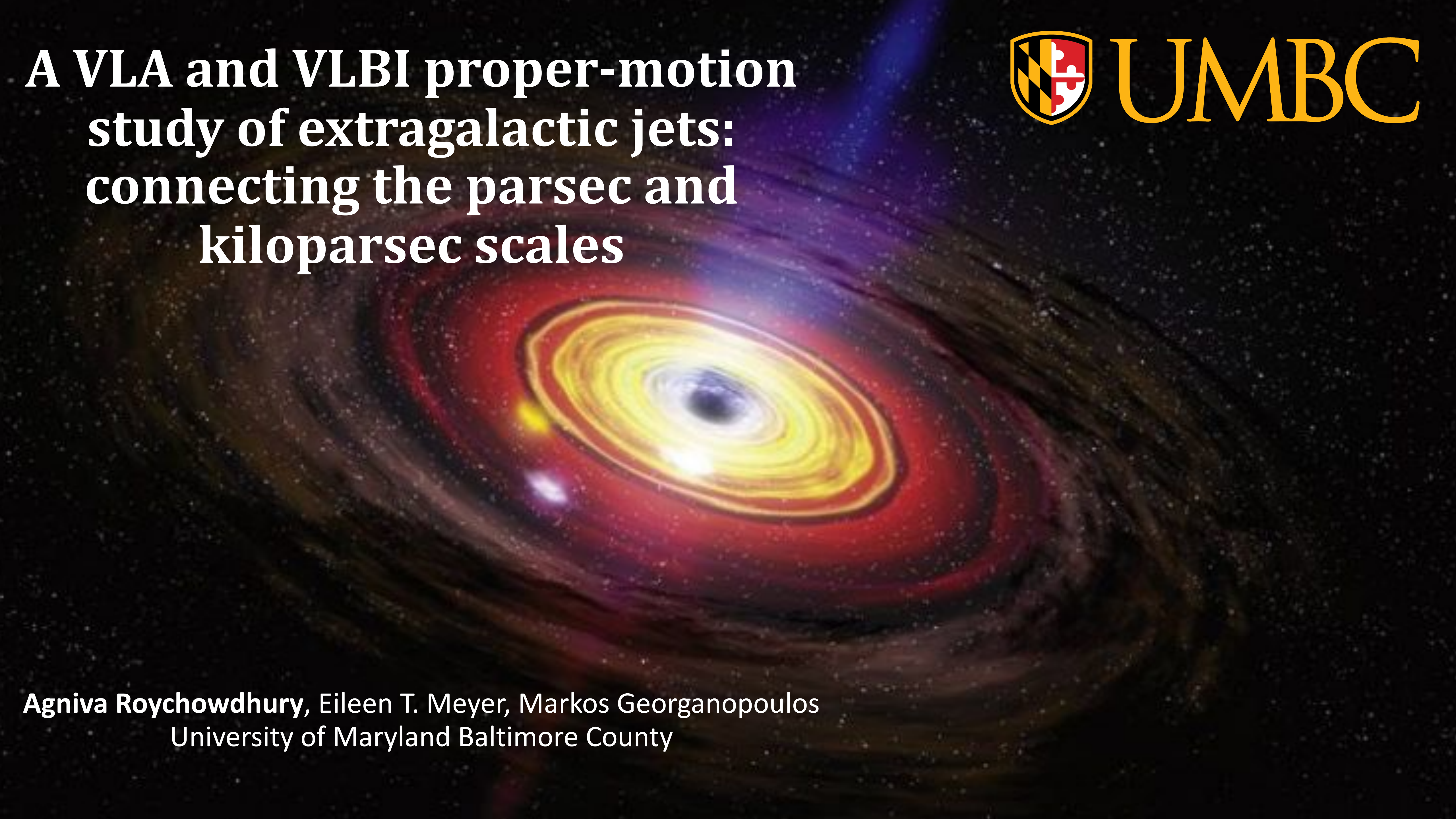
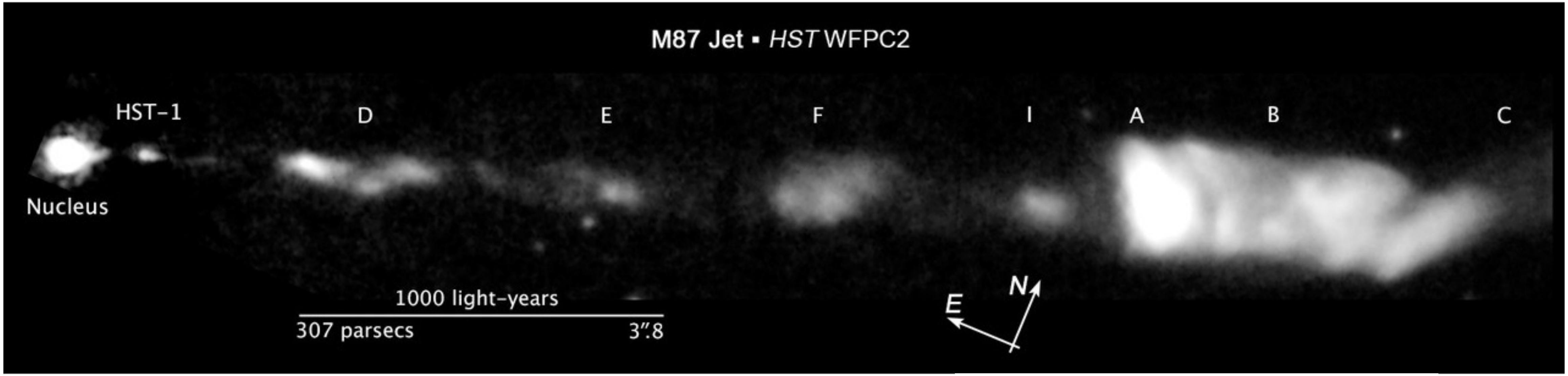
# A VLA and VLBI proper-motion study of extragalactic jets: connecting the parsec and kiloparsec scales

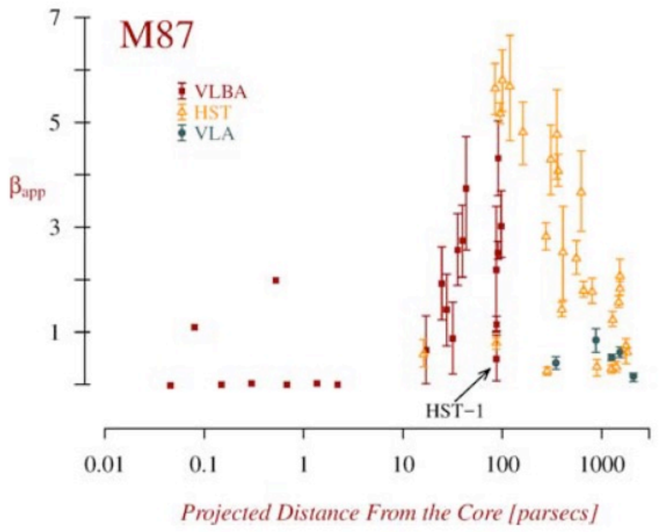


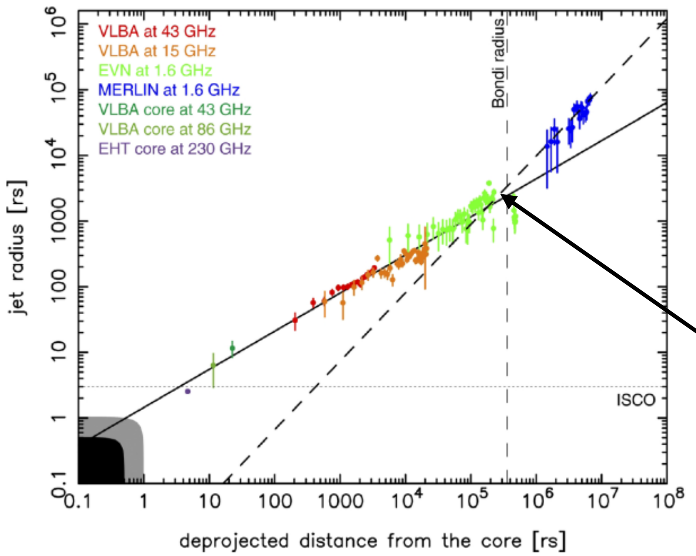
**Agniva Roychowdhury**, Eileen T. Meyer, Markos Georganopoulos
University of Maryland Baltimore County

# Connecting the parsec and kiloparsec scales: the case of M87

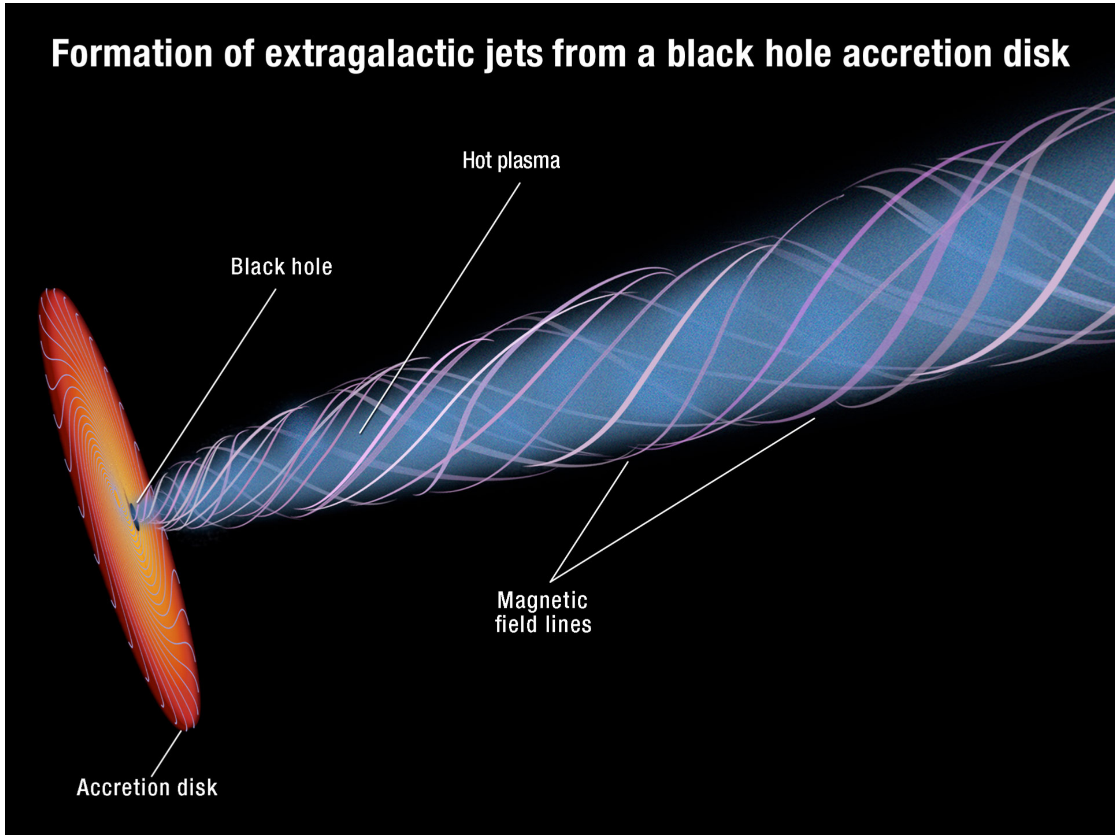


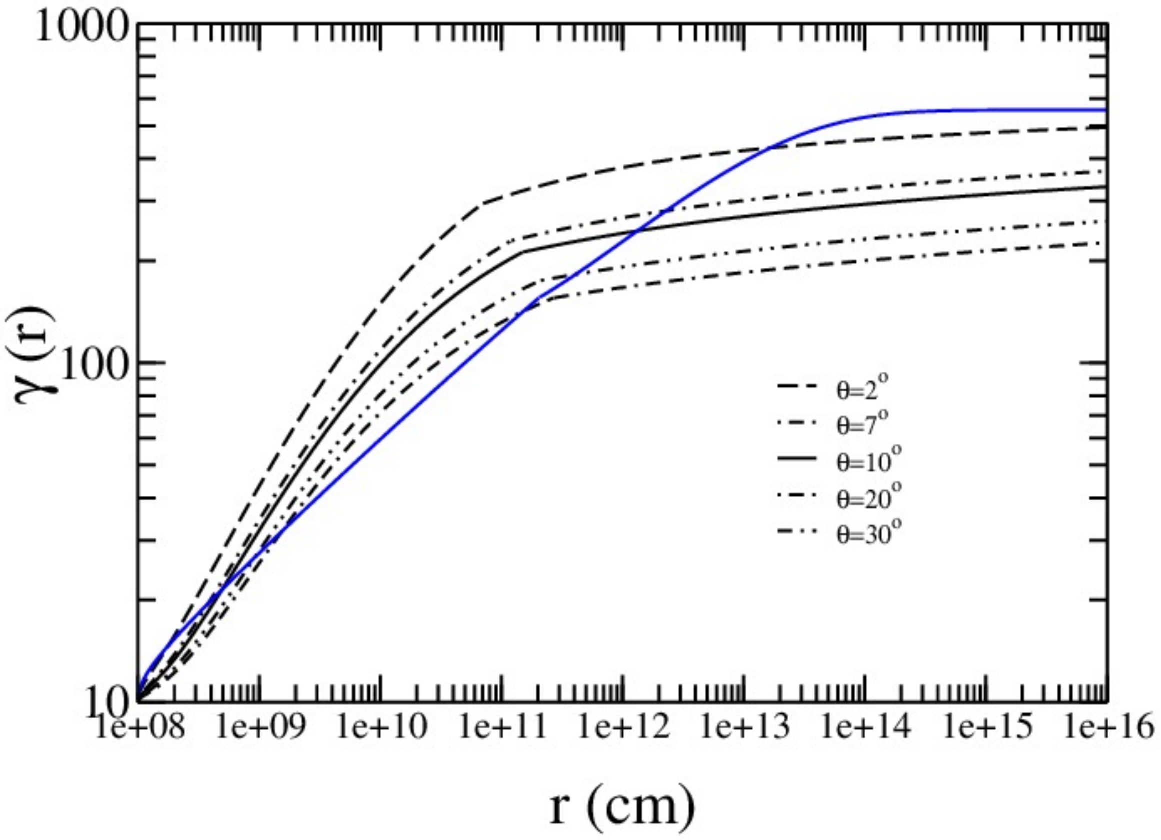

**Evidence of extreme acceleration at sub-kpc to kpc-scales:**



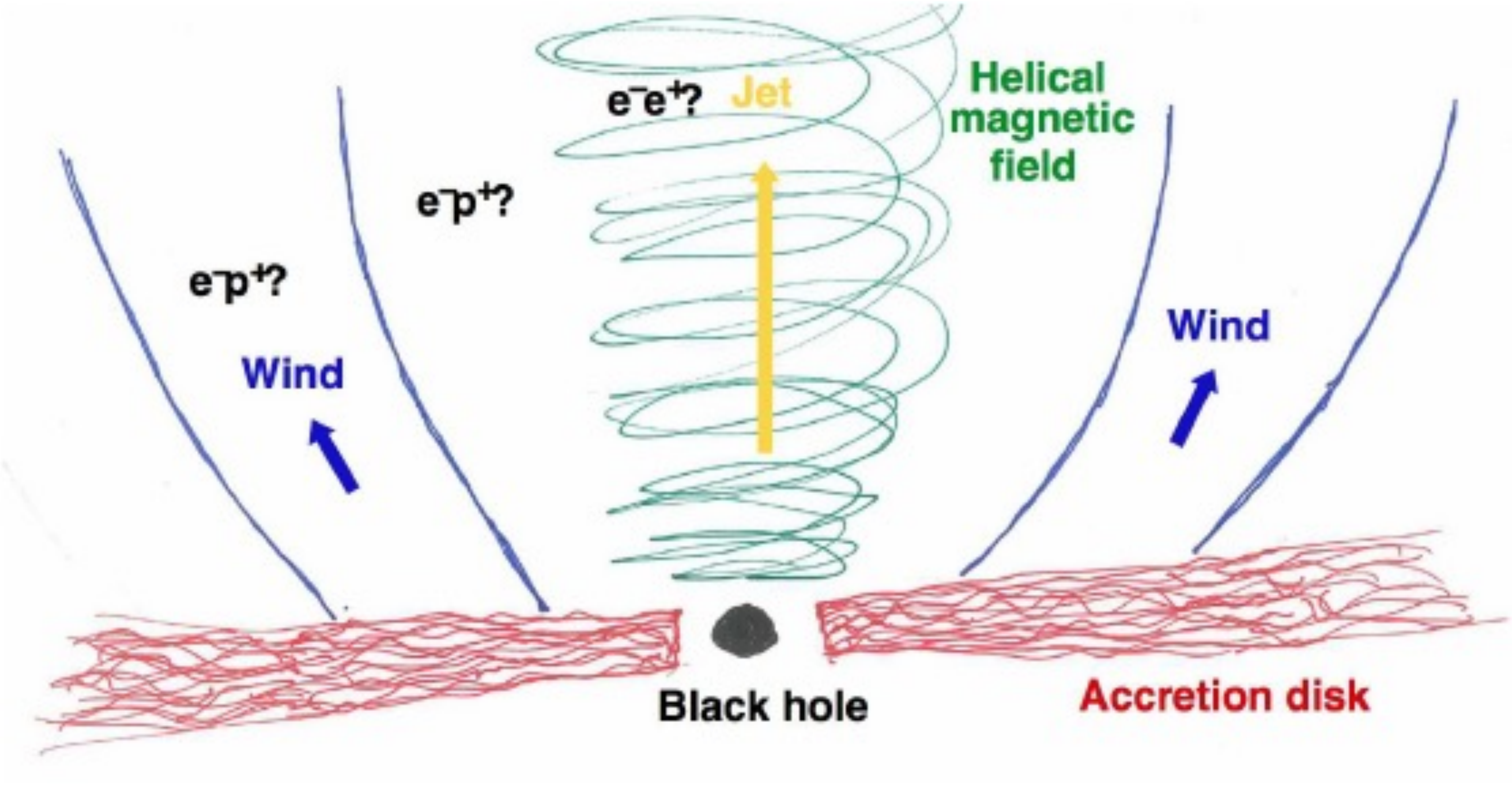
# How is a jet accelerated?




**Giannios+ 06**

# What is a jet composed of?

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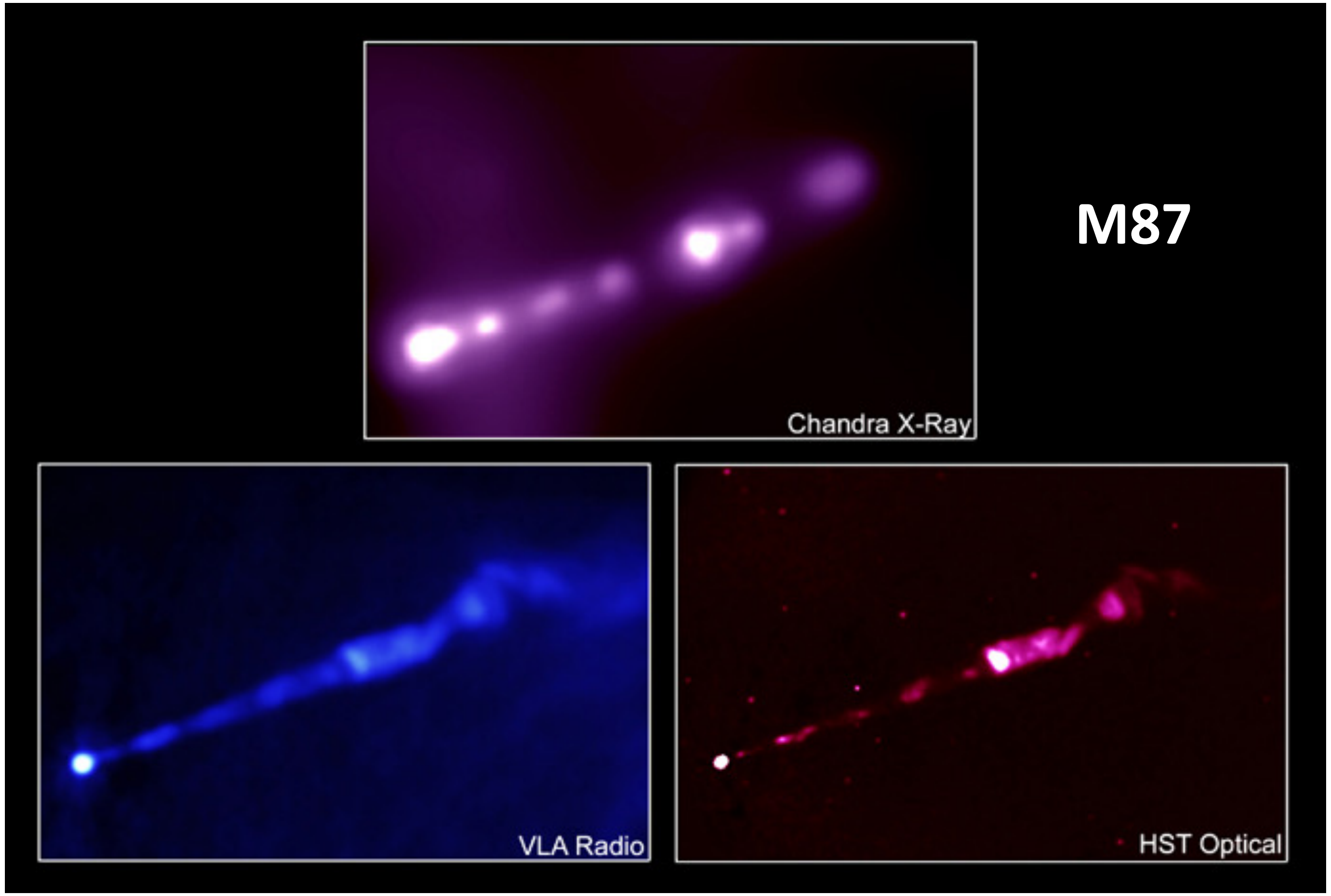
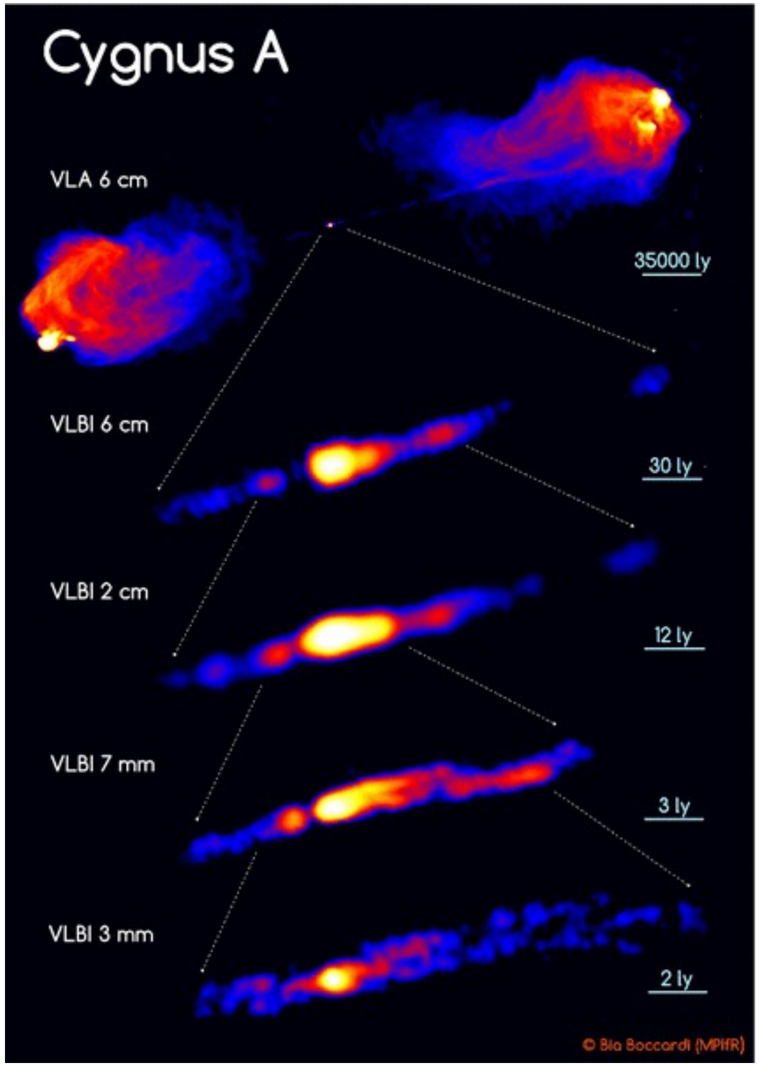
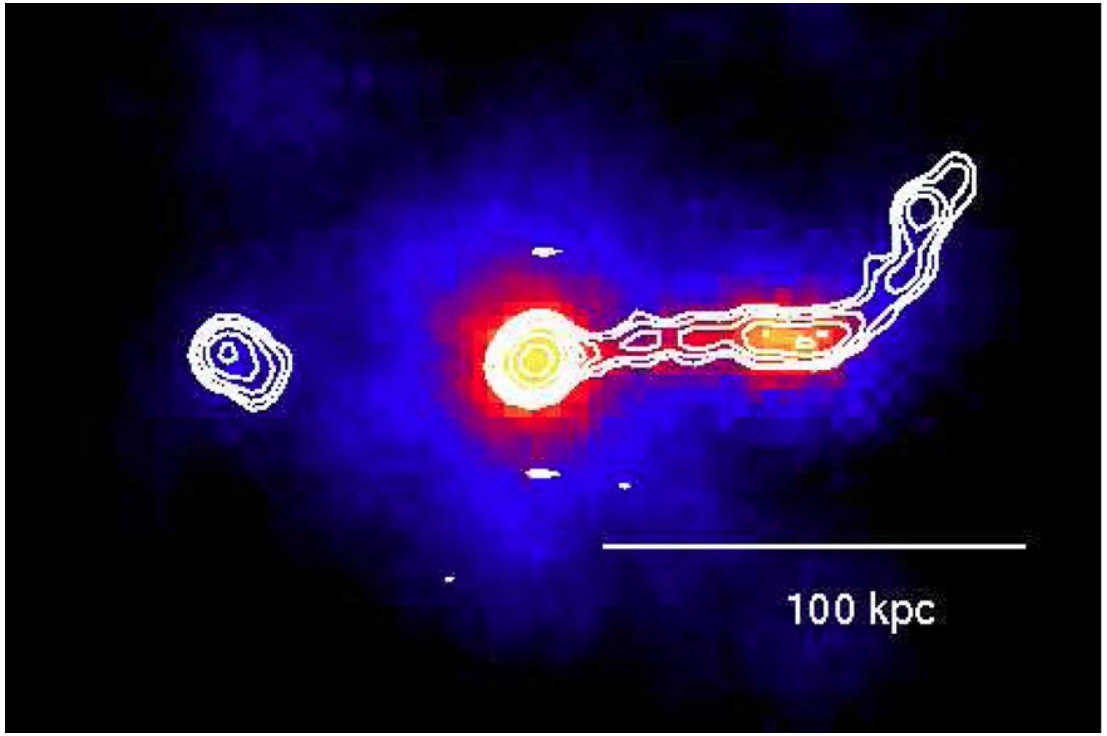
# What is the nature of these “knots”?



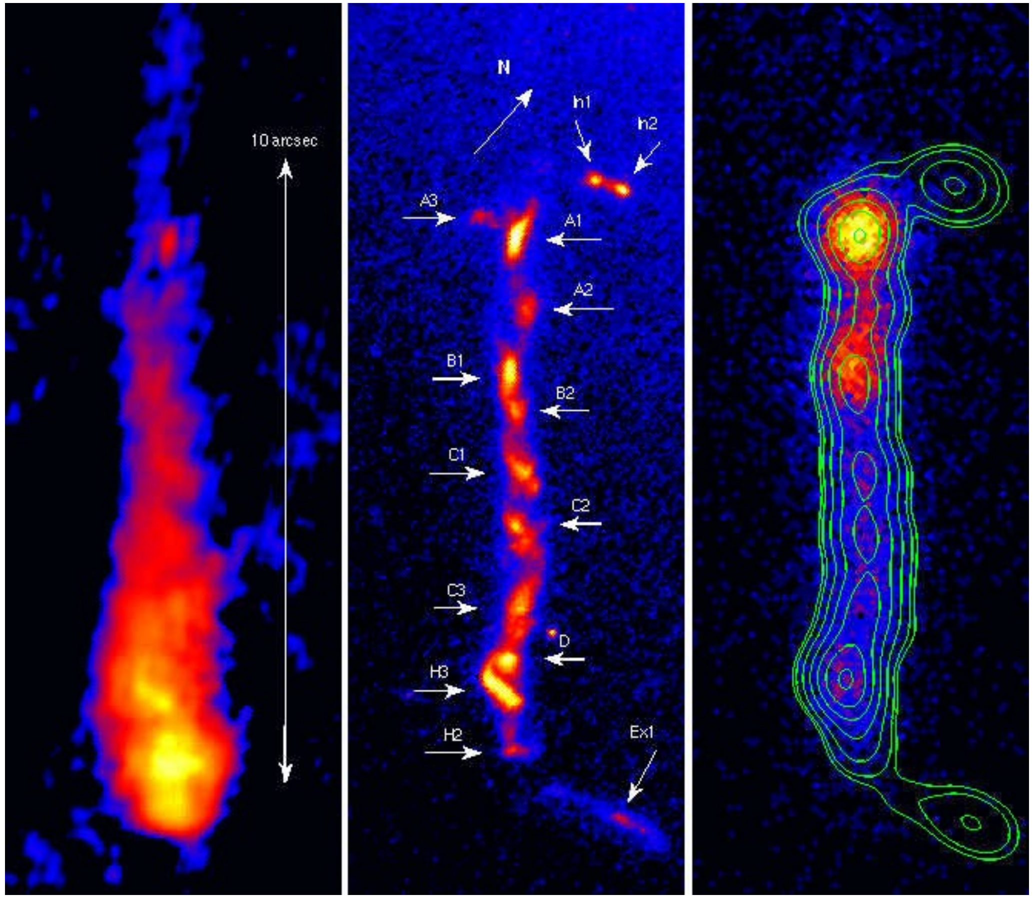



# Why are many kpc-scale jets bright in X-rays?

## The IC-CMB mechanism requires high jet bulk speeds and can be tested.

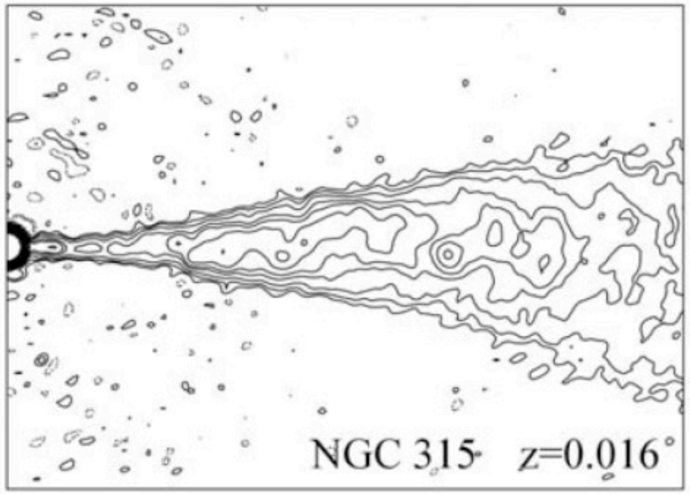


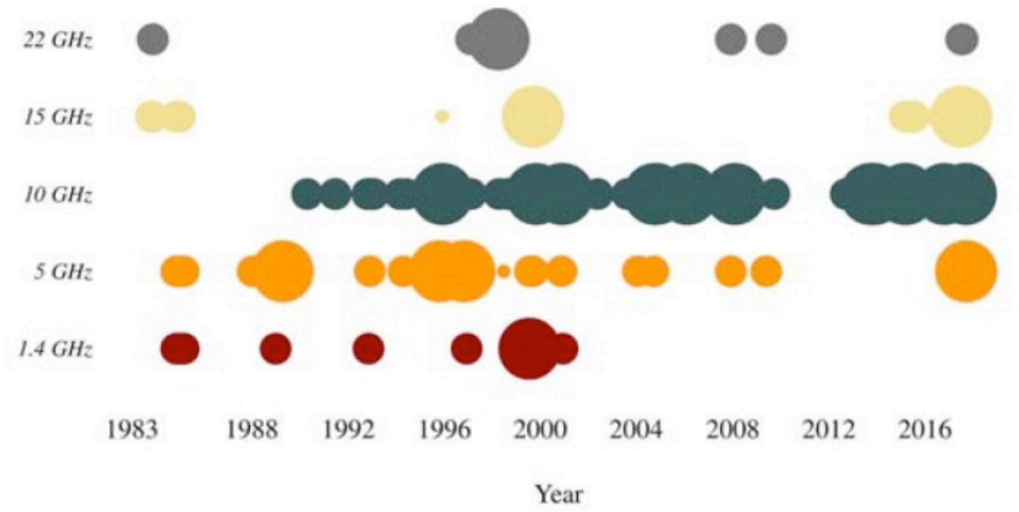

**PKS 0637-752**




**3C 273**

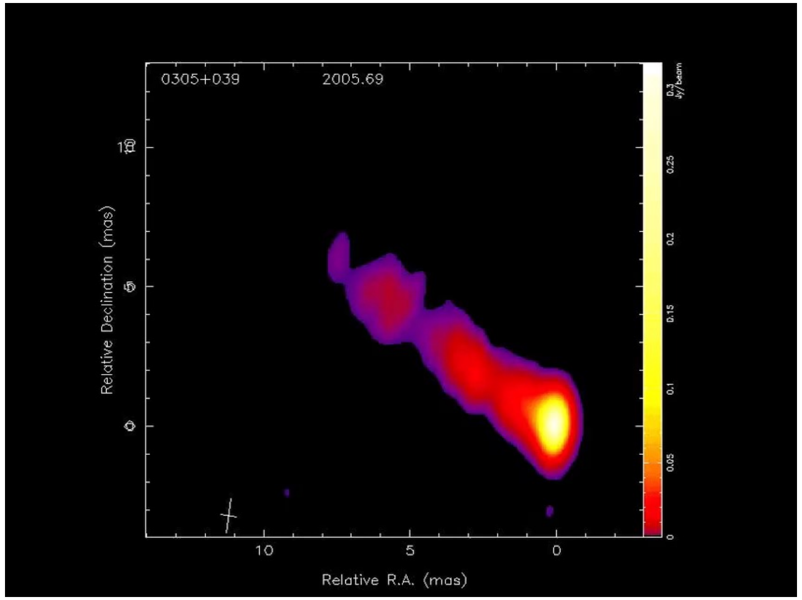
# Catalogue of motions in jets from Active galactic Nuclei using Very-large-Array Studies (CAgNVAS)




# The high-frequency VLA jet of FRI radio galaxy 3C 78

Objective: *robustly* identify component position over time



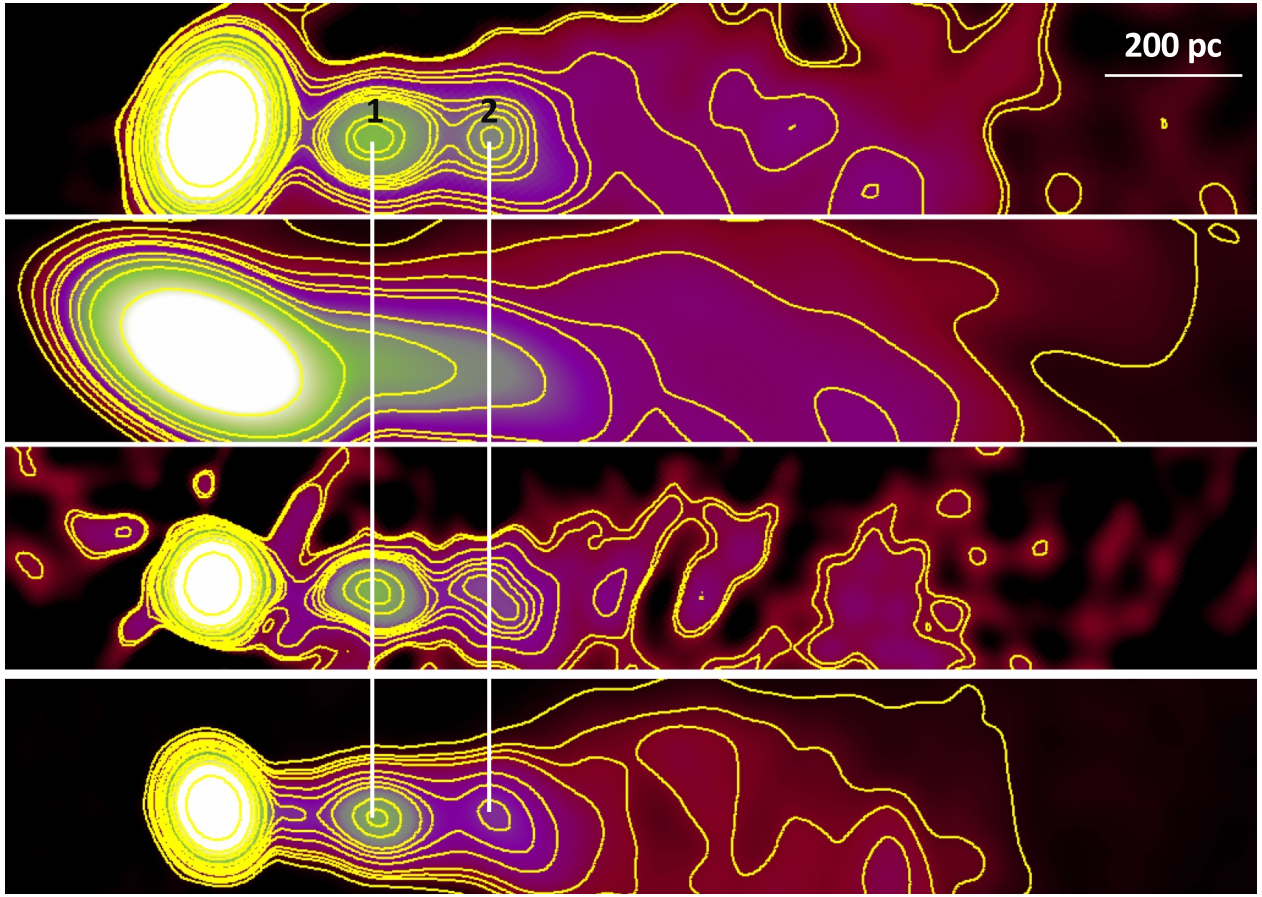

VLBI Jet of 3C 78

1985, 15 GHz

2000, 8.4 GHz

2003, 22 GHz

2019, 22 GHz

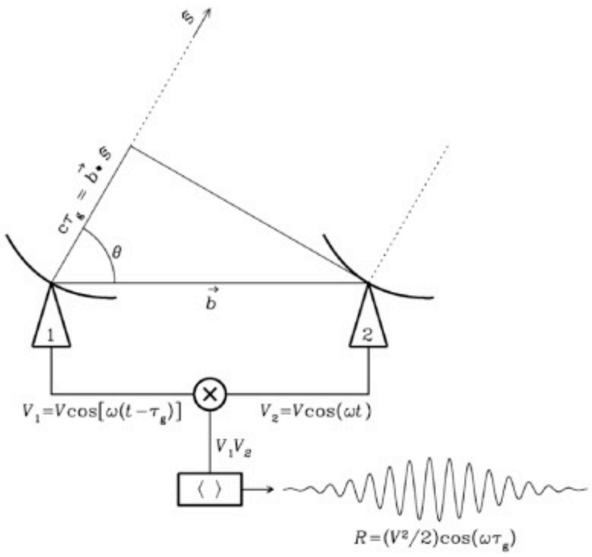


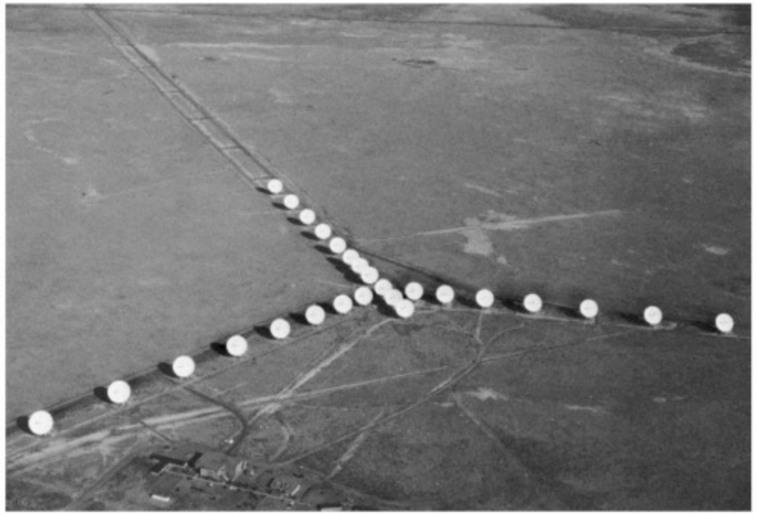
# Technique: Fitting in the Fourier plane of the jet image

- Measures the Fourier Transform of the source brightness or "complex visibility" in the "u-v" plane:

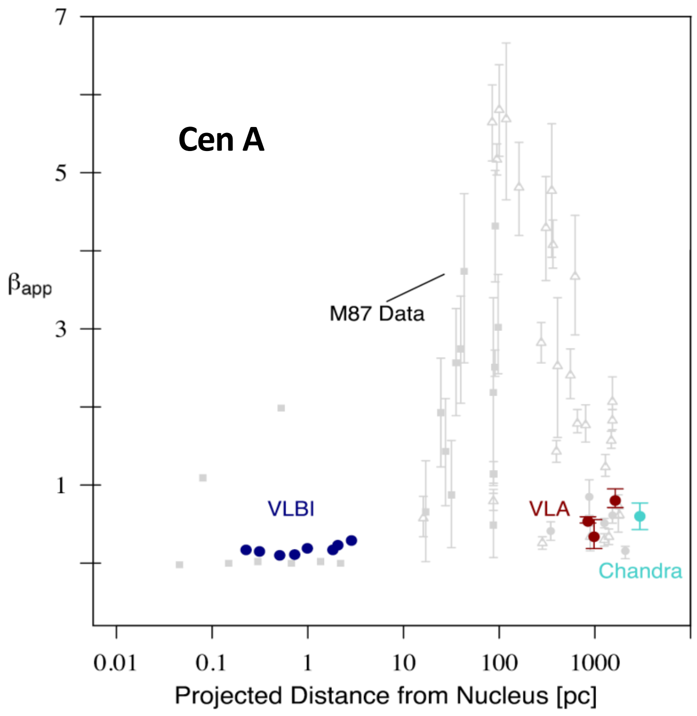
$$V(u,v) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} \mathcal{A}(l,m) I(l,m) \exp[-2\pi i(ul+vm)]\, dl\, dm.$$

- Calibration-independent "closure quantity" fitting using global optimizer inside *new* DIFMAP "3.0" (Difference Mapping, Shepherd et al. 1997).

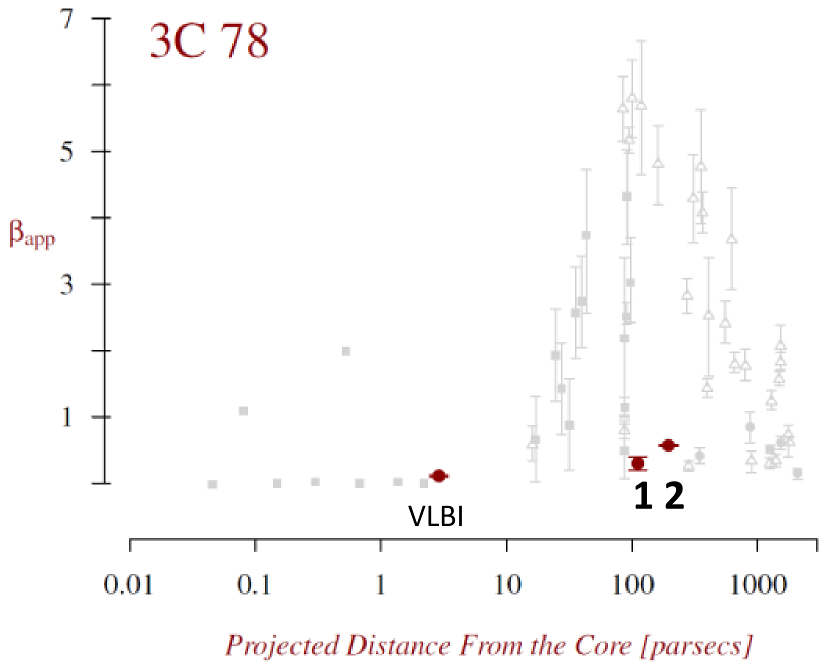


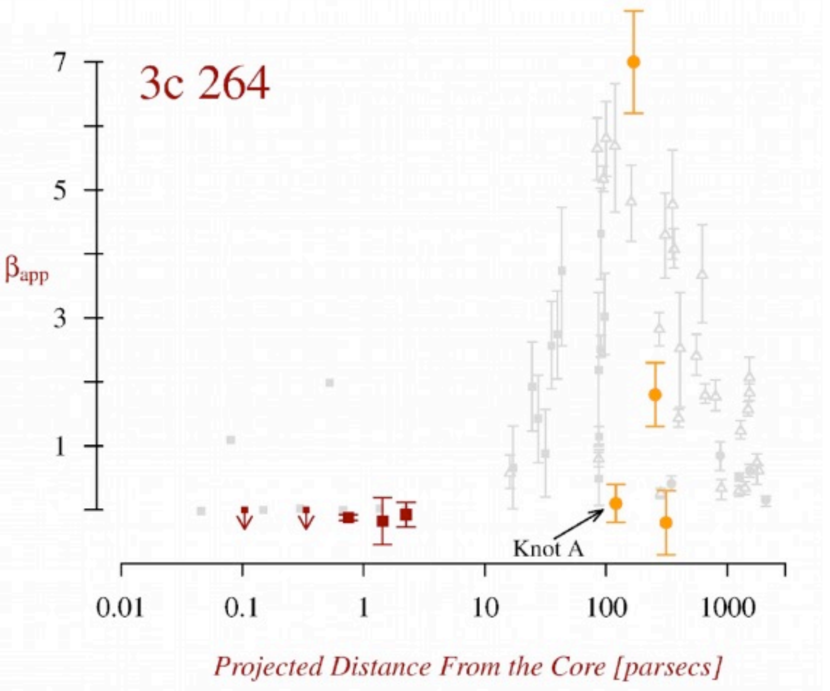
# 3C 78 velocity profile




Snios et al. (2019)



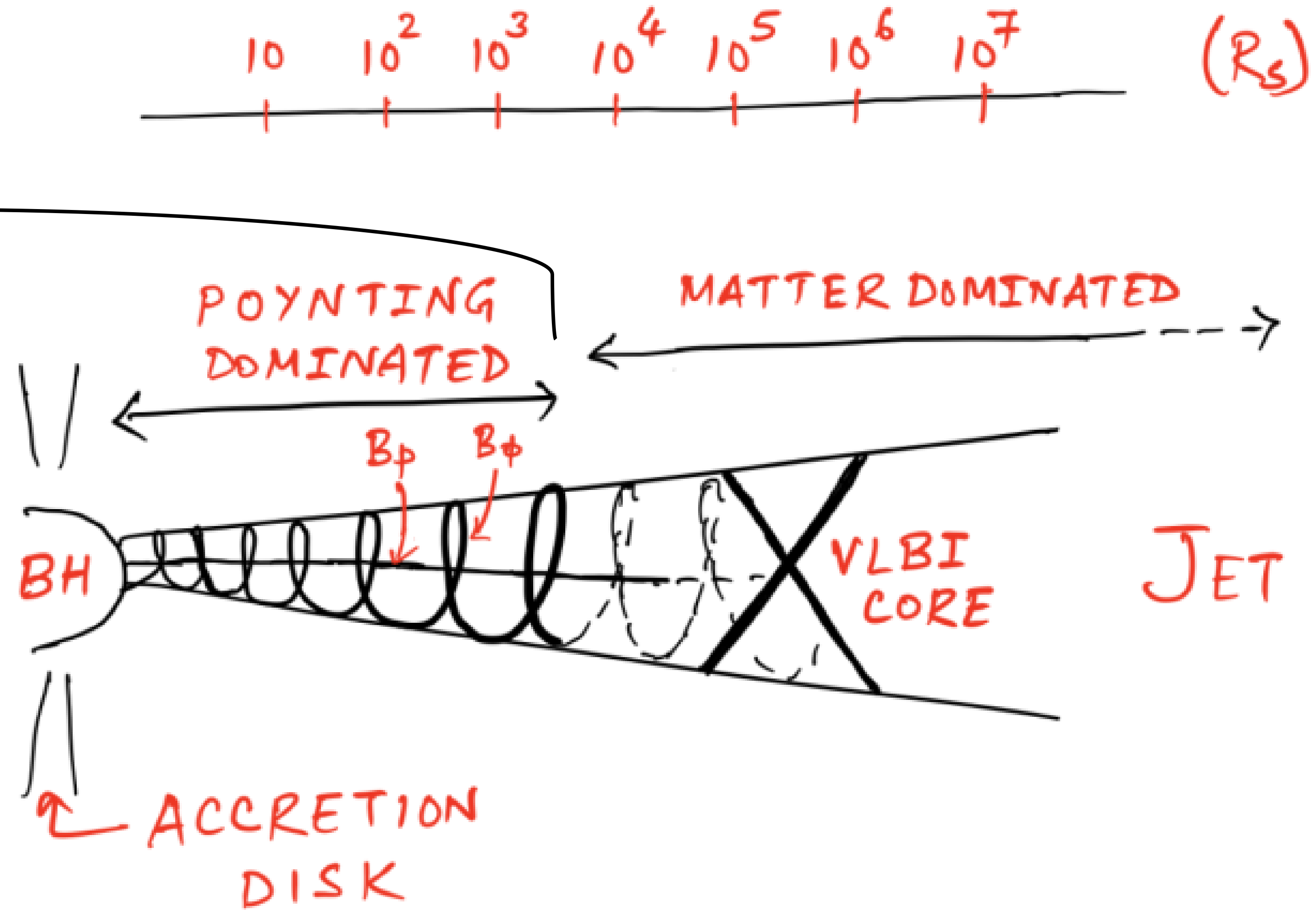

Roychowdhury et al. (in prep.)




Meyer et al. (2015)

# Implications of acceleration at 100 parsecs

- Magnetic acceleration ceases (standard model, Komissarov+).
- Generally, occurs at <0.1 pc (Sikora+ 05).
- Jet Poynting-dominated until 100 pc?
- Change in jet profile?
- Jet composition?



# Future goals

- Publish **DIFMAP 3.0**: contains state-of-the-art techniques for robustly modelfitting observations for *any* radio telescope.
- CAgNVAS → complementary to major VLBI monitoring studies , e.g., by Glenn Piner, MOJAVE or the BU Blazar Monitoring Program.

## DIFMAP: An Interactive Program for Synthesis Imaging

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**Abstract**

DIFMAP is a new interactive program for synthesis imaging. It includes data display, data editing, self-calibration, imaging, and deconvolution. The program, written in ANSI C, runs on UNIX workstations.

**1 Introduction**

DIFMAP is a program for the analysis of visibility data from aperture-synthesis radio telescopes, including data display, data editing, self-calibration, imaging (Fourier inversion), and deconvolution ("cleaning") (see Perley, Schwab & Bridle 1989; Pearson & Readhead 1984). DIFMAP takes advantage of the speed, large internal memory, and graphics capabilities of modern workstations to provide the astronomer with a fast and flexible data reduction environment. Cleaning is carried out by subtraction of model components in the

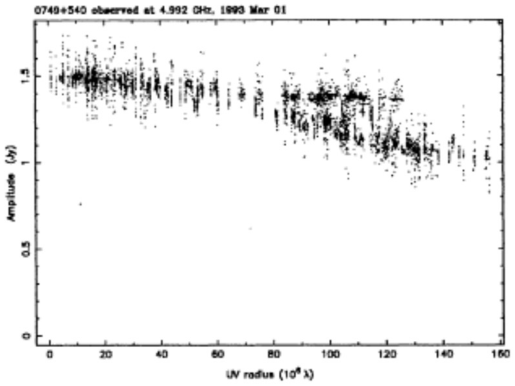


Fig. 1. Plot of visibility amplitude versus projected baseline from a VLBI snapshot observation of source 0749+540 (Taylor et al. 1994).

or other locator device. The data and processing parameters can be saved at any stage allowing the data analysis to be continued at a later time.

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## Interferometric Imaging Directly with Closure Phases and Closure Amplitudes

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