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

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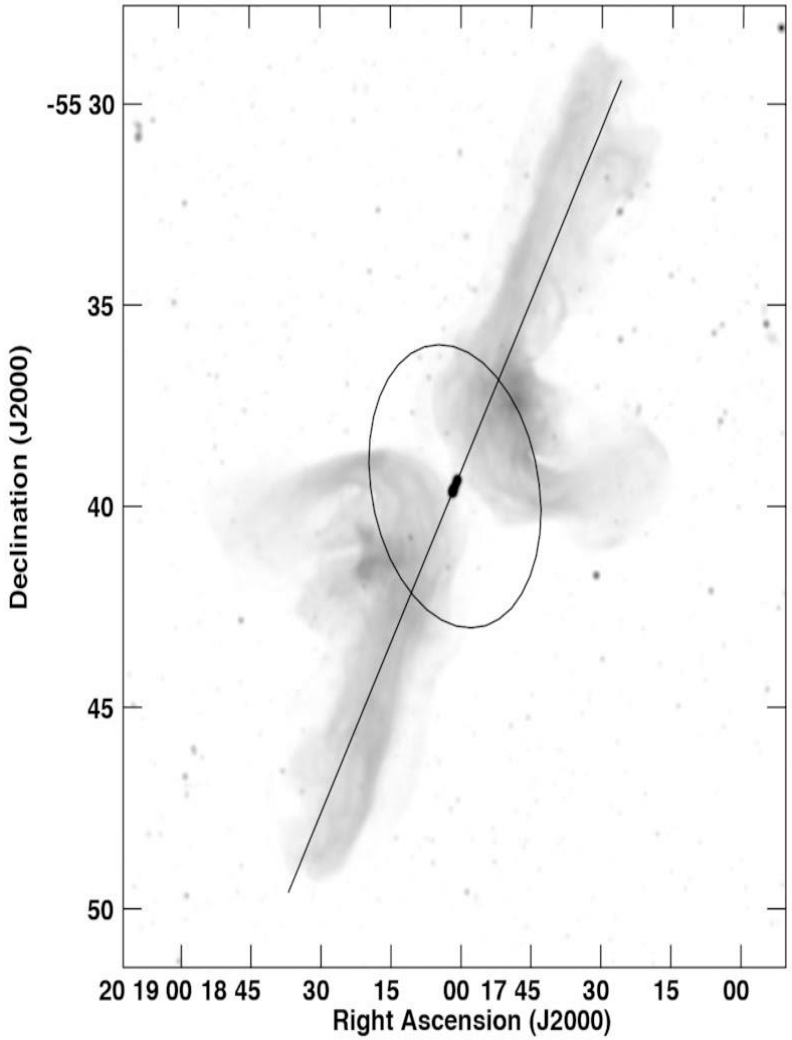
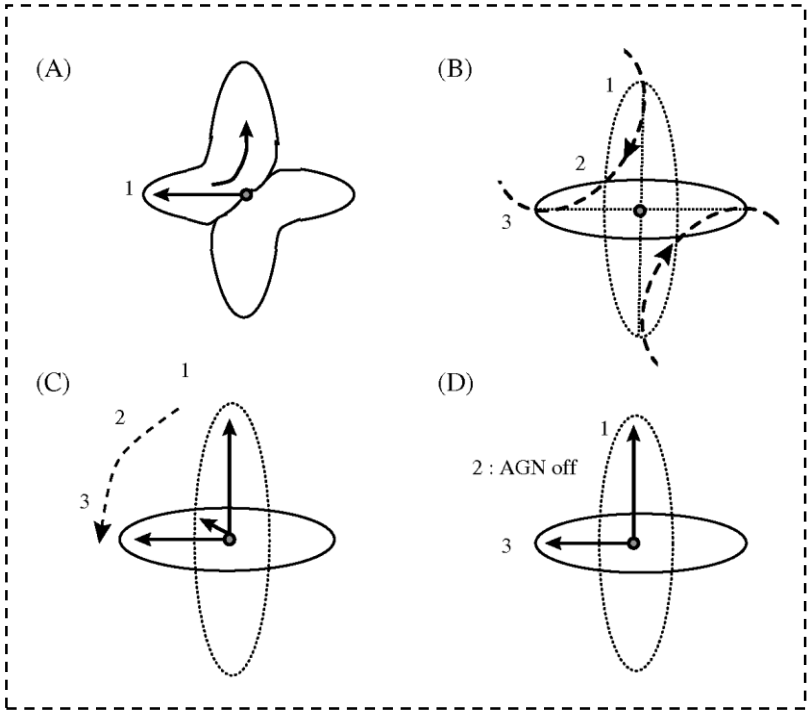
X-shaped radio galaxies



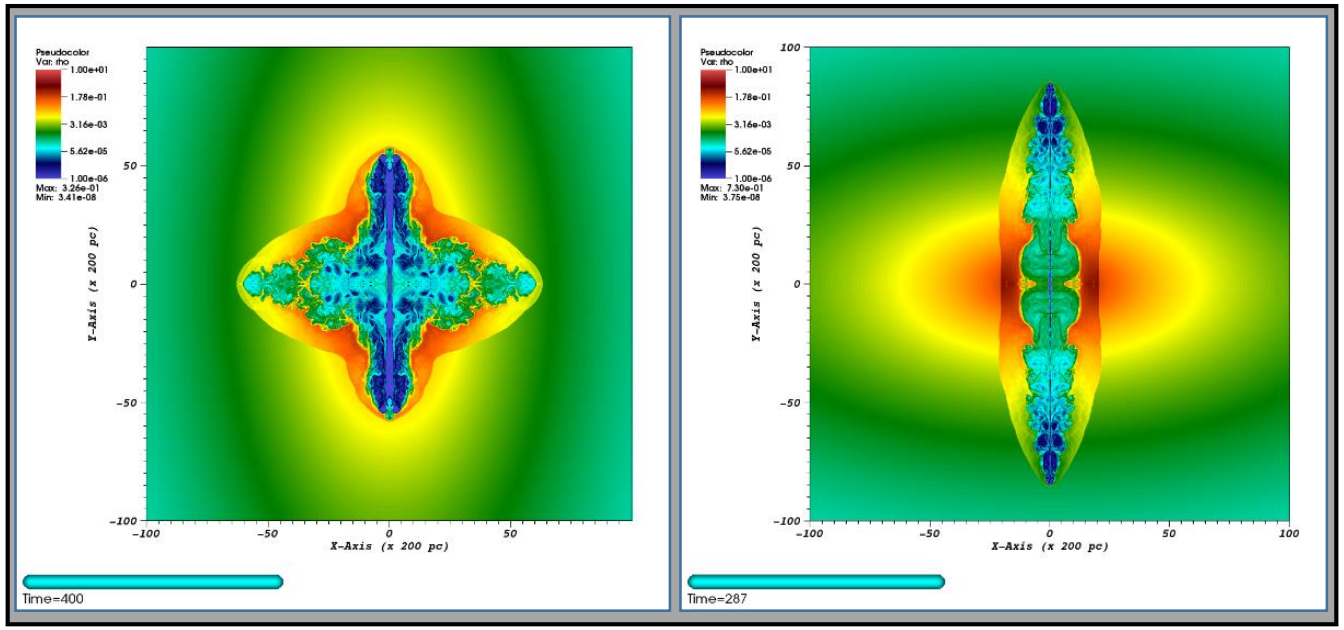
- Image of **PKS 2014-55**, an X-shaped radio galaxy, observed at a frequency of 1.28 GHz with the size of it's host galaxy overlaid on it, providing a strong evidence for the Back-flow model (Cotton et al. 2020).



- **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)

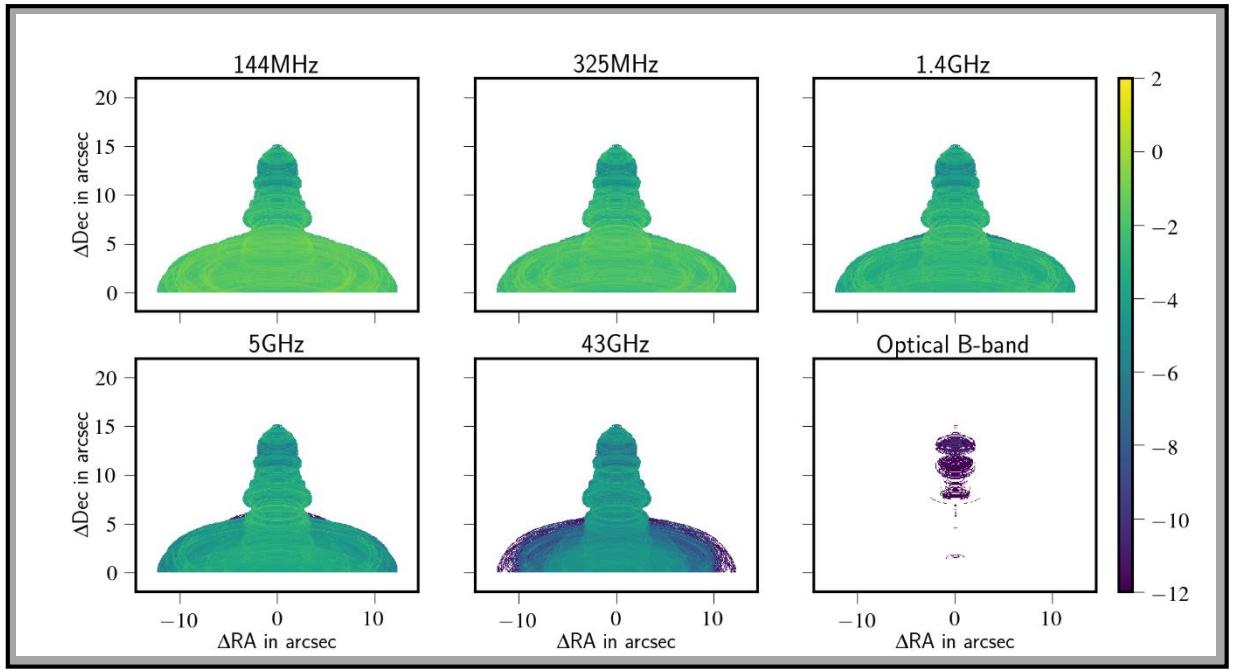
- Our goal is to study the formation and evolution of these galaxies due to the Back-flow model using numerical simulation (2D and 3D) where we have focused on both the dynamical and emission perspective of it. These simulations are executed using the relativistic-MHD module of PLUTO code (Mignone et al. 2007).

Results: 2D

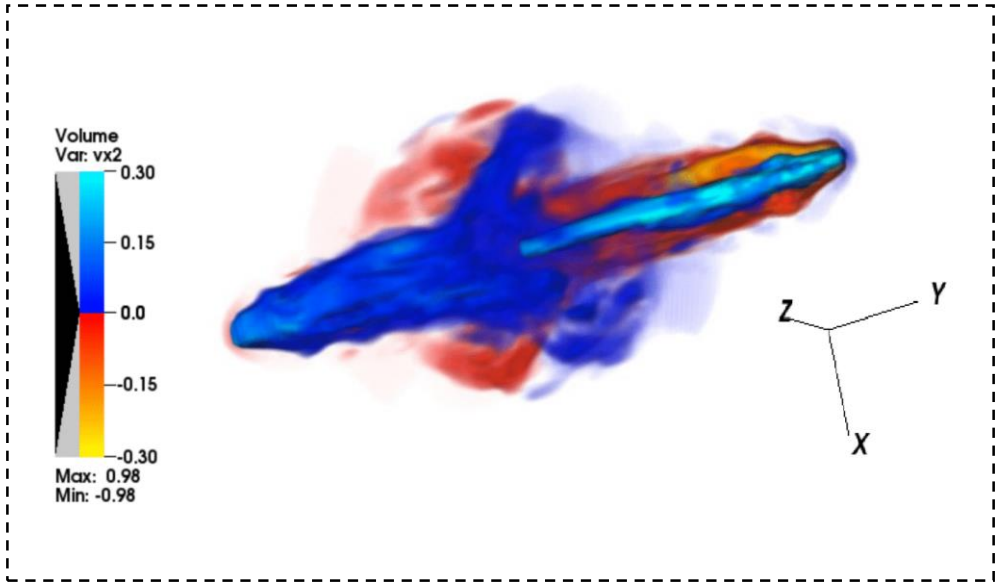


- **The top panel** demonstrates the formation of an XRG when the jet ejection axis coincides with the major axis of the tri-axial ambient medium and a classical radio galaxy if it is along the minor axis of it (Capetti et al. 2002).
- **The bottom panel** demonstrates the emission signatures of these galaxies modelled for the synchrotron emission in six different frequencies for a line-of-sight angle of ($\theta = 70^o$, $\phi = 0^o$).

Hybrid framework of PLUTO CODE (Vaidya et al. 2018)

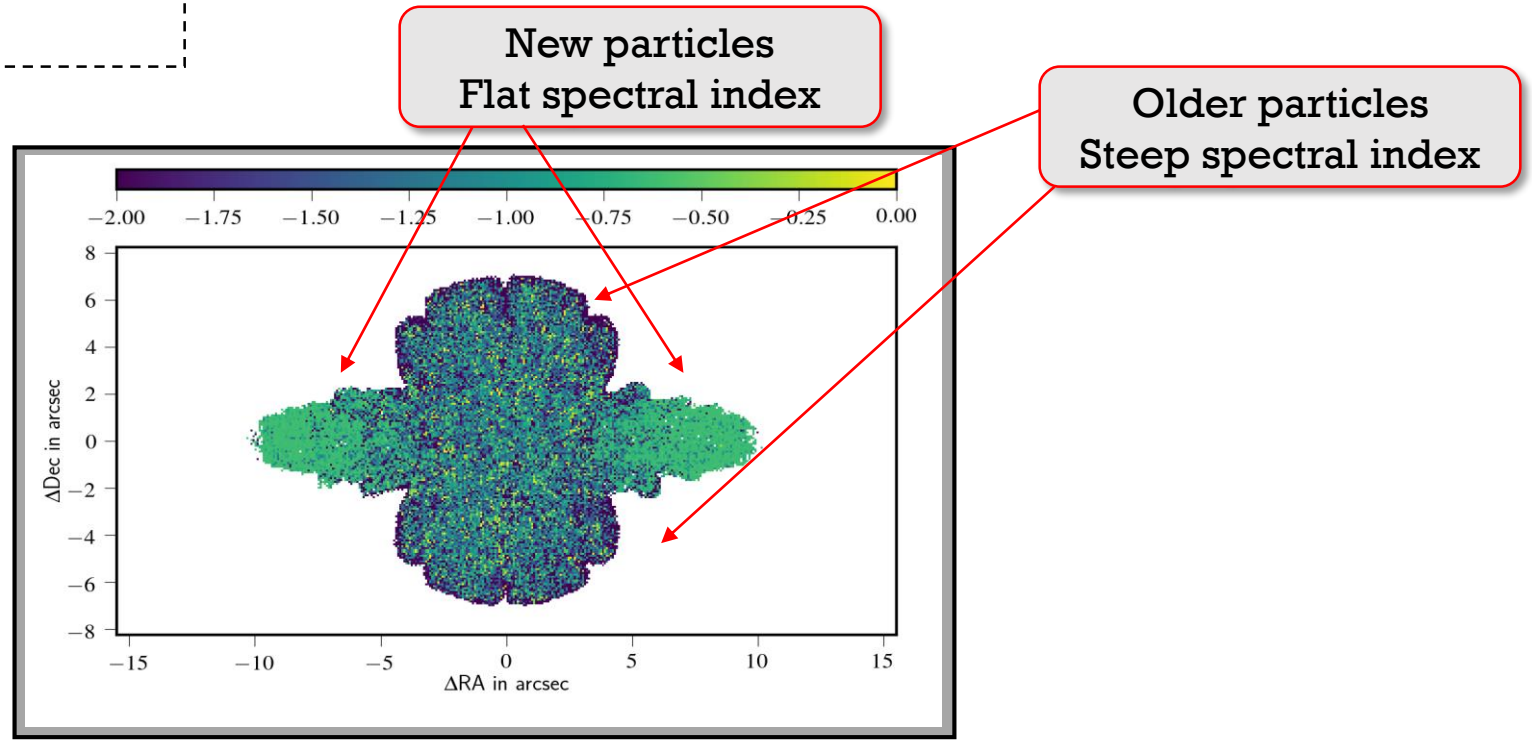


Results: 3D

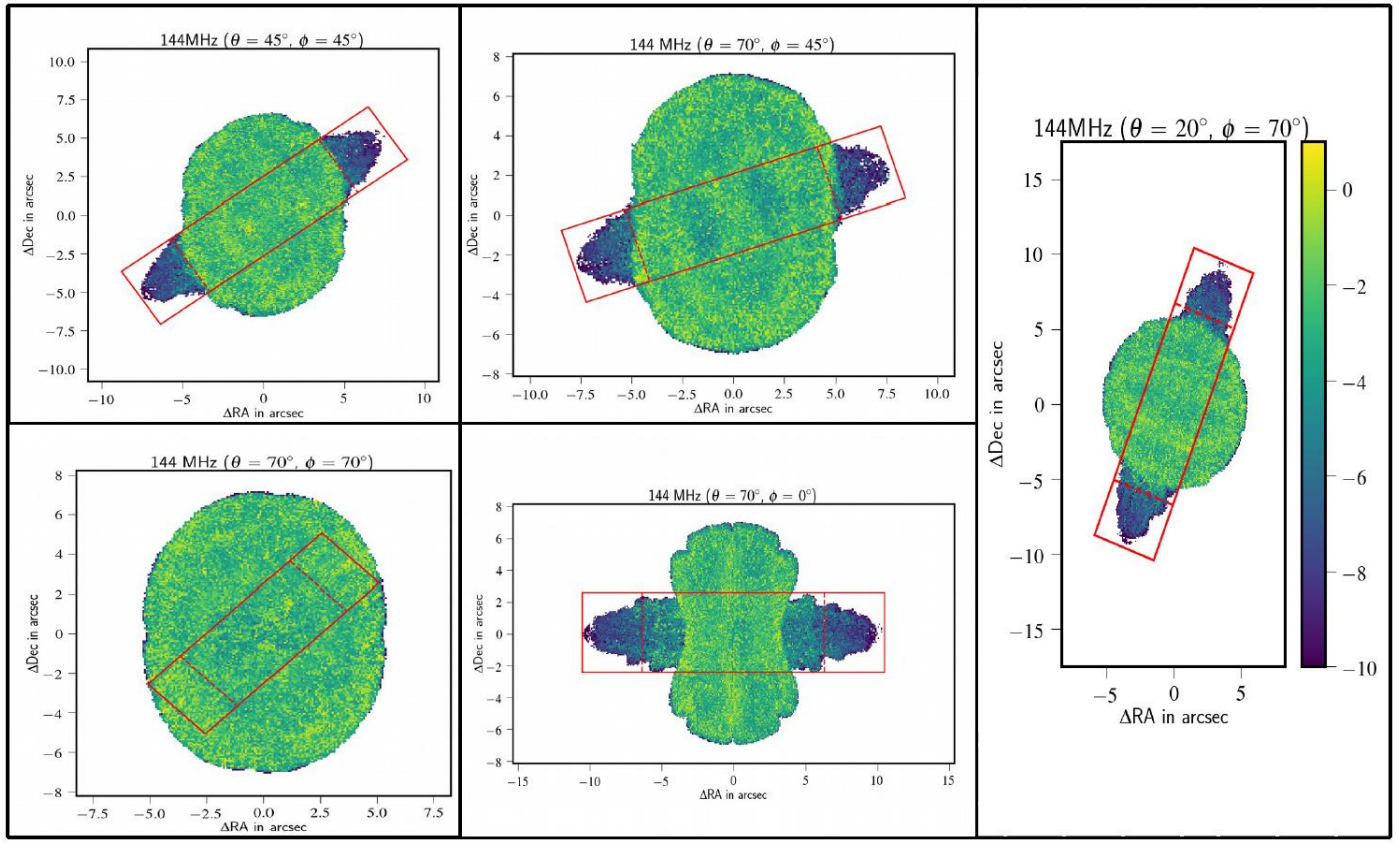


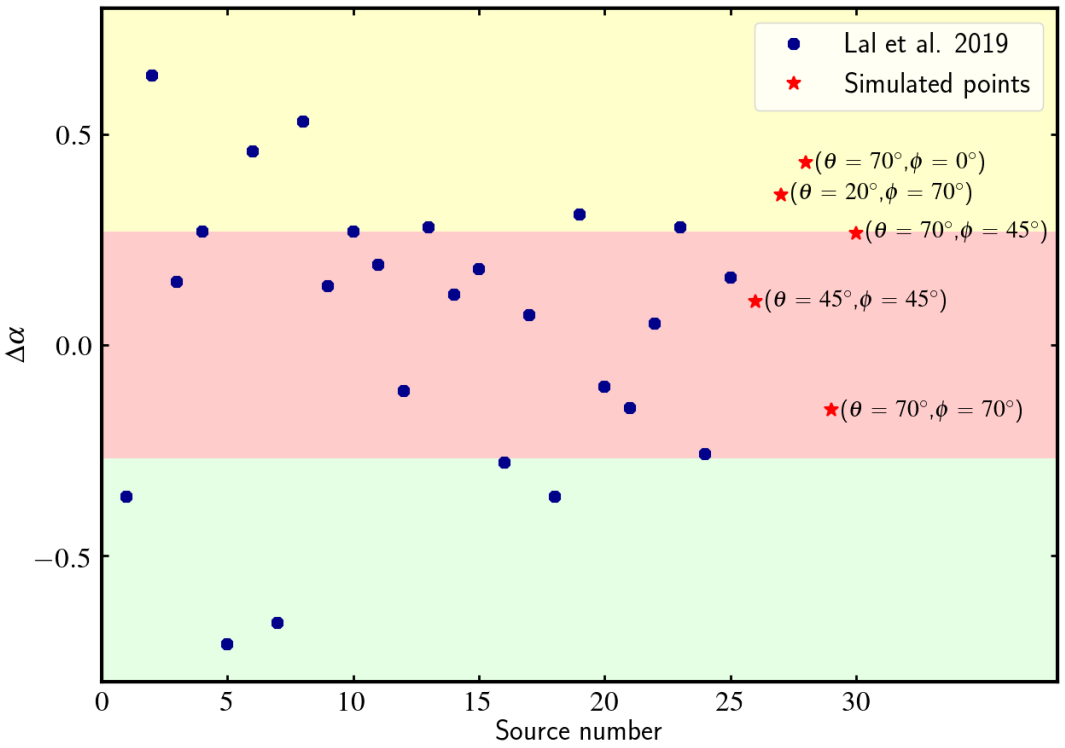
- **The top panel** demonstrates the velocity distribution (v_y) for our 3D case, viewed from an angle to the jet ejection axis (Y), indicating the formation of the back-flowing jet materials which are getting accumulated in the wings (Rossi et al. 2017).
- **The bottom panel** demonstrates the spectral 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 **(flux density ∝ ν^{α})**



Results: 3D





- Appearance of the same simulated structure, when viewed from five different line of sight angles. The corresponding colour bar represents the intensity distribution at 144 MHz in Jy/arcsec^2.
- Here, red rectangles (solid) are representing the active lobe region, outside of which it is the wing region which is further subdivided to find Δα (the difference between the spectral index of the active lobe and the wing) without contamination.

- Distribution of Δα with number of XRG sources (25) obtained from Lal et al. 2019 is plotted here which is divided into three colour category based on the class of XRGs provided in the above study.
- The distribution obtained for our simulated XRG for 5 los angle, is also overlaid.