The two sided parsec scale structure of the Low Luminosity Active Galactic Nucleus in NGC 4278

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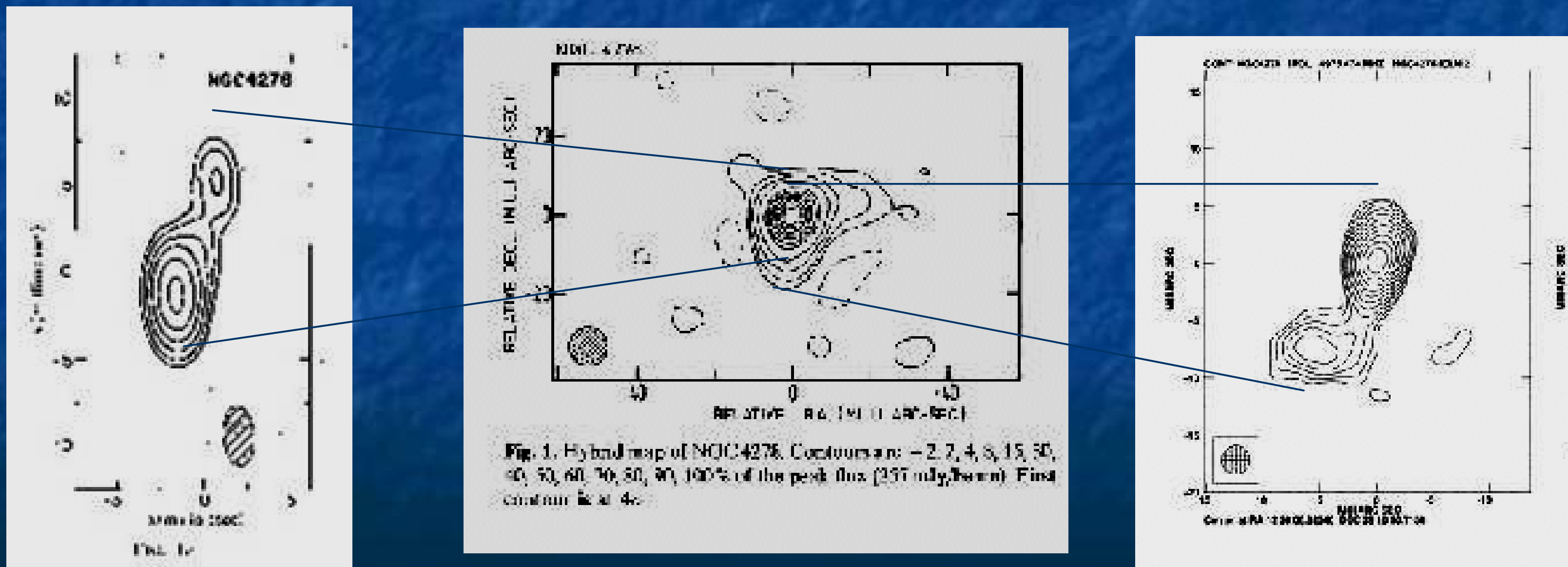
Introduction

- Nearby large dusty elliptical
- Direct distance measure = 14.9 Mpc (Jensen et al. 2003) ➔ 1mas = 0.071 pc
- $S_{1.4\ GHz}$=300 mJy, $P=10^{21.6}$ W Hz^{-1}: LLAGN
- Ionized nuclear gas typical of a LINER (Goudfrooj et al. 1994)
- HST observations reveal a central point source and a large distribution of dust N-NW of the core (Carollo et al 1997)

Radio data

- Compact on kpc scales between 1.4 and 43 GHz
- Moderately flat radio spectra ➔ non thermal emission
- Previous observations with VLBI:
  - -- Jones et al. 1981,1982,1984 USN
  - -- Schilizzi et al. 1983 EVN
  - -- Falcke et al. 2000 VLBA

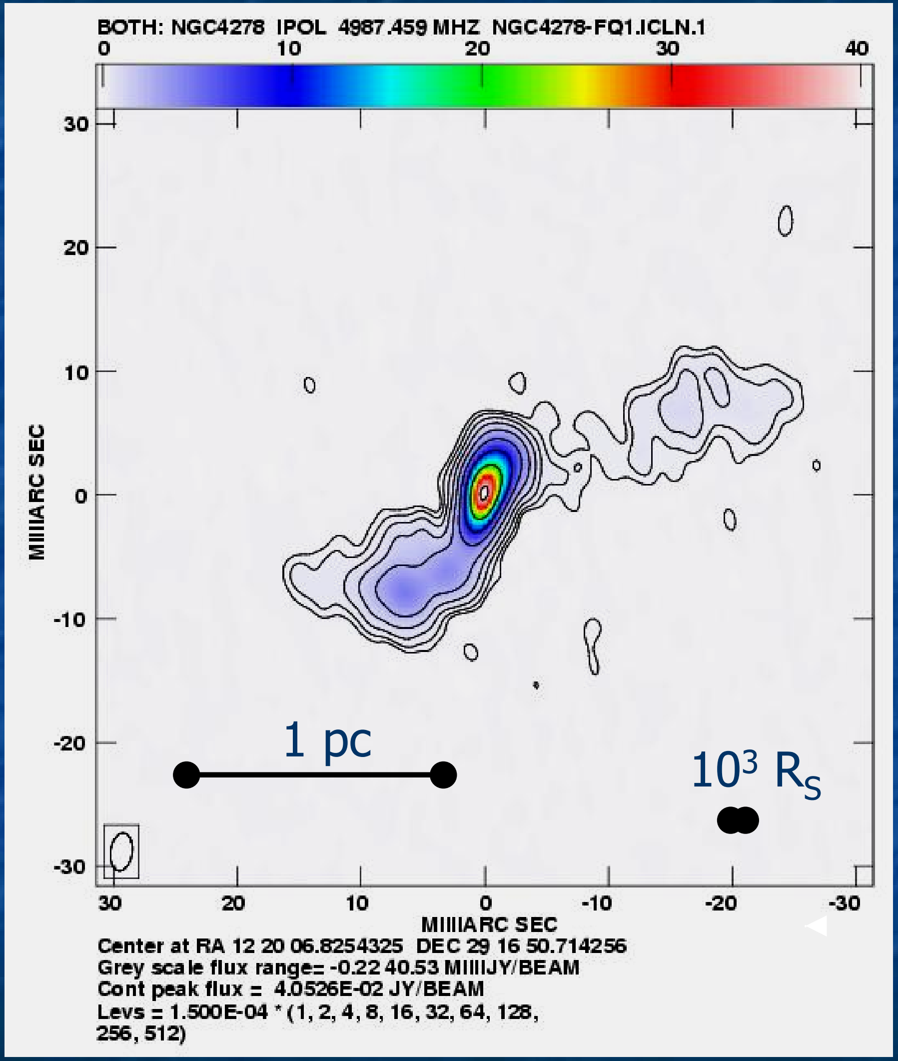


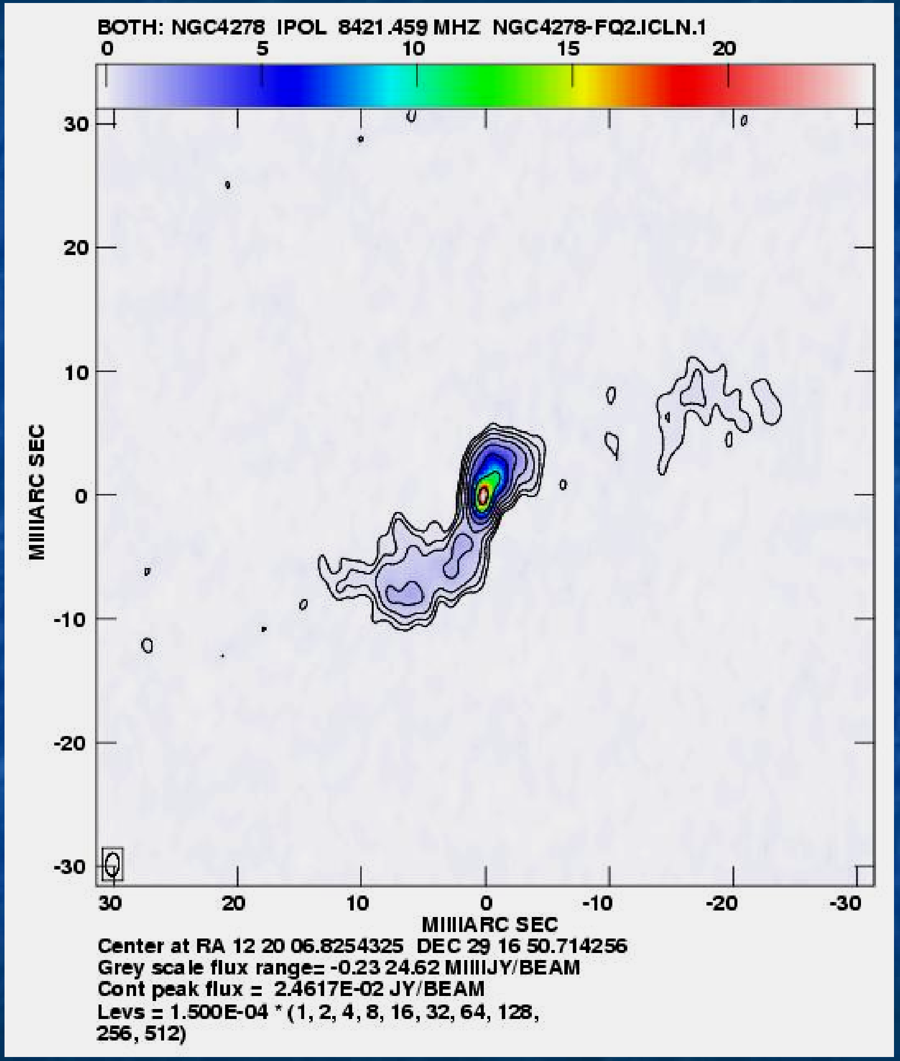
VLBA + Y1 observations

- August 2000, 5 and 8.4 GHz (12 hrs. total, full polarization)
- July 1995, 5 GHz (Giovannini et al. 2001 – 4 hrs – reanalyzed, improved thanks to the better position)
- Two sided emission thanks to the good short spacings uv coverage (Y1 Pt) (see also Bondi et al 2004)

More details in Giroletti et al. ApJ submitted

NGC 4278, images



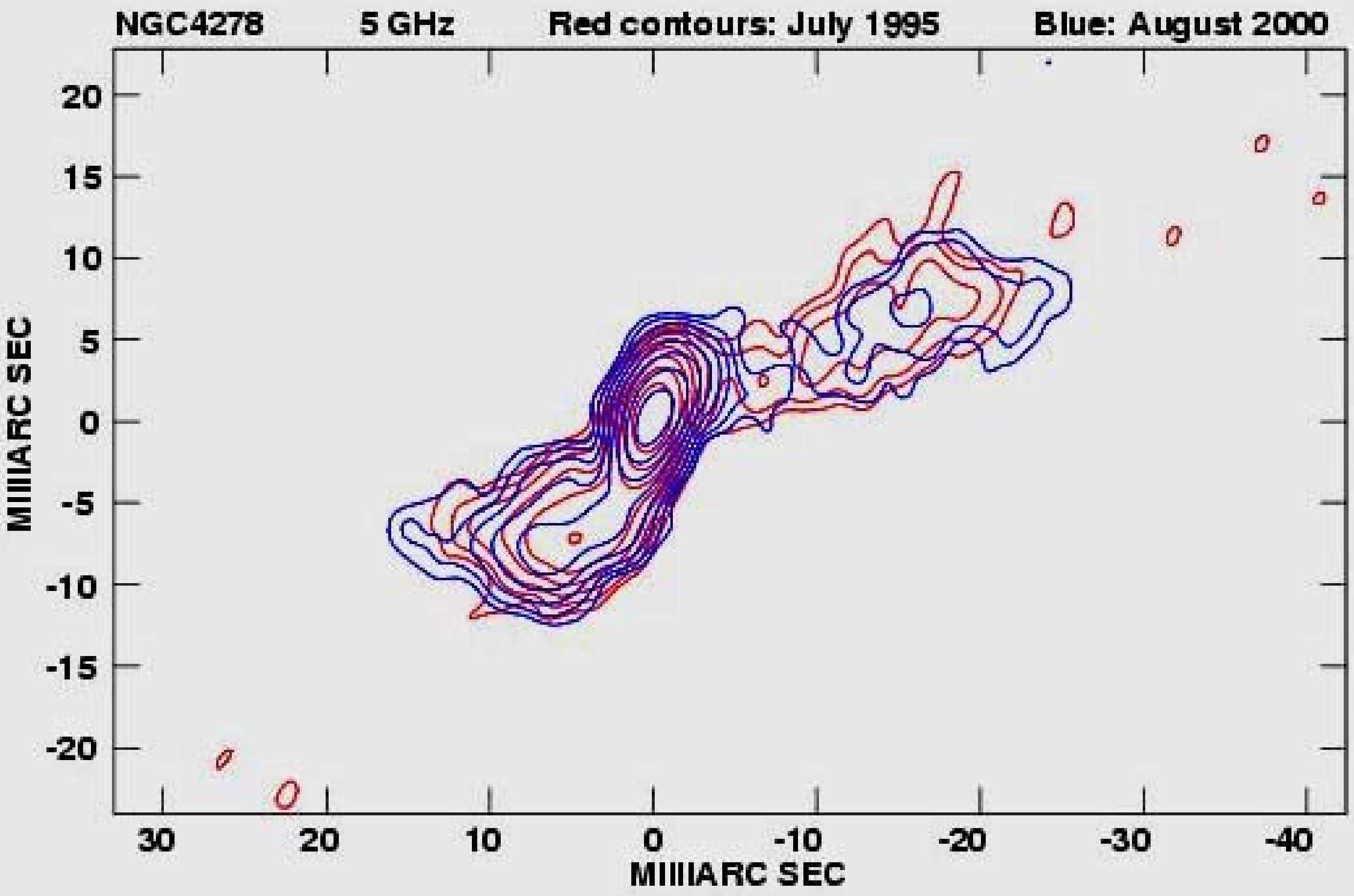


5 GHz

8.4 GHz

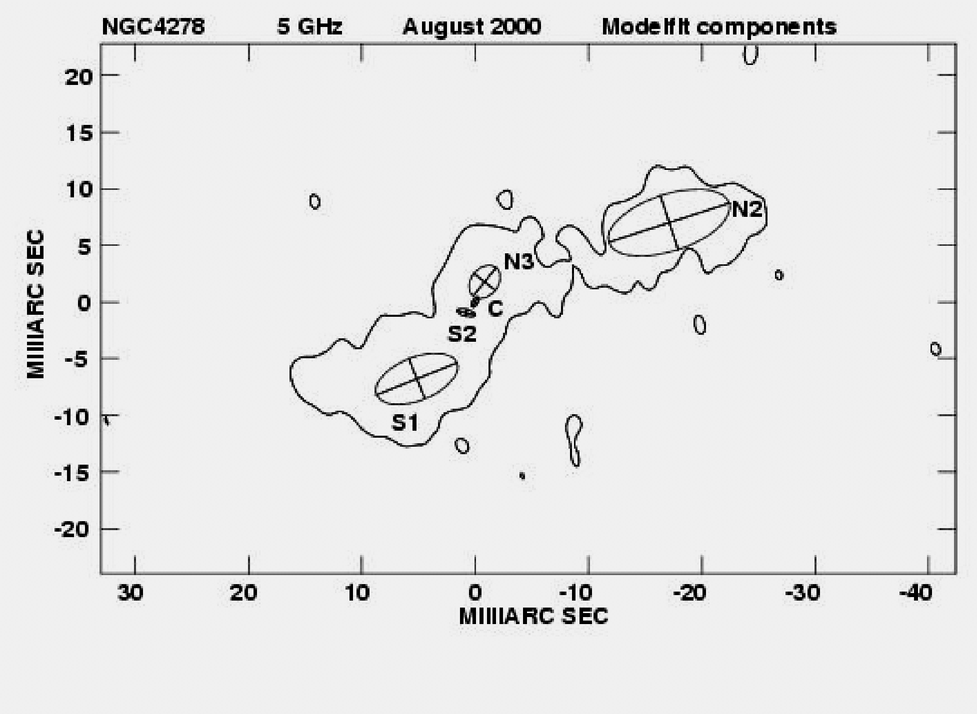
Correlated flux ≈ 85 -- 90 % total VLA flux density

NGC 4278, motion and age (1)



red: 1995 **blue: 2000**

NGC 4278, motion and age (2)



Comp.	motion (mas)	velocity (v/c)	age (yrs)	
S2…	0.45 ± 0.14	0.013 ± 0.004	29.1 ± 9.3	**
S1…	0.66 ± 0.12	0.019 ± 0.003	65.8 ± 12.4	
N3…	1.21 ± 0.09	0.034 ± 0.003	8.3 ± 0.5	
N2…	3.76 ± 0.65	0.106 ± 0.018	25.0 ± 4.8	**

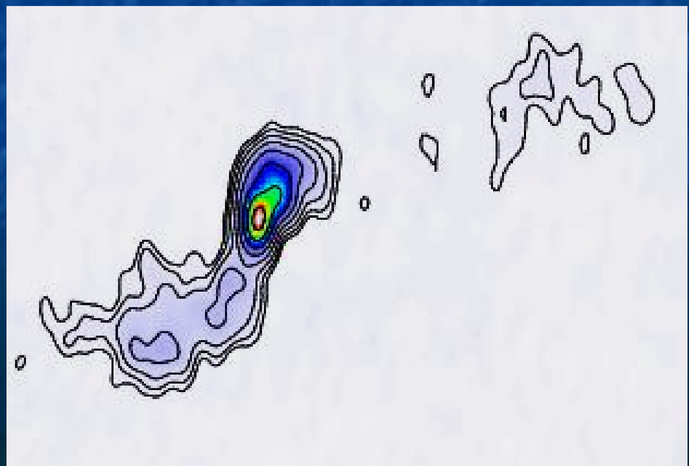
NGC 4278 is a two-sided source

Southern jet looks more collimated, however 8.4 GHz image clearly shows that the inner jet is brighter in the N jet region, in agreement with the apparent motion (larger in the N components)

This is in agreement also with the Jones et al image and with VLBA phase-referenced observations at 43 GHz (Ly et al. 2004)

We assume that the main and approaching jet is the Northern one

Assume N2 and S2 components are ejected in pairs with the same velocity and intrinsic brightness



Jet orientation and velocity

-- Arm ratio

$$R = r_{N2}/r_{S2} = (1+\beta\cos\theta)(1-\beta\cos\theta)^{-1}$$

-- $\beta_{asep}=(2\ \beta\sin\theta)(1-\beta^2\cos^2\theta)^{-1}$

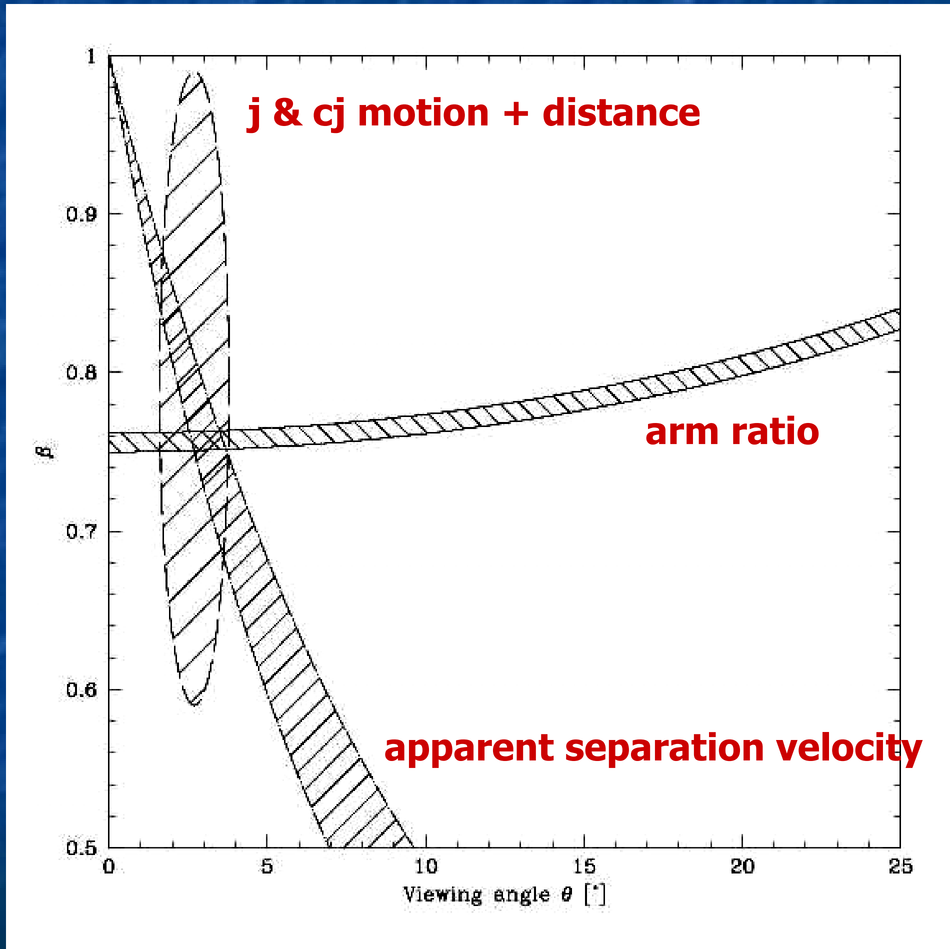
-- Since we know the source distance from the proper motion we can derive θ:

$$D = 0.5c\ \tan\theta\ (\mu_a - \mu_r)(\mu_a\mu_r)^{-1}$$

(Mirabel & Rodriguez, 1994)

NGC 4278, jet properties

- $0.65 < \beta < 0.85$
- $1.3 < \Gamma < 1.9$
- $2° < \theta < 4°$
- $2 < \delta < 3.5$
- $P_{int} < 10^{21}$ W Hz^{-1}



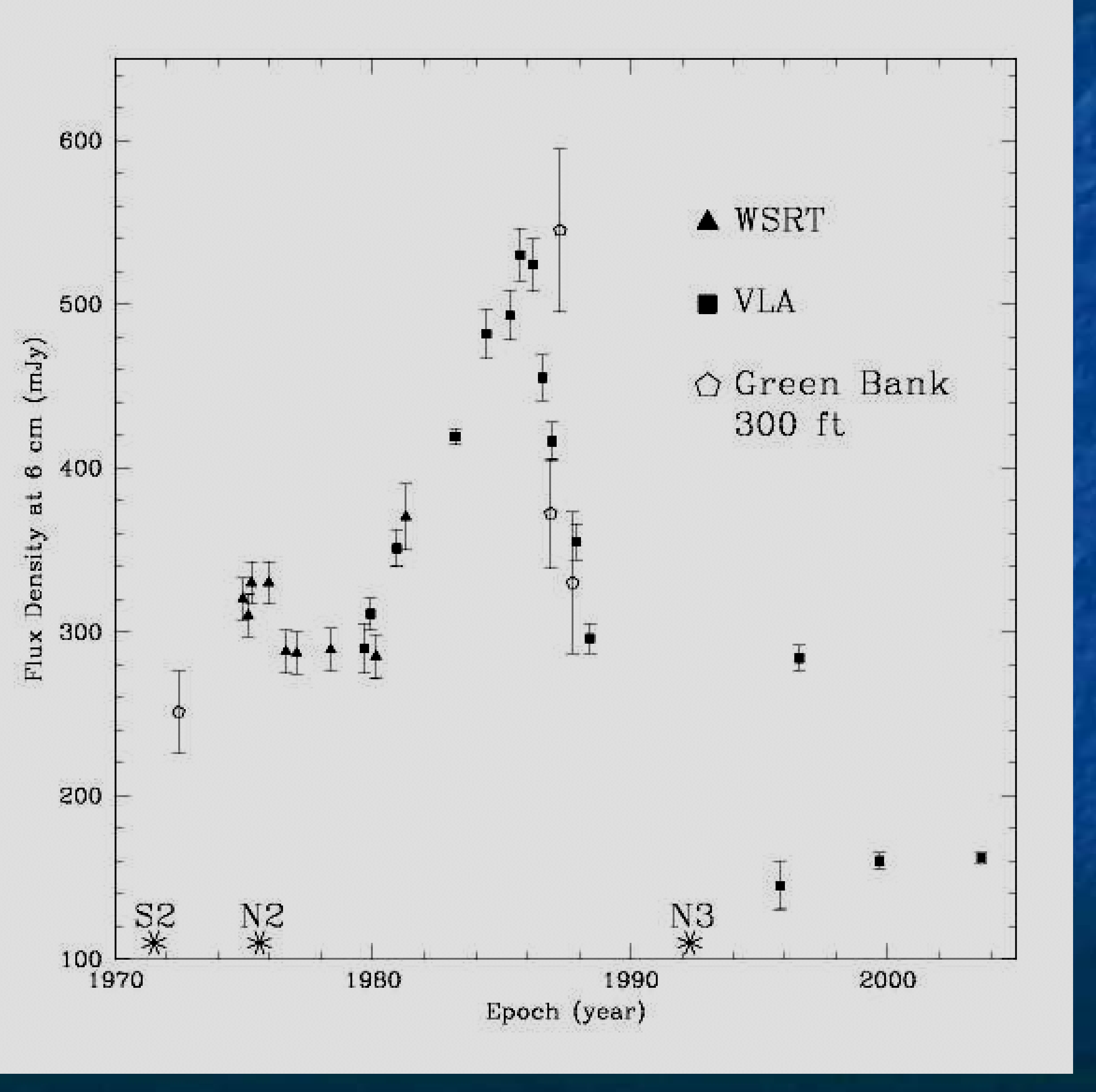
1) Moving components in the jets are not to be confused with hot spots present in CSO

2) Components are continually injected but they are soon disrupted and are not able to travel a long distance

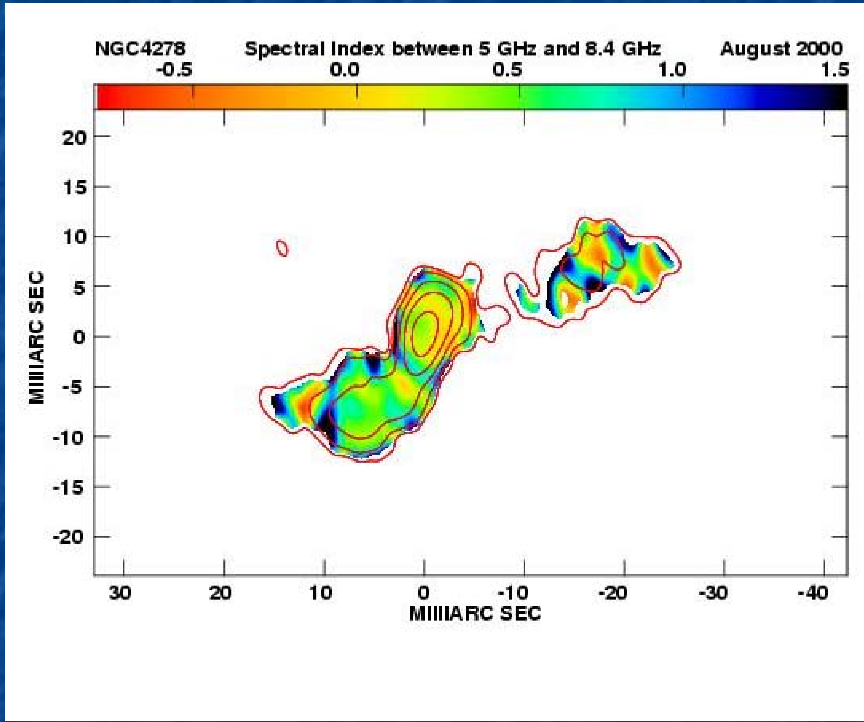
3) This source will not become a kpc scale radio galaxy but it will periodically inflate (slowly)

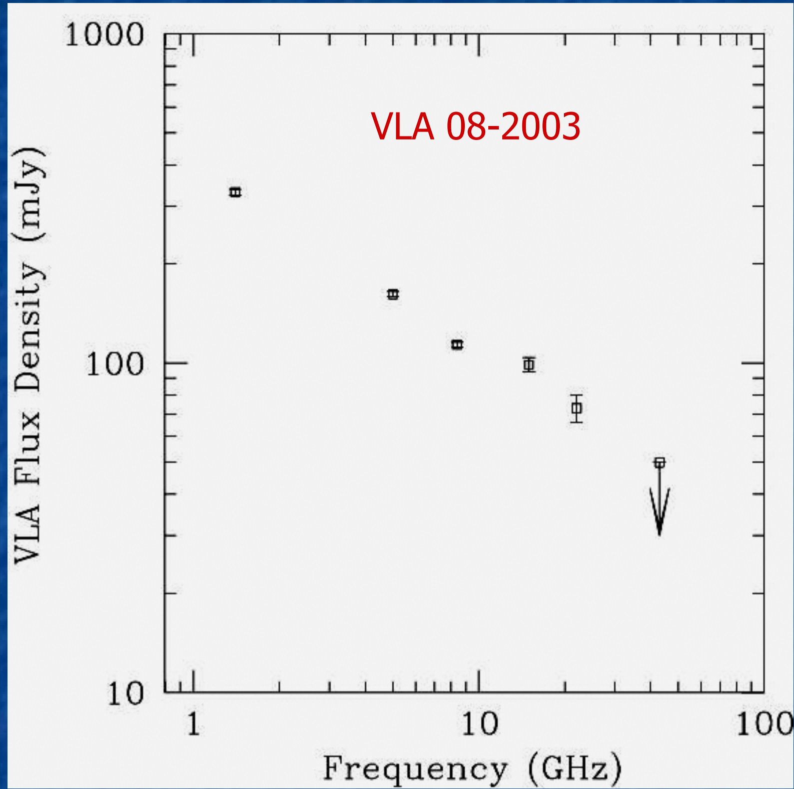
More in Giroletti et al. submitted to ApJ

Light curve for NGC 4278 at 5 GHz



NGC 4278, spectrum





- VLBA core flat, jets steeper
- VLA spectrum fitted by power law (α=0.54)
- together with morphology, and T_B = 10^9 K, confirms synchrotron emission in this LLAGN

Summary

- NGC 4278 → non thermal AGN activity
  - a two-sided LLAGN (on pc scale)
  - mildly relativistic jets, closely aligned to l-o-s
  - $T_b = 1.5 \times 10^9$ K
  - significant variability possibly related to the injection of new components
  - slowly expanding
  - because of its low radio power and maybe dense IGM it will not become a kpc scale radio galaxy

The End

Thanks