A JVN observation of double-peaked AGN 3C332

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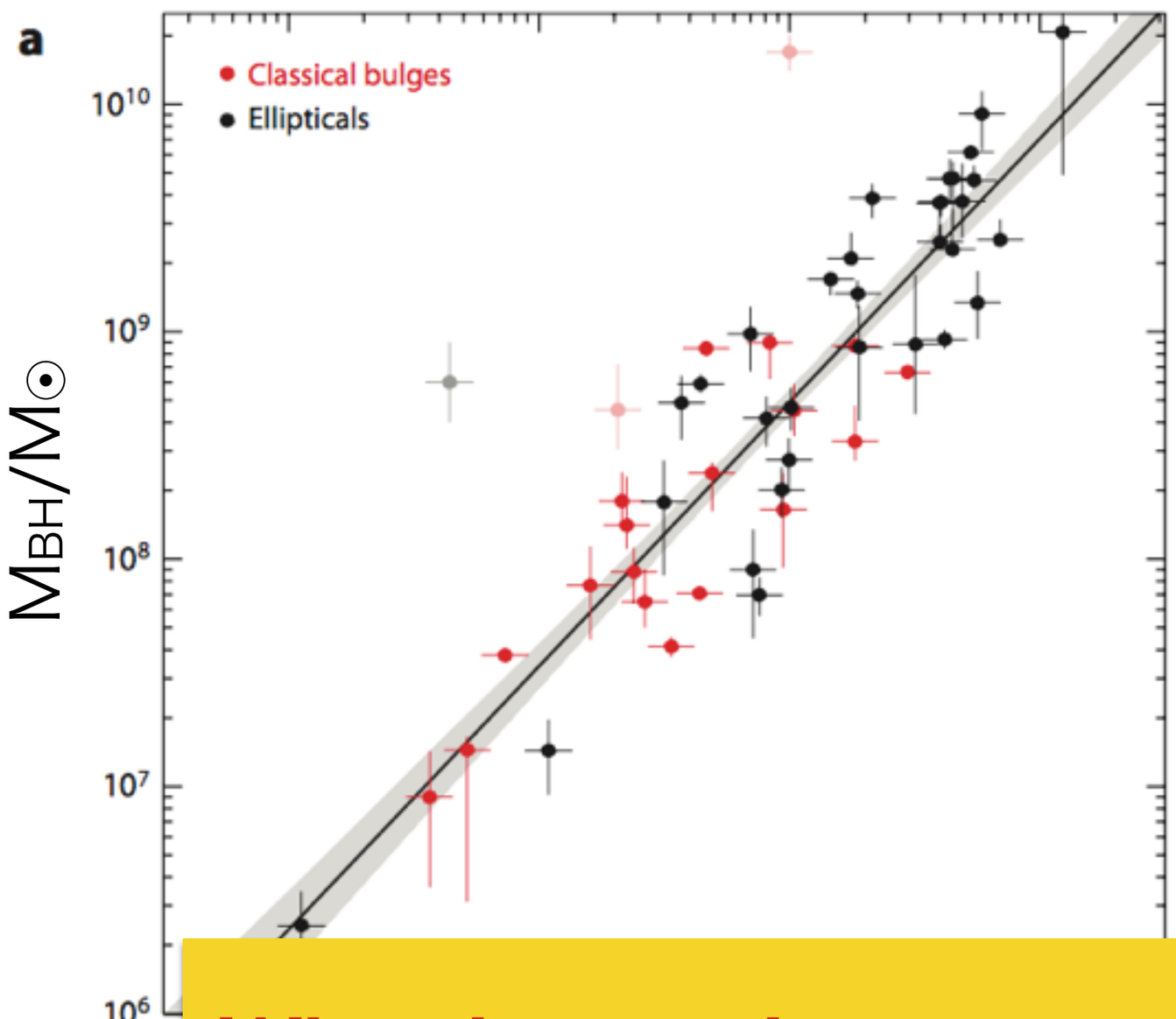
Abstract

- We have been surveying to reveal major process of coevolution of galaxies and SMBHs with JVN
  - merger process or not?

- 3C332 is one of our targets of this survey

- We detect at least single radio core of 3C332 at 8 GHz and estimate SMBH mass.

Coevolution of Galaxies and SMBH



Maggorian relation and

Coevolution ?

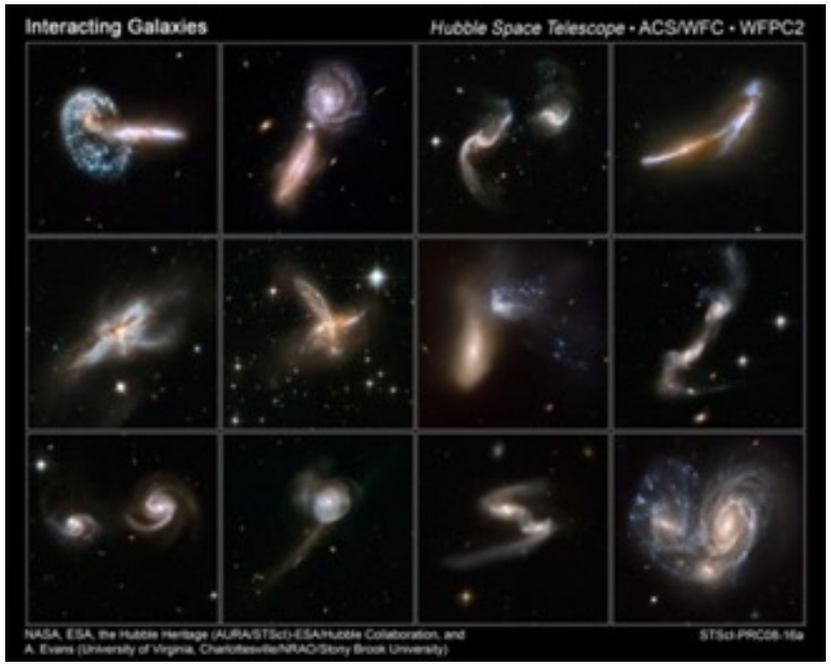
What is causing process of this coevolution?

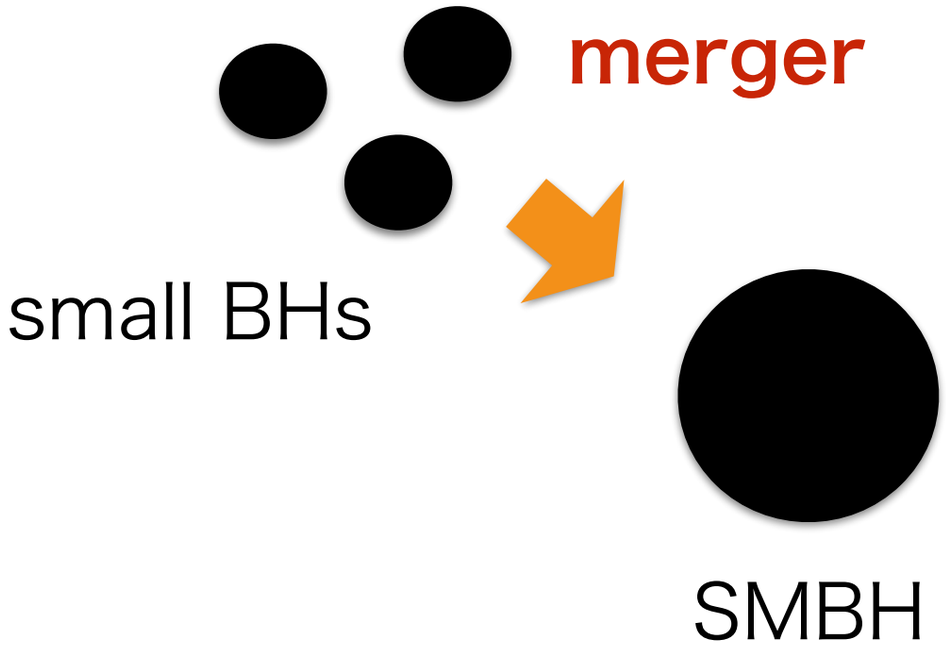
Kormendy&Ho 2013

Process of Coevolution — merger

ΛCDM model suggests hierarchical processes

One of the major processes is merger and this process indicates coevolution between host galaxy and SMBH. (Kormendy&Ho 2013)





http://spaceinfo.jaxa.jp/ja/collision_of_galaxy.html

Survey — for revealing frequency of merger

How do we assess the contribution of merger
to coevolution of host galaxy and SMBH ?

Counting the number of SMBHs from high-z to low-z

- High-resolution
- High-sensitivity
- Many targets

High-sensitivity VLBI observation.

Our group have been surveying observation to reveal signatures of merger by Japanese VLBI Network

Japanese VLBI Network (JVN)

Array performance

Baseline : 54 km ~ 2564 km

Sensitivity : 4 mJy ~ 94 mJy

(@8 GHz)

http://www.astro.sci.yamaguchi-u.ac.jp/jvn/

Our observation

Array :

- Usuda(臼田) station
- Tsukuba(筑波) station
- Hitachi(日立) station
- Yamaguchi(山口) station

Sensitivity (8GHz) :

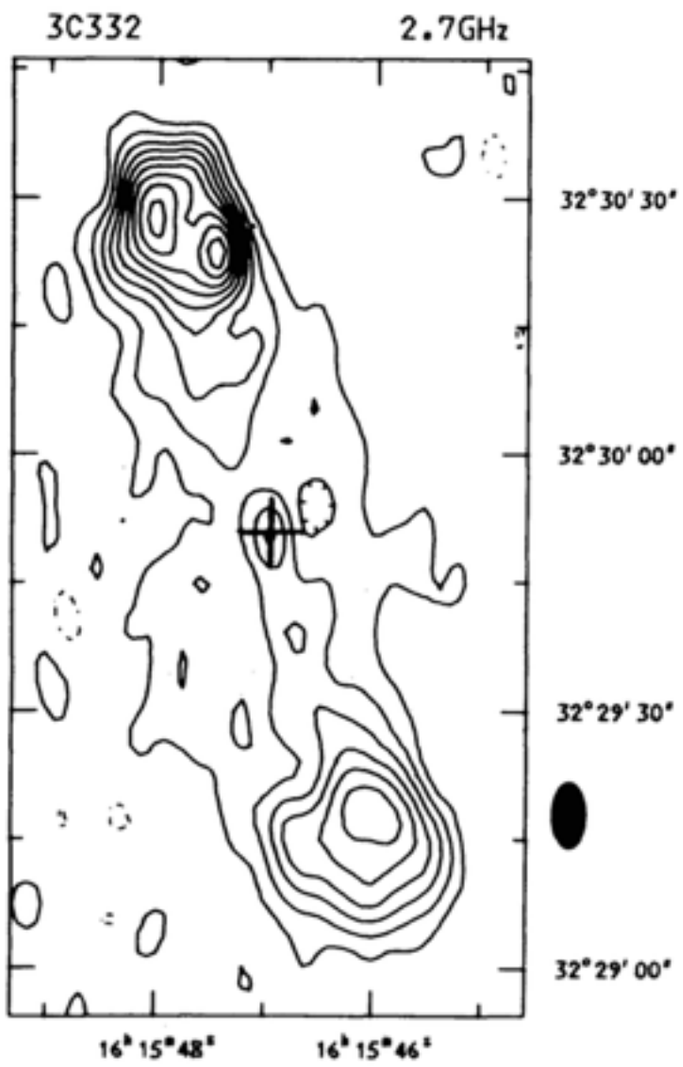
- 7 σ ~ 3.6 mJy

Resolution(Baseline) :

- 10 mas(800 km)

Radio Galaxy 3C332 (z ~ 0.15)

No detection with VLBI



Miller 1985

Properties:

- Pair of radio lobes (Miller 1985)
  - pair of radio lobes in 1.4 GHz with **VLA.**
- Double peaked AGN (Cao & Wang 2006)
  - bipolar outflow
  - accretion disk
  - symmetric BLR
  - a binary BLR in a binary SMBH system

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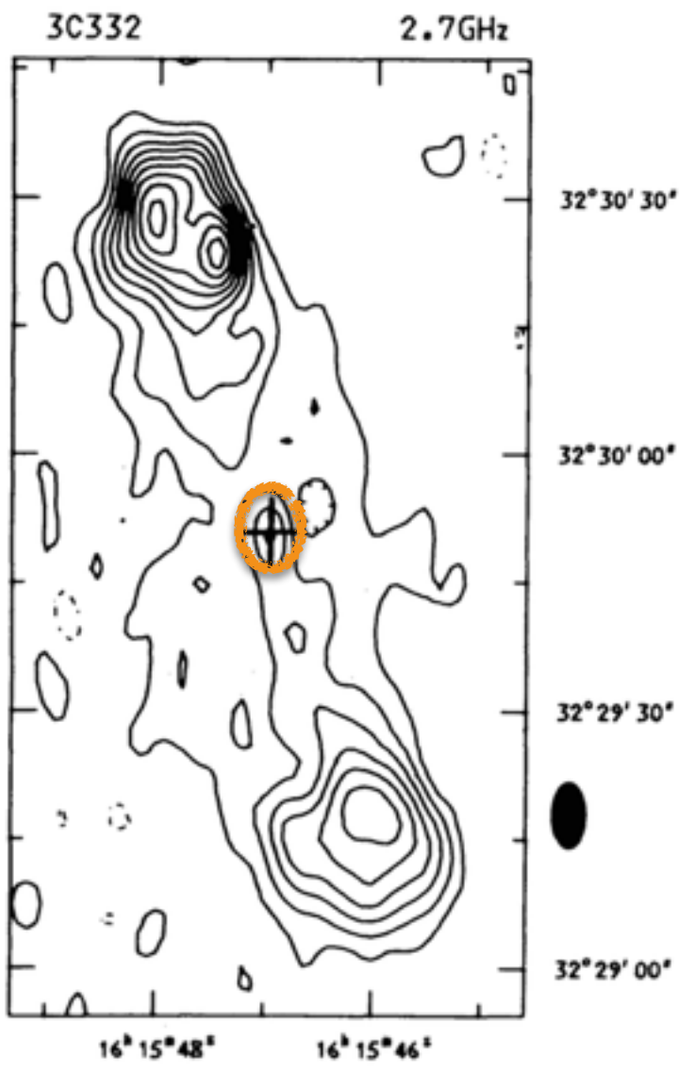

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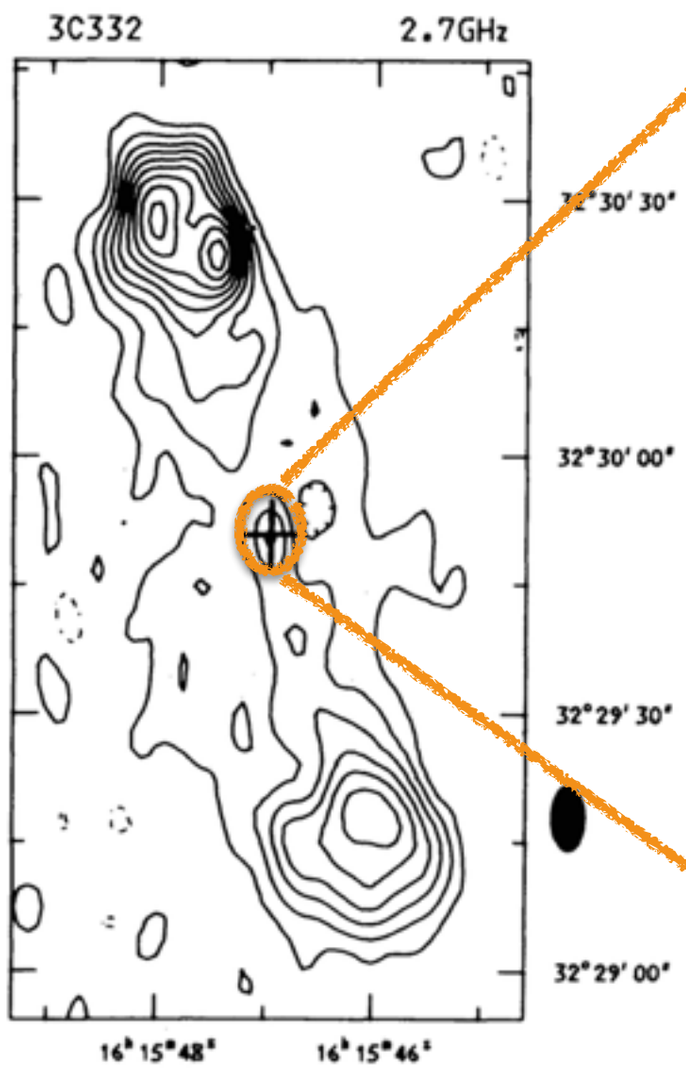
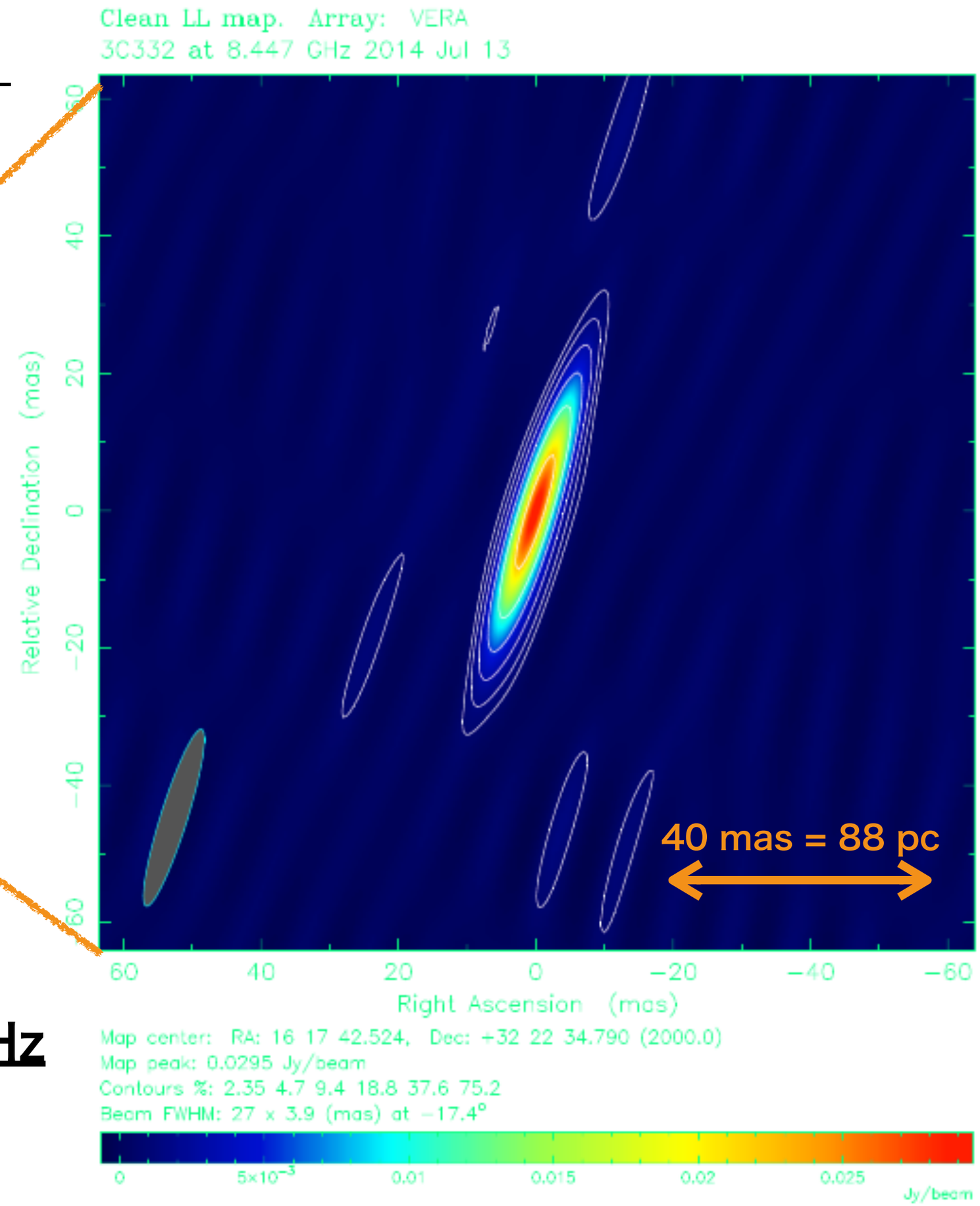
Result

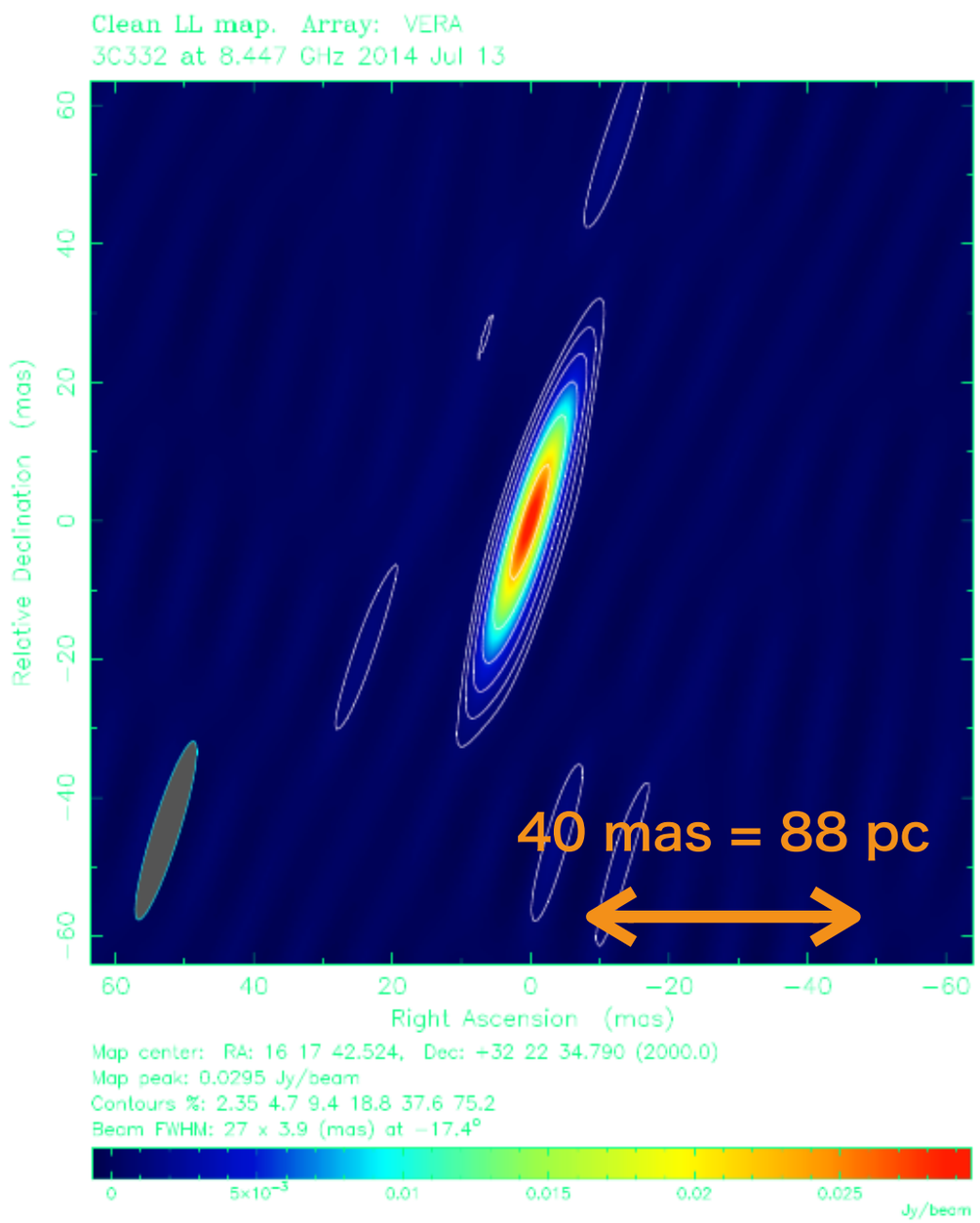
Image of 3C332





- Flux : ~ 30 mJy@8 GHz

Origin of detected component in 3C332



- Brightness Temperature :
  $T_B \sim 2 \times 10^9$ K

linear scale of beam size :~22 pc
$T_B > 10^5$ K (typical value of SN)

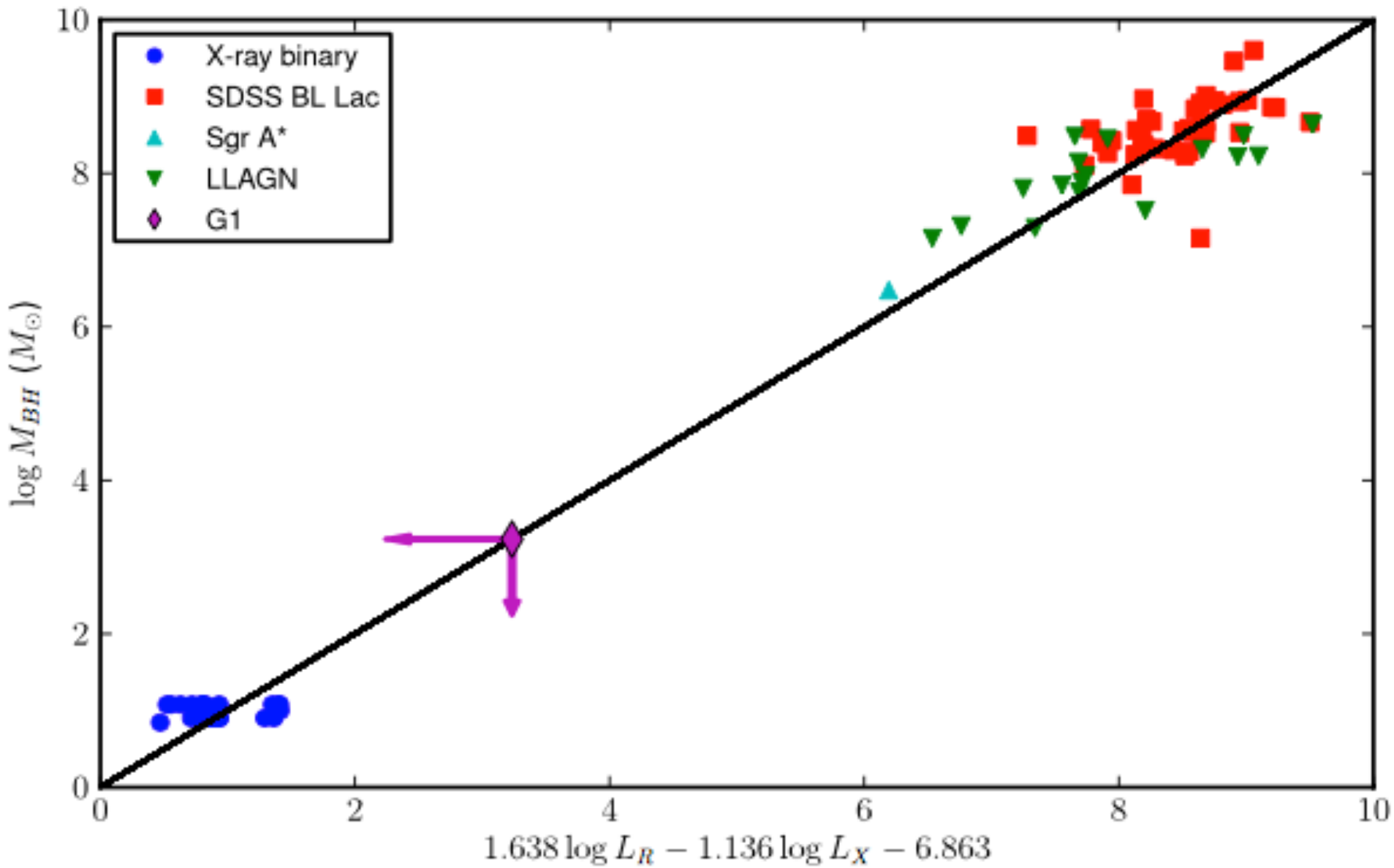
The origin of component is

- ○ **AGN**
- × **SNR or SNe**

SMBH mass of 3C332 radio core

Estimate SMBH mass (assumed single core)

← Fundamental Plane(Merloni et al.2003, Falcke et al.2004)



Paragi et al.2014

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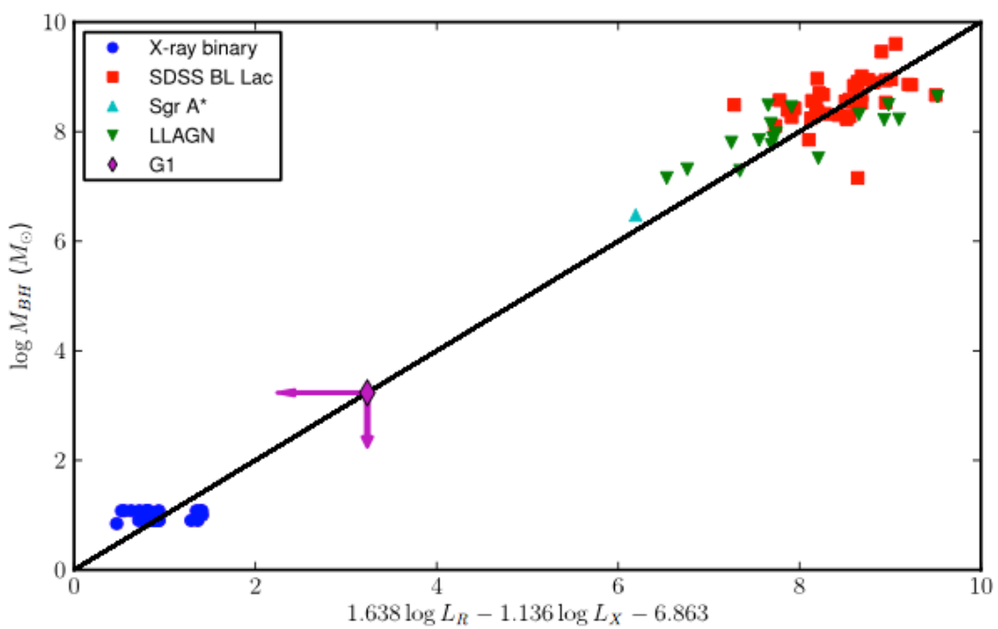
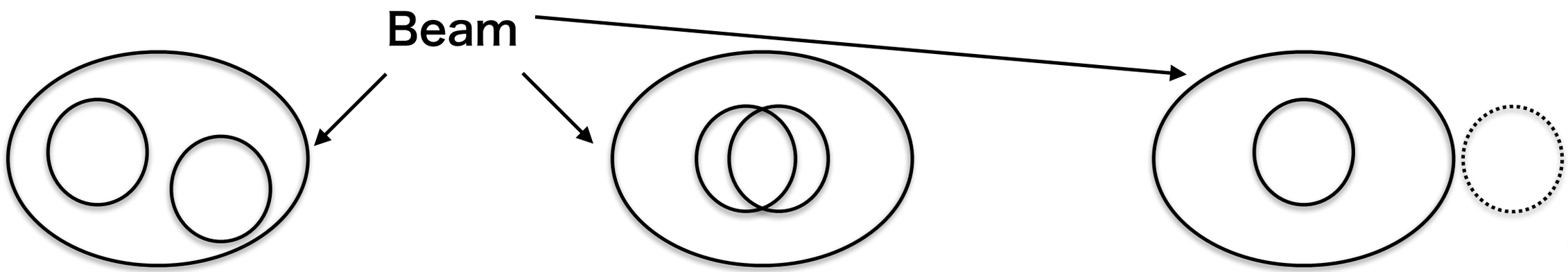


Paragi et al.2014

- L(5GHz) = 6.0×10^{33} W
  (assumed α=0.3 (Slee et al.1994))
- L(2-10keV) = 1.6×10^{36} W
  (Sambruna et al.1999)

SMBH mass of 3C332 : 4.0×10^7 M⊙

How many nuclei ?

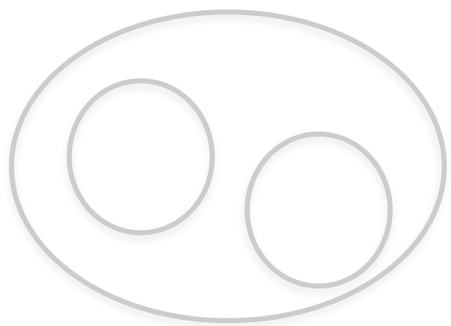


- Approaching within 22pc
- Already merged
- One source is radio quiet

- Dual AGN only detected by Rodriguez et al.2006 : ~ 7 pc (~7 mas)

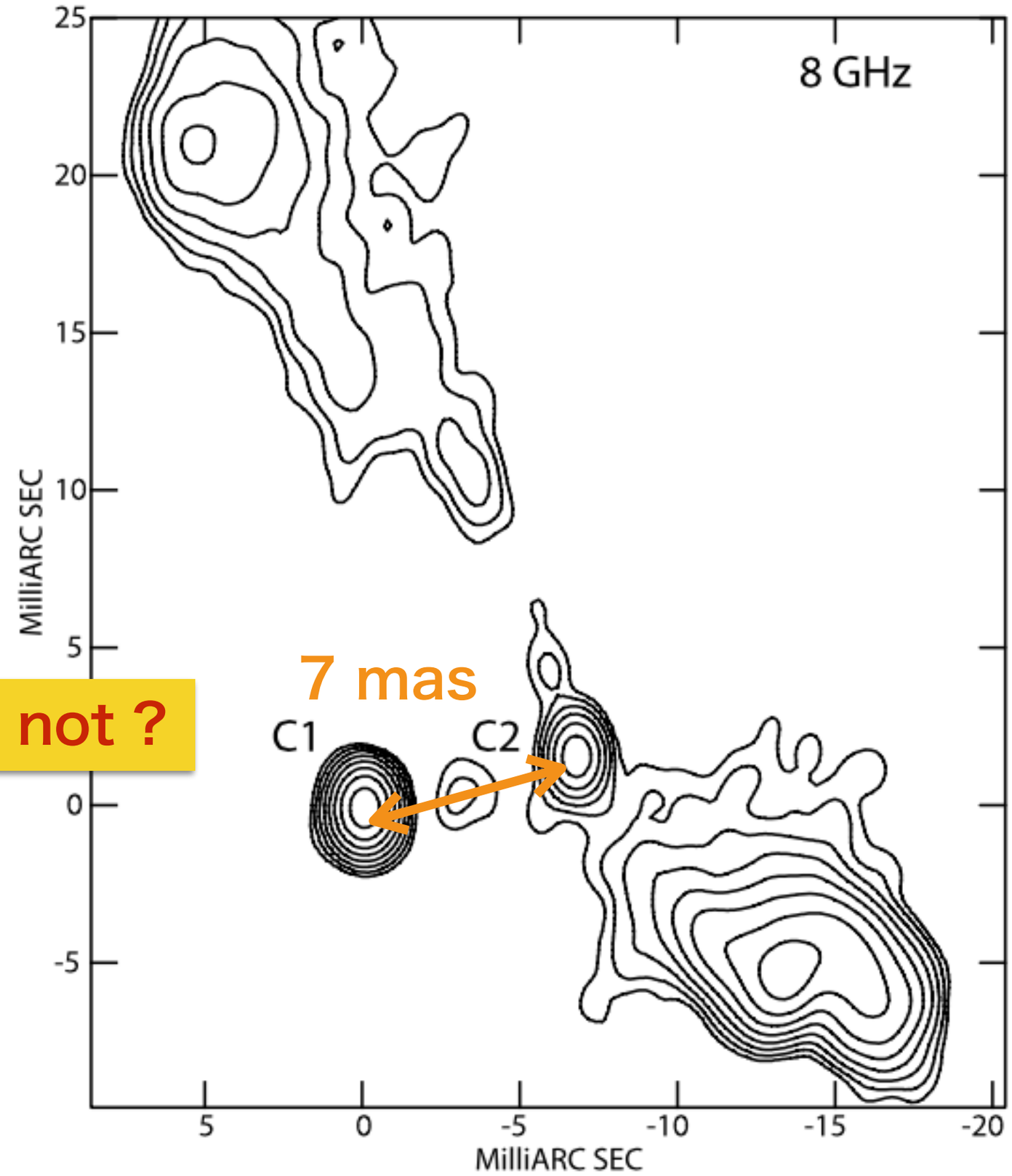
Discussion

How many nu



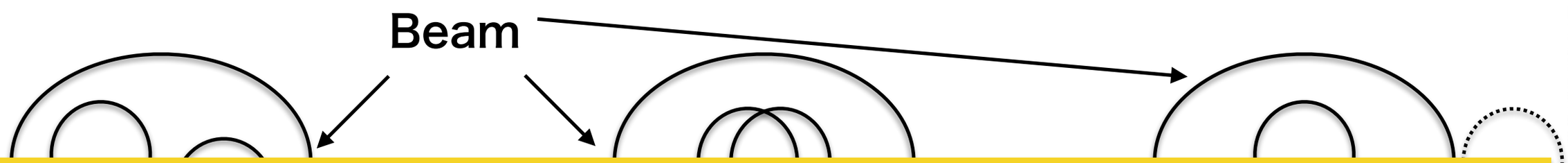
- Approaching

Typical value or not ?



Rodriguez et al.2006

How many nuclei ?



But our observation is frist detection for 3C332

Maybe many VLBI sources in hiding

・Dual AGN only detected by Rodriguez et al.2006 :
~ 7 pc (~7 mas)

We only say “detect radio core in 10 mas resolution”

Conclusion

- **We detect radio core of double peaked AGN 3C332.**

- **Estimate SMBH mass of 3C332 from Fundamental Plane**
  → $M_{BH} \sim 4.0 \times 10^7\ M_\odot$

- **Detected <u>single core</u>**
  → Three possibilities :
    - Already quenched in radio
    - Already merged
    - One source is quenched

Future work

3C93 — nearby double peaked AGN
3C8 and PKS0139-273 — high-z radio galaxies
and much more samples sources・・・

- 3C93 are not detected with JVN three baseline
  (3, December, 2014), (Yamaguchi, Tsukuba, Hitachi)

- 3C8 are only detected with JVN in short baseline(800 mas)
  (4, December, 2014), (Yamaguchi, Hitachi, Tsukuba)

- PKS0139-273 are observed by JVN
  - PKS0139-273 is observed 4 stations(21, May, 2015)

- Survey observation
  - ongoing project (have observed 109 targets)