of the same simulated structure, when viewed from four different line of sight angles (intensity maps).
- Here, red rectangles (solid) are representing the active lobe region, outside of which it is the wing region which is further subdivided to find $\Delta\alpha$ (the difference between the spectral index of the active lobe and the wing) without contamination.
- Distribution of $\Delta\alpha$ with number of XRG sources obtained from Lal et al. 2019 is plotted here which is divided into three colour region based on the class of XRGs provided in the study.
- The distribution obtained for our simulation is also overlaid.

Results: 3D





- Distribution of maximum Lorentz factor of electrons in the galaxy representing the regions with highly energized particles.
- This figure infers that the wing structure is not a passive feature at all, rather the particles get re-energized due to shock.

- Histogram, showing the time evolution of equipartition condition (Hardcastle et al. 2002) of the galaxy, obtained from particle distribution in the domain.
- The figure infers that the equipartition condition is not a static condition, rather evolves with time.