EVN observations of the BBH candidate SDSS J1536+0441

M. Bondi (IRA-INAF, Bologna, Italy)

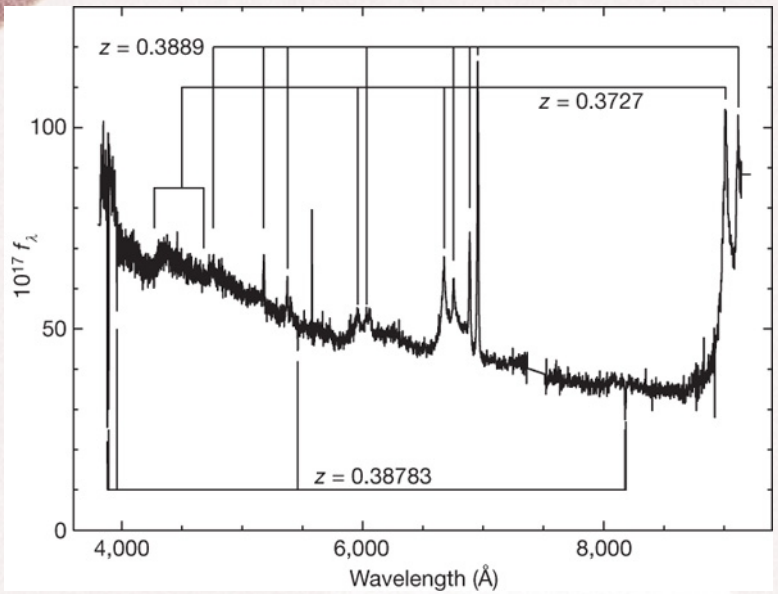
&

M.-A. Pérez-Torres (IAA-CSIC, Granada, Spain)

(ApJ Letters, 714, L271)

A sub-pc binary BH ?

J1536+0441



Boroson & Lauer, 2009, Nature

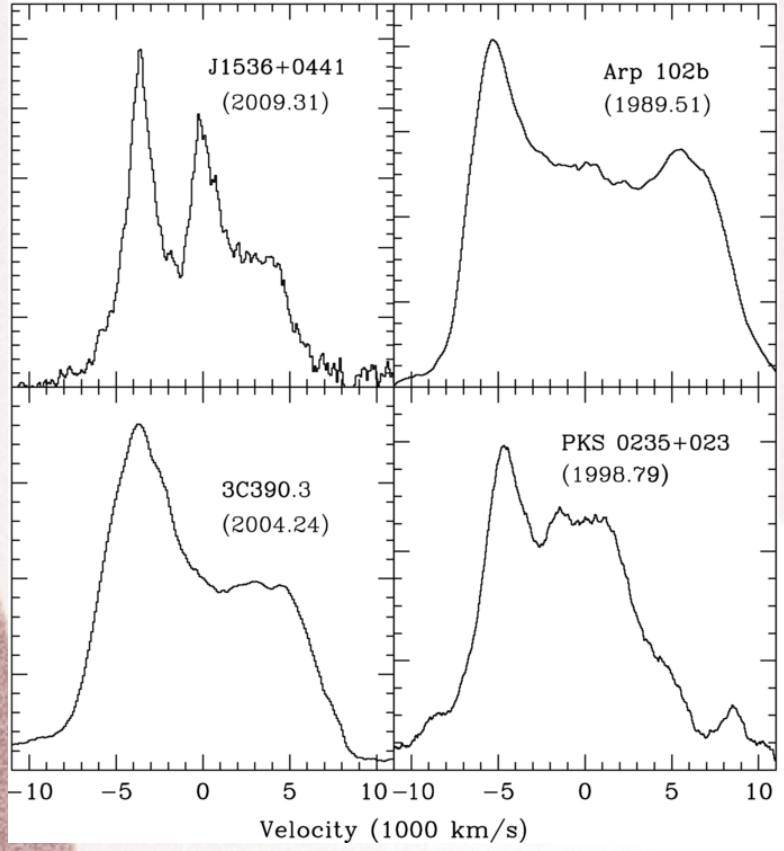
- *r-system: z=0.3889 broad + narrow,* ***typical***
- *b-system: z=0.3727 broad only, no narrow or forbidden lines,* ***unusual***
- *a-system: z=0.3878 absorption only, unresolved, due to neutral gas not stars,* ***unusual***

- *Binary black-hole system separated by 0.1 pc (0.02 mas) and orbital period of about 100 yr*

… or a double peaked emitter

(Gaskell 2010, Chornock et al. 2010)

2 rounded peaks of roughly equal strength joined by a flat central plateau. This form can be well fitted by simple relativistic accretion disk models (Eracleous & Halpern '94).

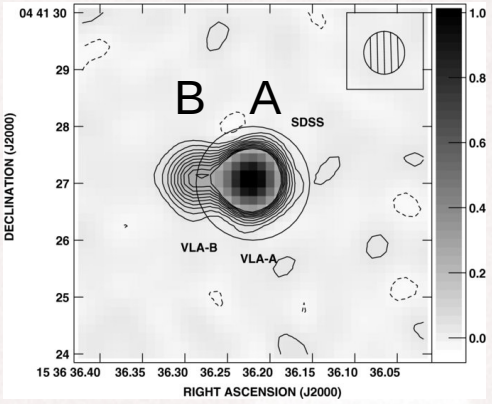


But … a peculiar one

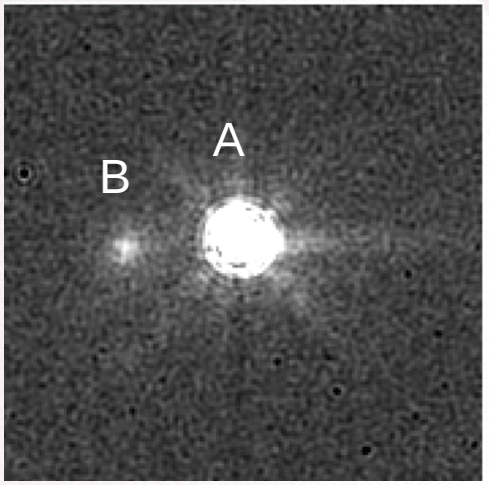
Lauer & Boroson 09

... or a kpc-scale AGN pair ?

- AGN pair:



Wrobel & Laor (2009): VLA 8.5 GHz VLA-A (1.17 mJy) and VLA-B (0.27 mJy) comps. separated by **0.97 arcsec (5 kpc)**

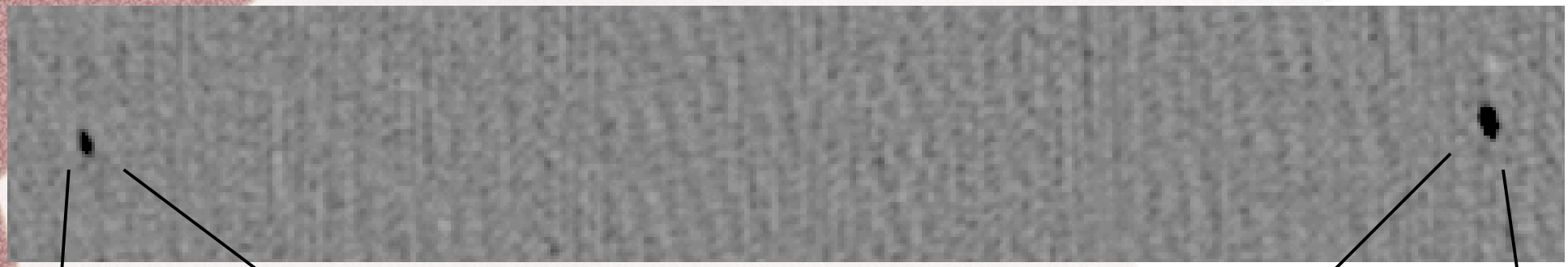


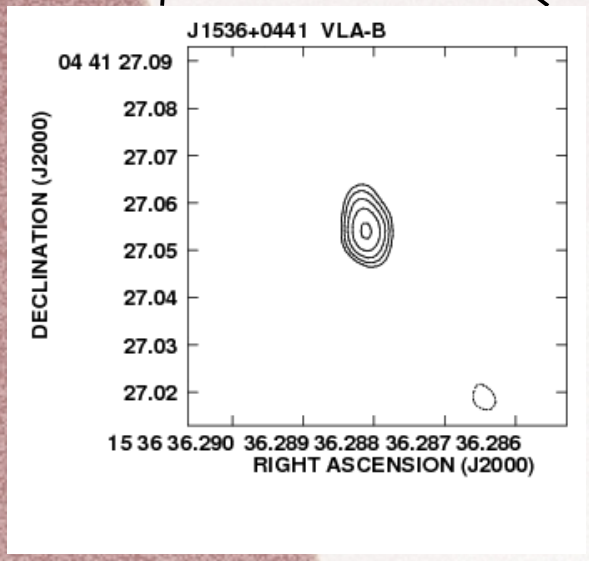
Lauer & Boroson 2009: HST image

EVN Observations

- Main goals:
  - Pinpoint the AGN/AGNs position
  - Identify the nature of the radio-emission in VLA-B
  - Image the pc-scale structure of VLA-A and derive spectral index info using the available VLA-VLBA data
- EVN Observations:
  - Oct. 2009, 5 hr on-source
  - 5 GHz @ 1024 Mbit/s
  - Beam 12 x 7 mas natural weighting
  - r.m.s. 15 μJy/beam

EVN Images

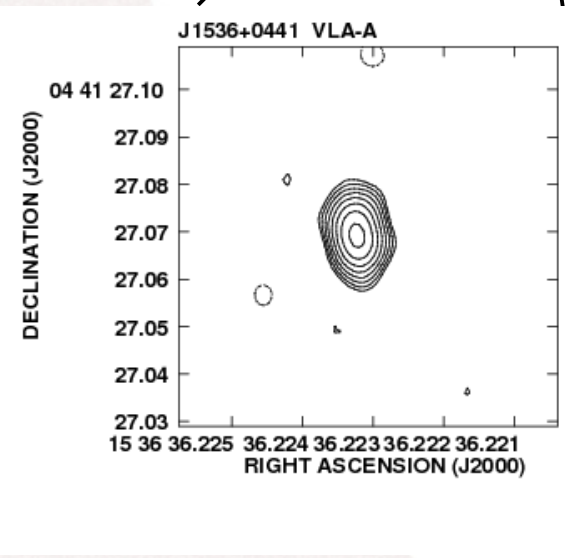




Beam: 12 x 7 mas natural weighting
r.m.s = 15 μJy/beam

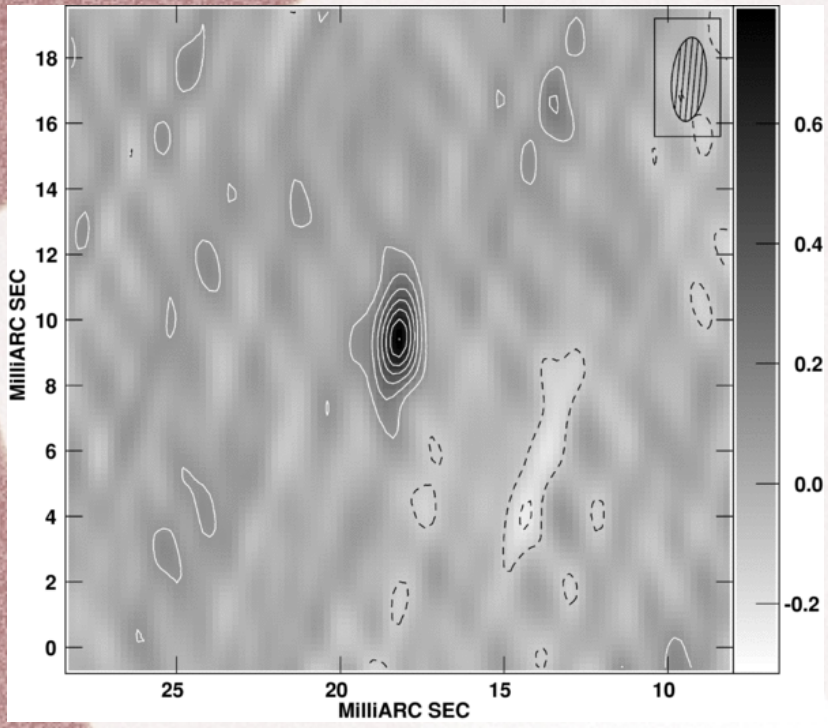
VLA-A: 0.72 ± 0.06 mJy
S/N = 40
3.2 x 2.5 mas

VLA-B: 0.24 ± 0.04 mJy
S/N = 15
unresolved



VLBA Image

VLA-A



- Wrobel & Laor 2010:

  VLBA 8.5 GHz

  Beam 2.6 x 1.0 mas

  r.m.s. 56 μJy/beam

Results

The Spectral shape

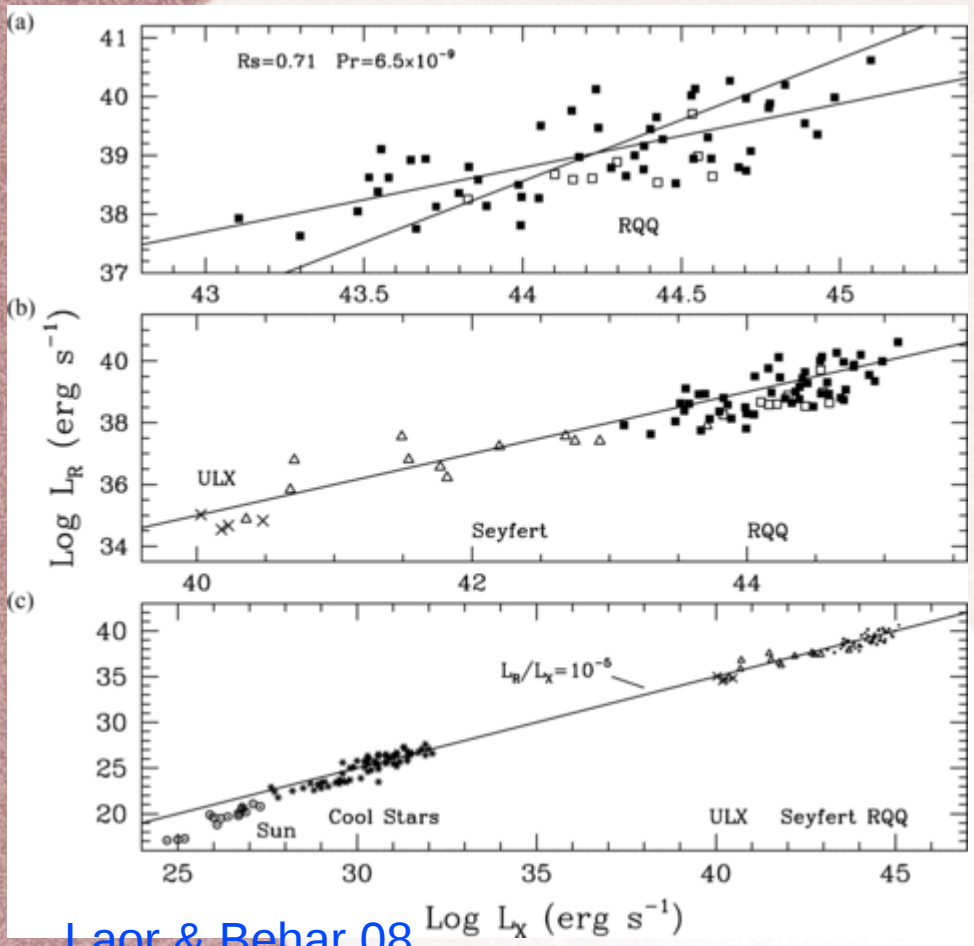
	VLA	VLBI	VLBI	VLA	VLA
COMP.	1.4 GHz	5 GHz	8.5 GHz	8.5 GHz	22.5 GHz
J1536+0441A	< 0.6 (A+B)	0.72 ± 0.06	0.88 ± 0.12	1.17 ± 0.04	1.65 ± 0.11
J1536+0441B	< 0.6 (A+B)	0.24 ± 0.03		0.27 ± 0.02	
	FIRST	2009 Oct	2009 Oct	2009 Feb	2009 May

Brightness Temperature

J1536+0441A = 10**7 K
J1536+0041B > 6 x 10**6 K

Results

Origin of radio emission in J1536+0441A



Laor & Behar 08

Inverted radio spectrum
Low brightness temperature

Thermal free-free emission from a disk wind heated by the X-ray continuum (Gallimore et al. '96, Blundell & Zuncic '07)

$$L_R/L_X = 1.4 \times 10^{-5}$$

Summary

- Detected compact cores in both sources with $L_{5\mathrm{GHz}} \sim 10^{23}\ \mathrm{WHz}^{-1}$
- Spectral shape in comp-A produced by thermal free-free emission.
- Consistent with radio-X luminosity correlation observed in RQQ and Seyfert galaxies.