Synthetic Observation of S-shaped Jet from Dual AGN Candidate 2MASX J12032061+1319316

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Abstract

Extended radio galaxies are characterized by the presence of well-collimated plasma flows from the centre of a compact core. Sometimes, these jets show significant distortion in their structure, forming an S-shaped radio morphology. This appearance is predicted to be the outcome of a precessing jet. The existence of dual or binary AGN at the centre of these galaxies or a tilted accretion disk are the two plausible mechanisms invoked to explain this precession. The goal of this work is to study the formation and evolution of S-morphology due to the rotating jet. In this regard, we have performed 3D MHD simulations of a precessing jet propagating in an ambient galaxy and have obtained synthetic emission signatures in the presence of radiative losses and diffusive shock acceleration. Here, I will discuss the parametric restrictions under which the S-morphology is formed along with the characteristics obtained from its dynamics. Further, the implication of equipartition in the age estimation of the galaxy is discussed. A comparison between our synthesized maps with VLA observations of dual AGN candidate 2MASX J12032061+1319316 is presented, along with a prediction for the polarization map in the radio band.

Introduction

- S-shaped radio morphology (: Precessing Jets)
- Mechanism: Dual/ binary AGN, tilted accretion disk
- Galaxy mergers may result in dual/binary AGN
- Example: 2MASX J12032061+1319316 (Rubinur et al. 2017)

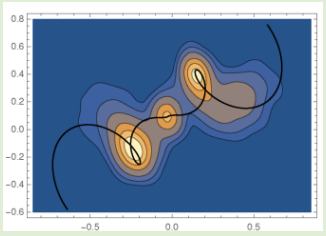
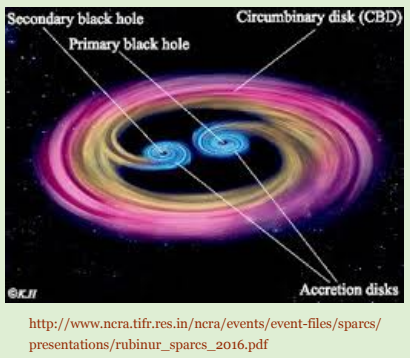


Image of 2MASX J1203 Rubinur et al. (2017)

Motivation

- Formation mechanism of S-shaped radio sources
- Better constraint on parameters, parameter study to reproduce observed structure
- Multi-wavelength emission maps, spectral maps, polarization maps.

NGC 4676 A & B (Mice Galaxies) interacting with each other in a galaxy merger. (NASA APOD)



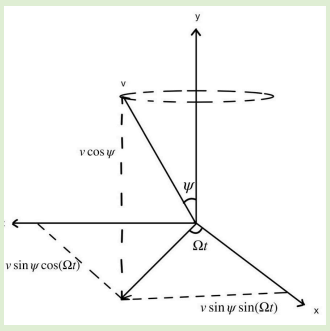
http://www.ncra.tifr.res.in/ncra/events/event-files/sparcs/presentations/rubinur_sparcs_2016.pdf

Dual (separation 0.1-10 kpc) or binary AGN (separation <100 pc)

Simulation Setup

- Hybrid framework of PLUTO Code (Mignone et al. 2007, Vaidya et al. 2018)
- Domain: 2kpc x 4kpc x 2kpc
- Hjellming and Johnston (1981) Model
- Ambient galaxy:

$$\rho = \rho_o \left(1 + \left(\frac{r}{r_c}\right)^2\right)^{-3/2} \quad \text{(King's Profile)}$$



Jet velocity vector precessing about y-axis

- Parameters:

$v = 0.023c$, $\psi = 21^\circ$, $\tau = 2\pi/\Omega = 0.095$ Myr (Rubinur et al. 2017)

$B = 203.5\ \mu G$, No. density of non-thermal particles = 3.3×10^{-7} /cc

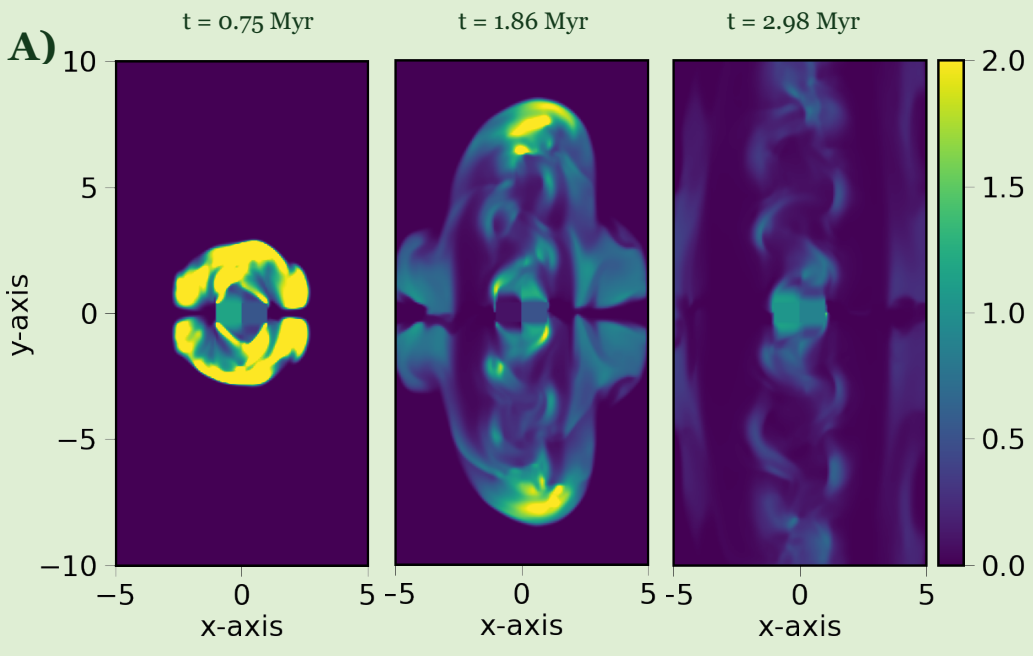
Results

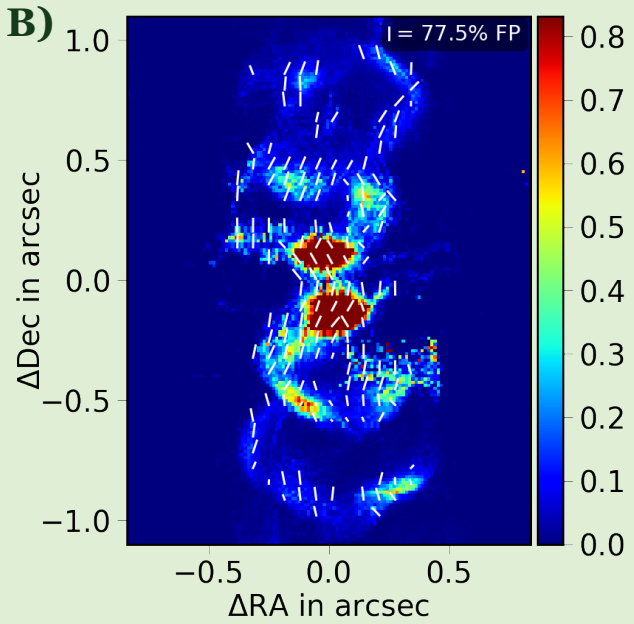
A) Evolution of cocoon pressure with time.

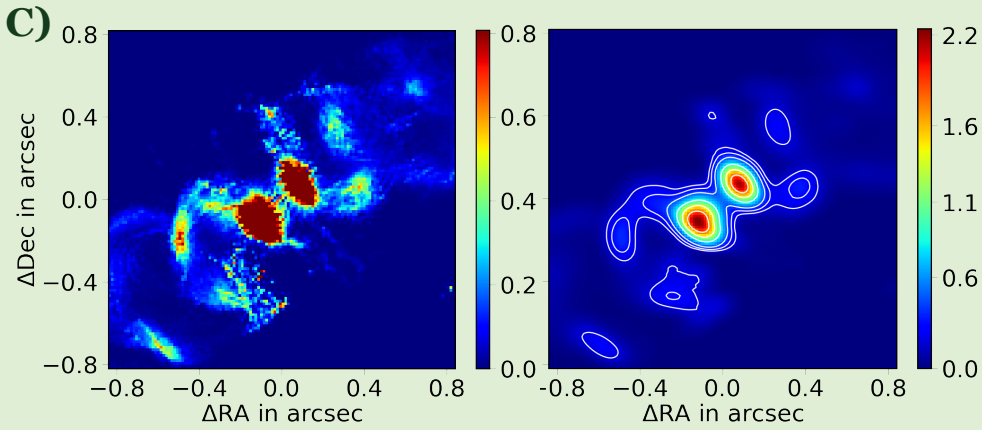
B) Fractional polarization and magnetic field lines in the cocoon at 11.5 GHz.

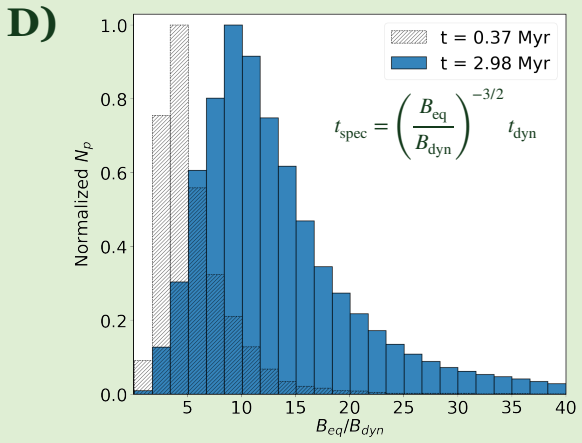
C) Left to right: Simulated intensity map, same map Gaussian convolved with beam size mentioned in Rubinur et al. 2017, observed radio map all at 11.5 GHz.

D) Evolution of equipartition condition (B_{eq}/B_{dyn}) with time









Conclusions

- Precessing jets can lead to the formation of S-shaped morphology.
- The dynamical age calculated in our simulation is larger than the spectral age suggested for this source in previous studies. This can be explained using presence of sub-equipartition conditions in the jet.
- Magnetic field is highly polarized (Max. FP ~ 77.5 %), and follows the jet locus.

References

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