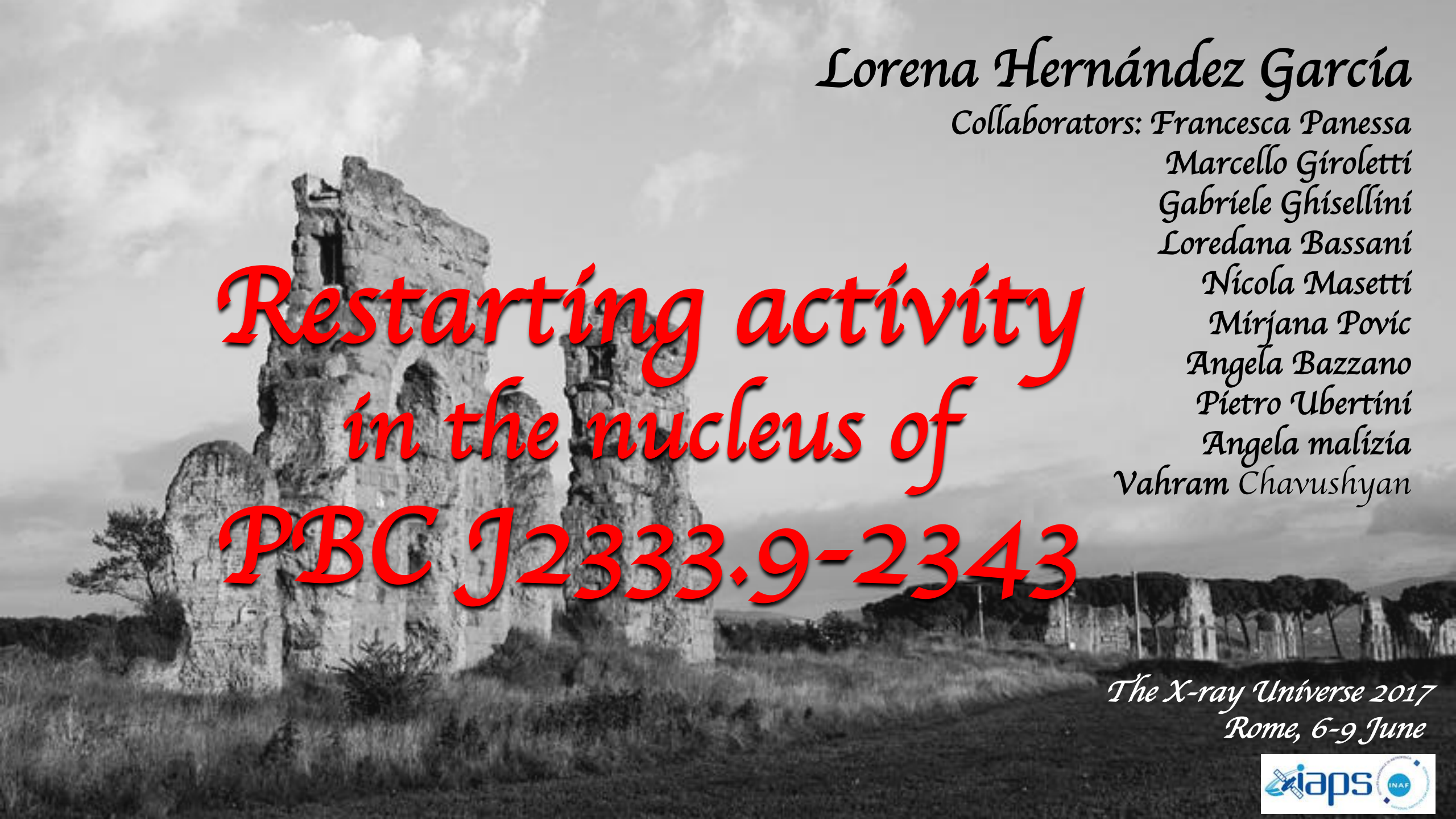

Restarting activity in the nucleus of PBC J2333.9-2343

Lorena Hernández García

Collaborators: Francesca Panessa
Marcello Giroletti
Gabriele Ghisellini
Loredana Bassani
Nicola Masetti
Mirjana Povic
Angela Bazzano
Pietro Ubertini
Angela malizia
Vahram Chavushyan

The X-ray Universe 2017
Rome, 6-9 June

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Giant radio galaxies (GRG)

Introduction

- Extended emission > 0.7 Mpc (Ishwara-Chandra & Saikia 1999)
- Spectral ages can be 10^7-10^8 yr (Alexander & Leahy 1987)
- Perfect laboratories to study intermitent activity and AGN evolution

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PBC J2333.9-2343

- Giant radio galaxy (Bassani et al. 2016)
- Classified as Seyfert 2 in the optical, with z= 0.0475 (Parisi et al. 2012)
- Unobscured at X-rays , i.e., type 1 ? (Parisi et al. 2012)
- Blazar at radio frequencies (Massaro et al. 2009), jet in VLBI at 8.4 GHz (Ojha et al. 2004)

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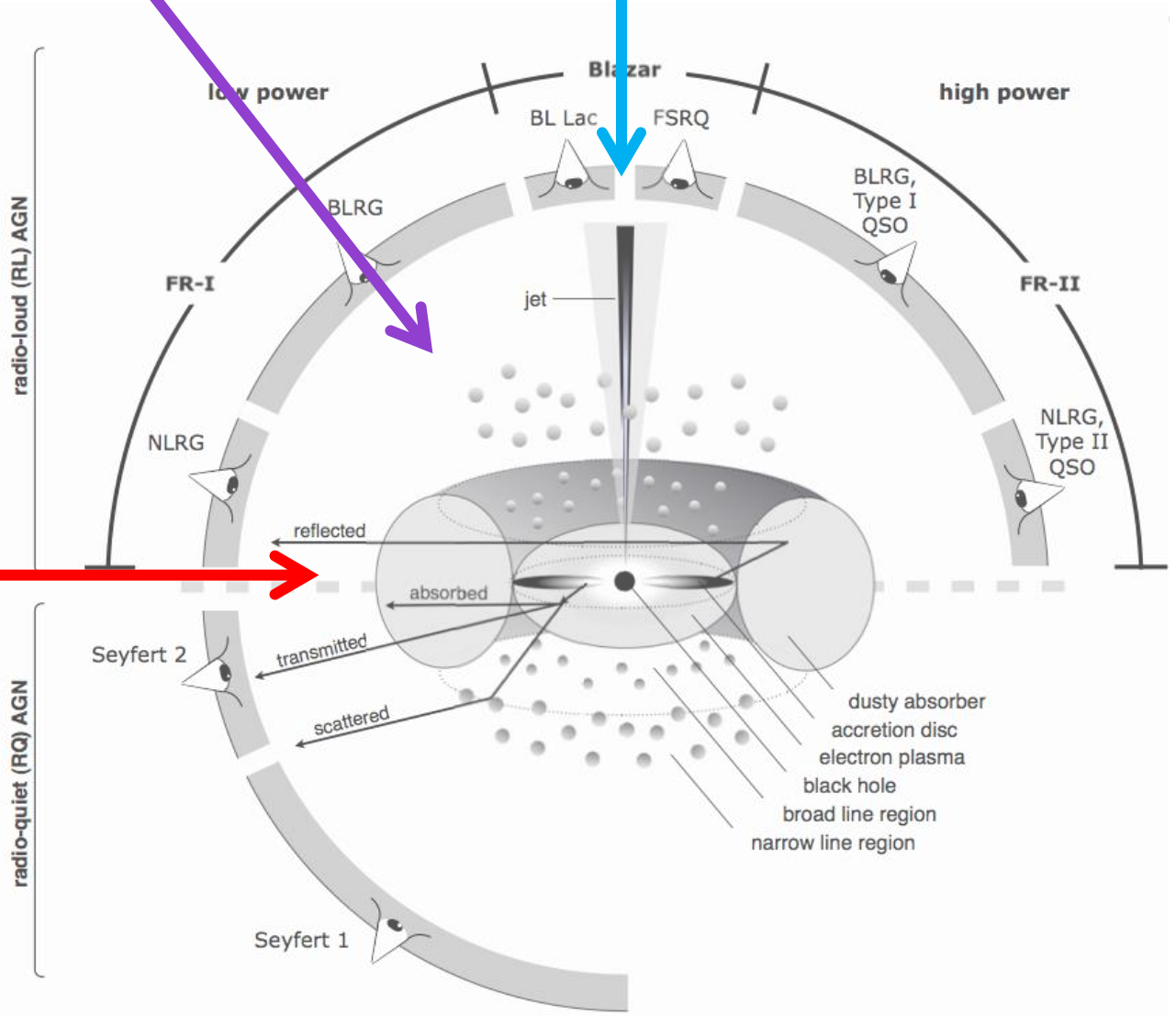
Introduction

PBC J1

- Giant radio galaxy (Bassani et al. 20
- Classified as Seyfert 2 in the o
  2012)
- Unobscured at X-rays , i.e., ty
- Blazar at radio frequencies (Ma
  GHz (Ojha et al. 2004)



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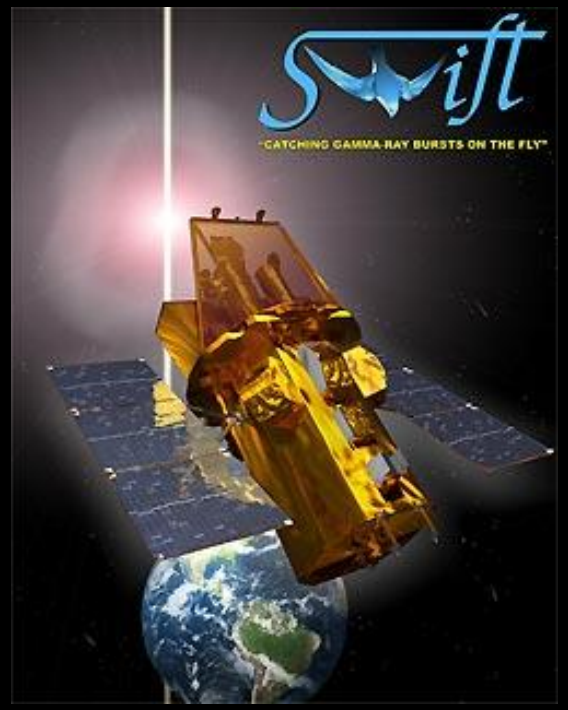
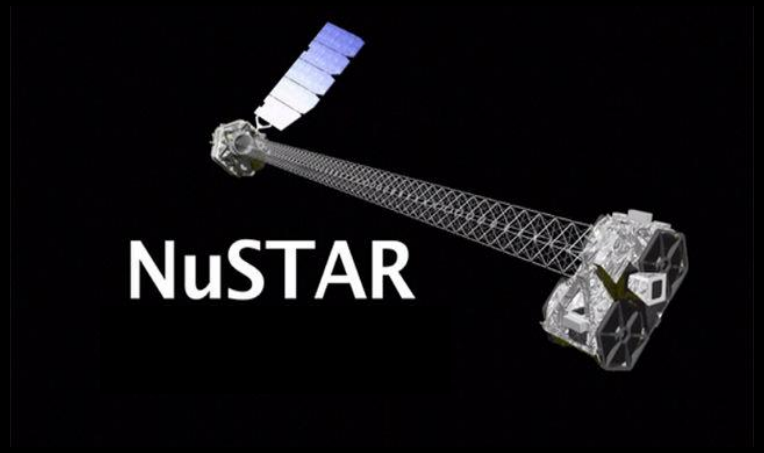
Data





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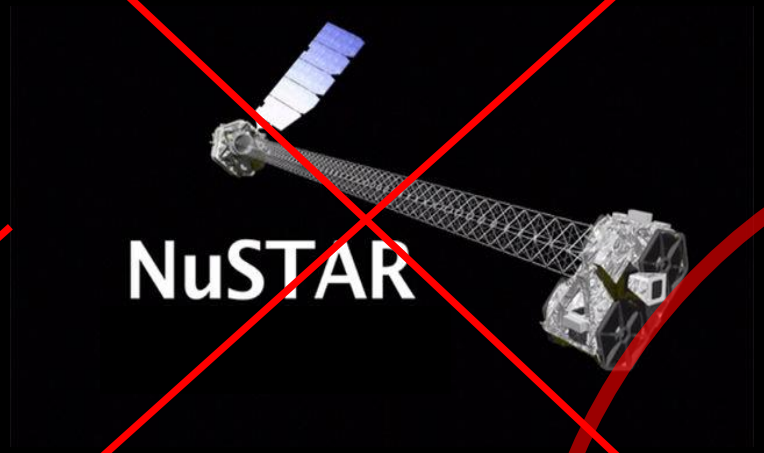
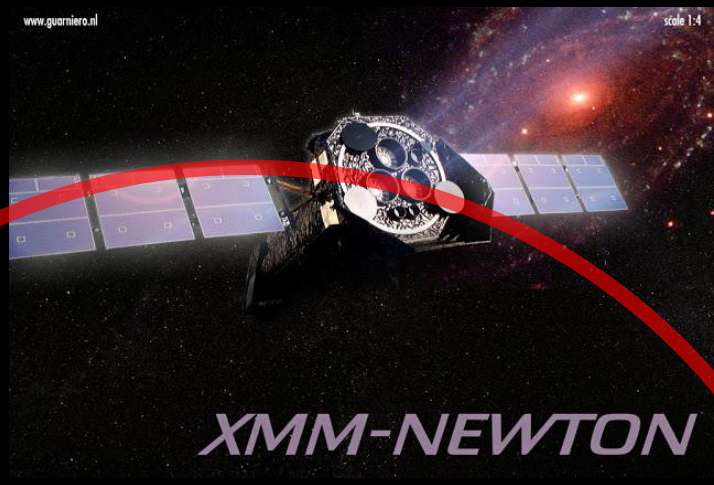
Data





Simultaneous!

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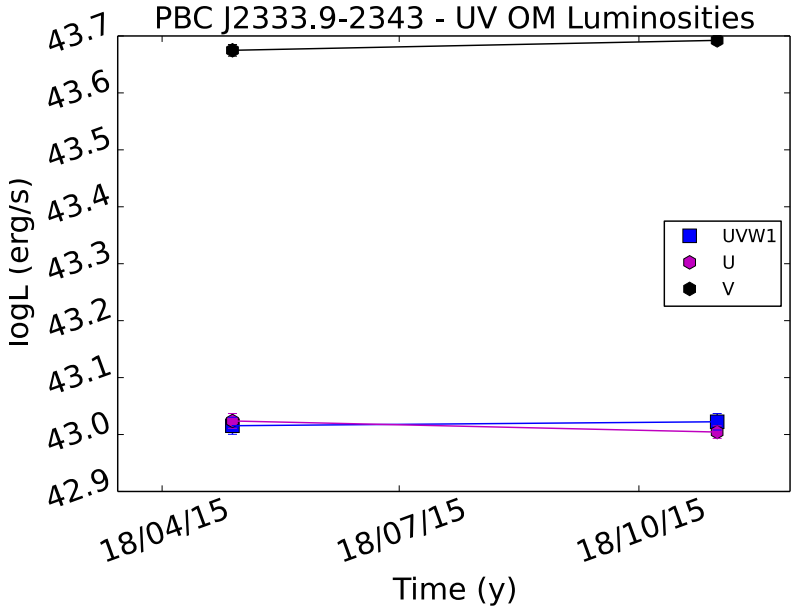
XMM-Newton

- Propietary data (PI. Parisi)
- Two observations:
  - 2015-05-15 (23 ksec)
  - 2015-11-17 (25 ksec)



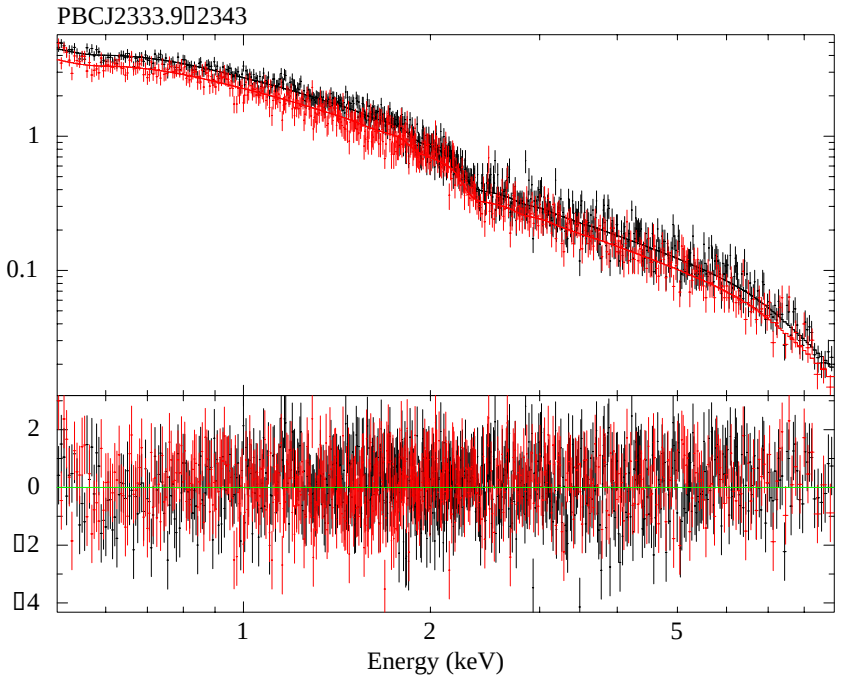
Results

UV variations from the OM are NOT detected

Power law model with varying normalization (16%):

$\Gamma = 1.77[1.76\text{-}1.80]$

$\log L(2\text{-}10\ keV) \sim 43.7$



Hernández-García et al. (2017)

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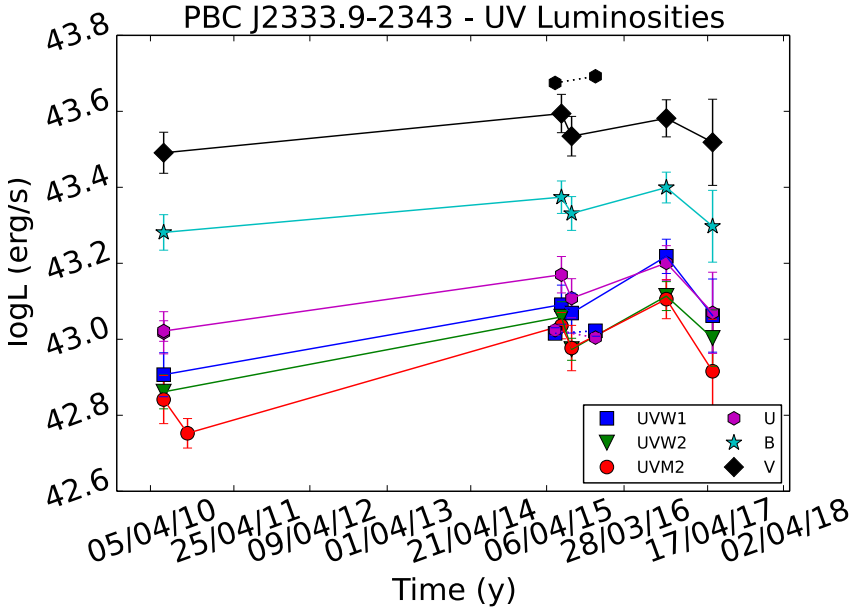
Results

Swift

- Public data
- Seven observations:
  - 2010-06-05 (2 ksec)
  - 2010-06-05 (4 ksec)
  - 2010-09-23 (9 ksec)
  - 2015-06-13 (7 ksec)
  - 2015-07-30 (6 ksec)
  - 2016-09-10 (6 ksec)
  - 2017-05-10 (3 ksec)

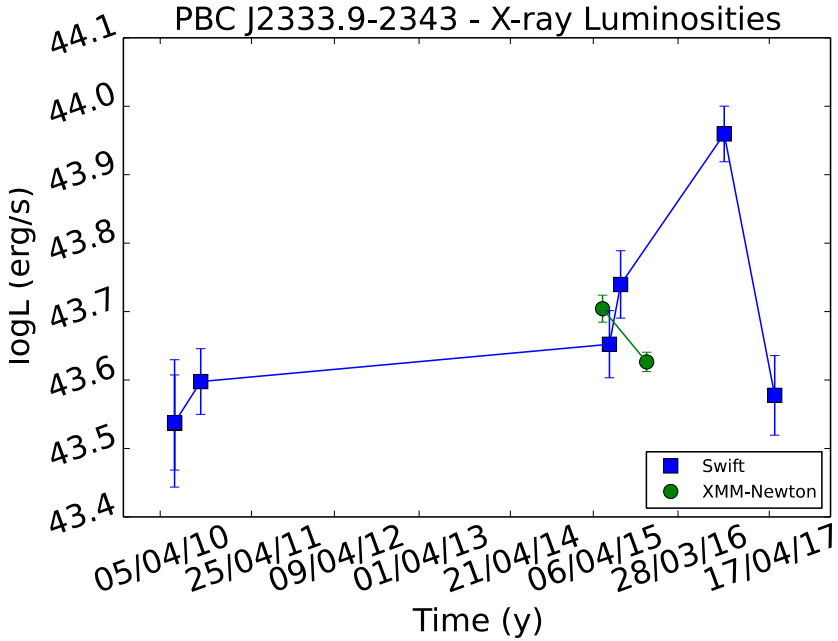


UV variations from UVOT are detected (~19-56%)

Power law model with varying normalization (62%):

$\Gamma = 1.65[1.58\text{-}1.75]$

$\log L(2\text{-}10\ keV) \sim 43.5\text{-}44.0$



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Results

NuSTAR (+ Swift)

- Public data
- One observation:
  - 2015-07-30 (21 ksec) simultaneous with a Swift observation

Partial covering model:

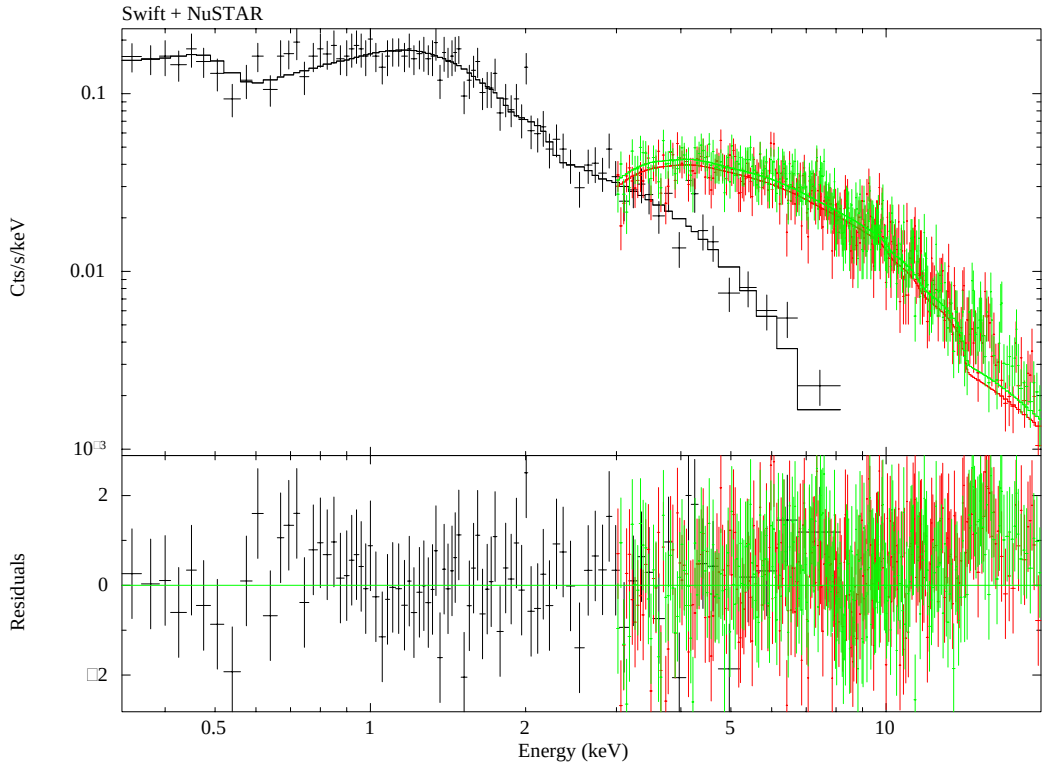
$\Gamma = 2.01[1.96\text{-}2.05]$

$N_H = 5.0[3.5\text{-}6.9] \times 10^{21} cm^{-2}$

$f = 0.66[0.60\text{-}0.70]$

$\log L(2\text{-}10\ keV) \sim 43.7$

$\log L(0.5\text{-}20\ keV) \sim 43.9$



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Results

NuSTAR (+ Swift)

- Public data
- One observation:
  - 2015-07-30 (21 ksec) simultaneous with a Swift observation

Partial covering model:

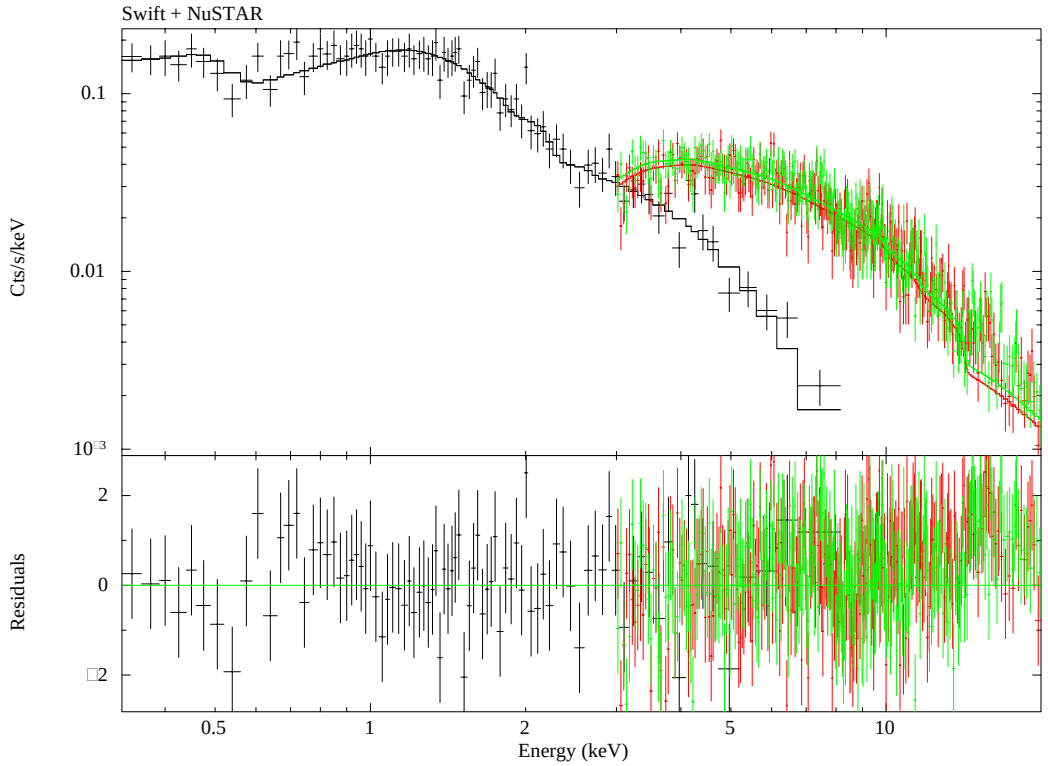
$\Gamma = 2.01[1.96\text{-}2.05]$

$N_H = 5.0[3.5\text{-}6.9] \times 10^{21} cm^{-2}$ → **Unobscured**

$f = 0.66[0.60\text{-}0.70]$

$\log L(2\text{-}10\ keV) \sim 43.7$

$\log L(0.5\text{-}20\ keV) \sim 43.9$

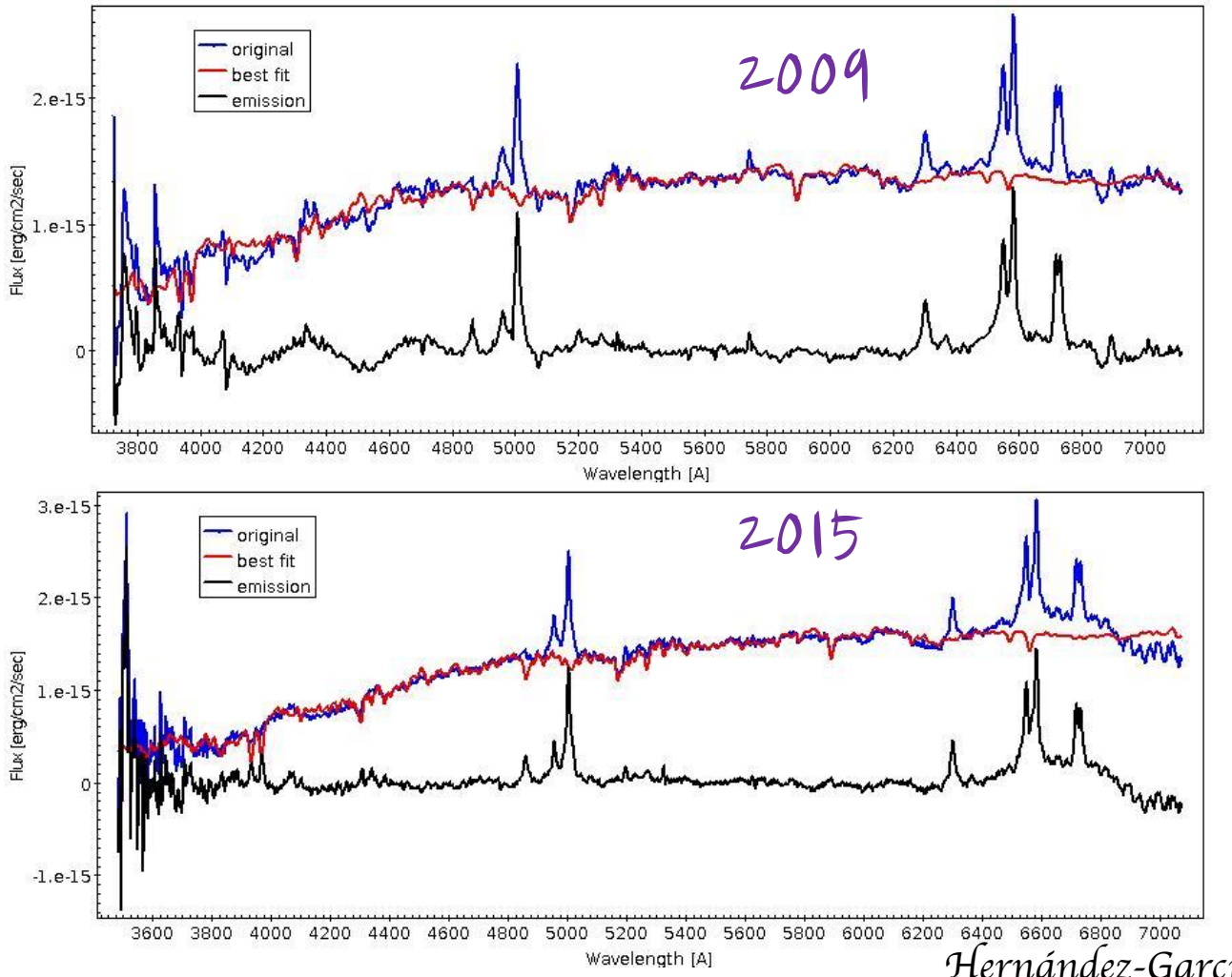


Results

San Pedro Martír Telescope

- Propietary data
- Two observations:
  - 2009-09-18 (3.6 ksec)
  - 2015-11-07 (5.4 ksec)
- Subtraction of the stellar population for the first time

Broad H_α component -> Seyfert 1.9 (Osterbrock 1981)

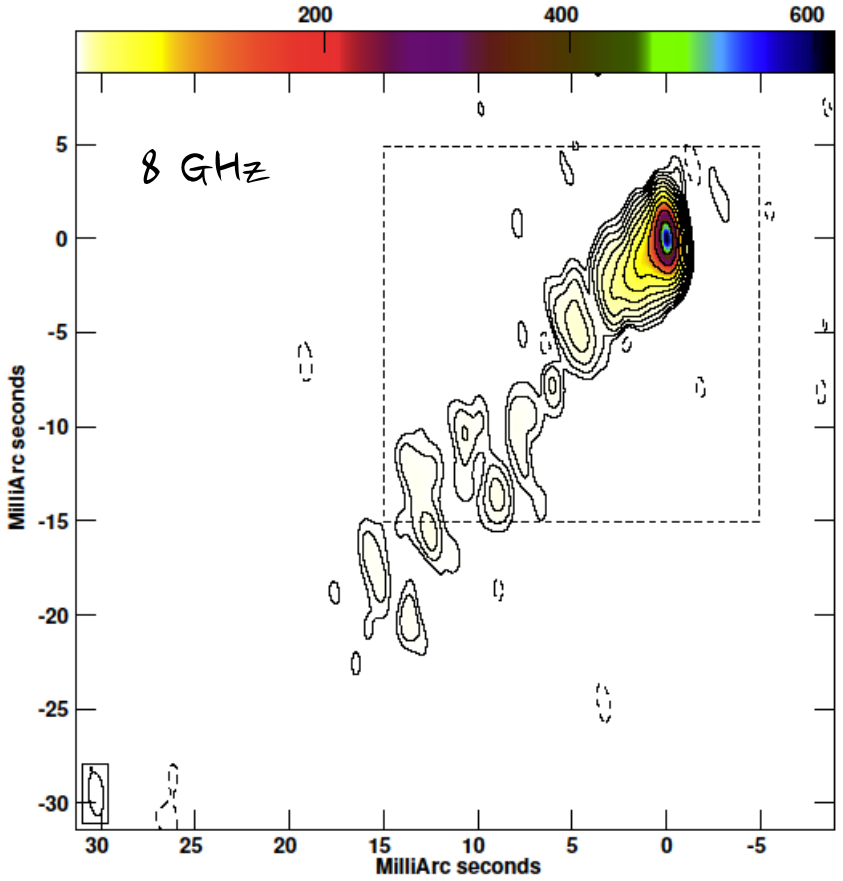


Hernández-García et al. (2017)

Results

VLBA

- Propietary data
- One observation (16/11/2015):
  - 8.4 GHz (72 ksec)
  - 15 GHz (119 ksec)
  - 24 GHz (162 ksec)



Hernández-García et al. (2017)

- Compact bright core
  - $\alpha_c = 0.40$ ($S(\nu) \sim \nu^{+\alpha}$)
- One sided jet:
  - $\alpha_{j,8\text{-}15} = -0.5$
  - $\Theta < 40^\circ$
- Variability at 8 GHz (Ojha et al. 2004)

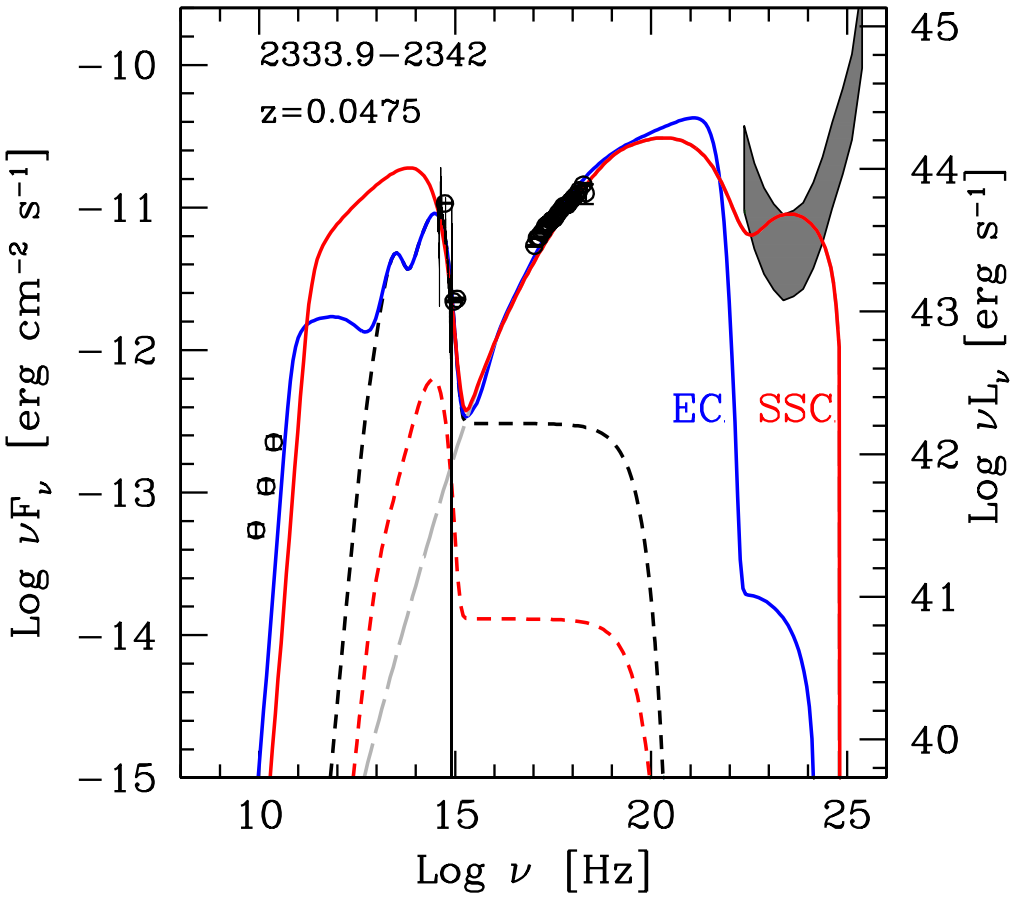
Results

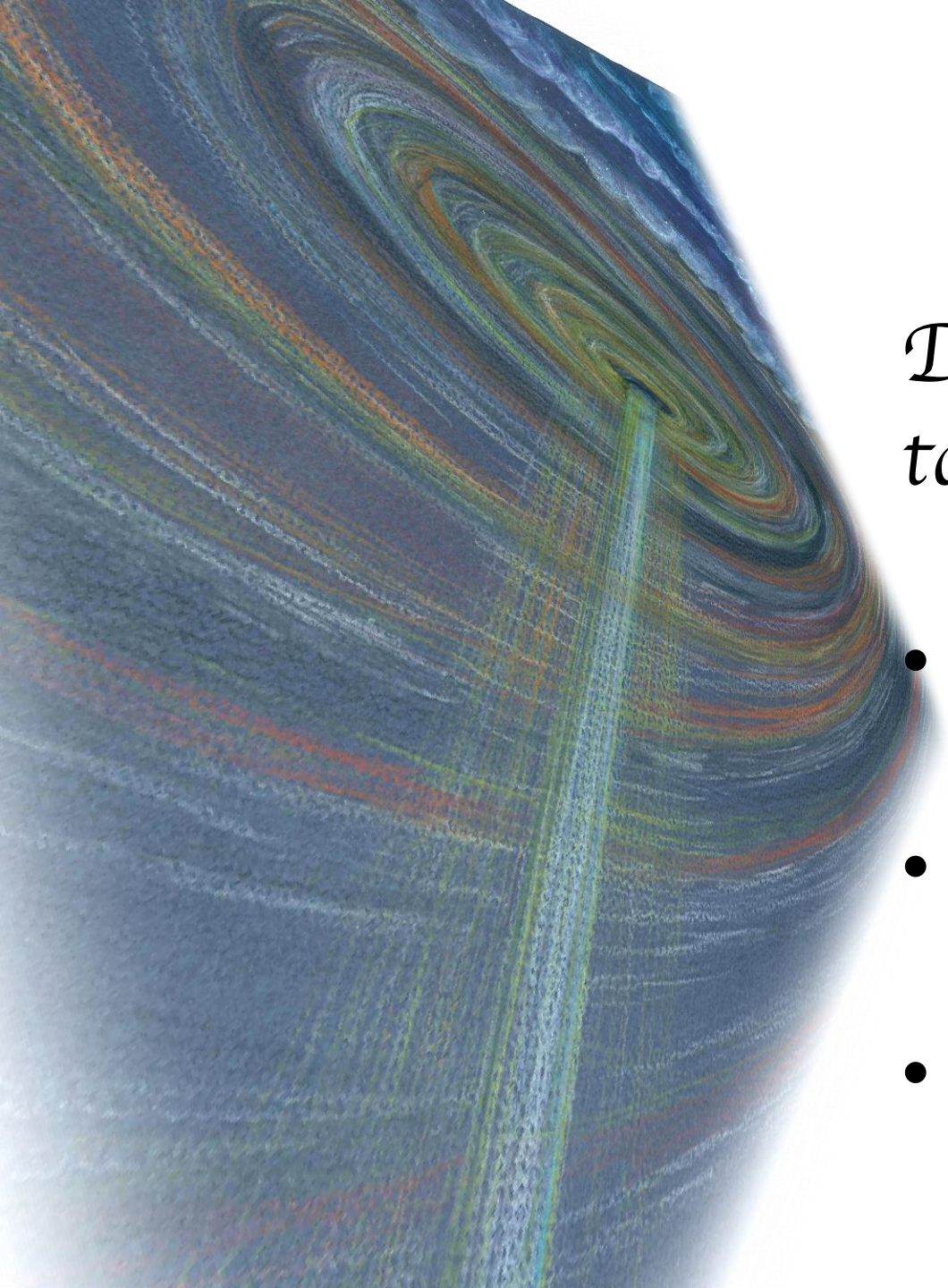
- Blazar template (Ghisellini & Tavecchio 2009)
- Jet observed at small angles: Θ = 3-6°

SED fitting

External Compton (EC) is preferred

Hernández-García et al. (2017)





Discussion

Different classifications are not due to variability:

- *Seyfert 1.9*
- *Unsobscured*
- *Blazar*

} *Blazar*

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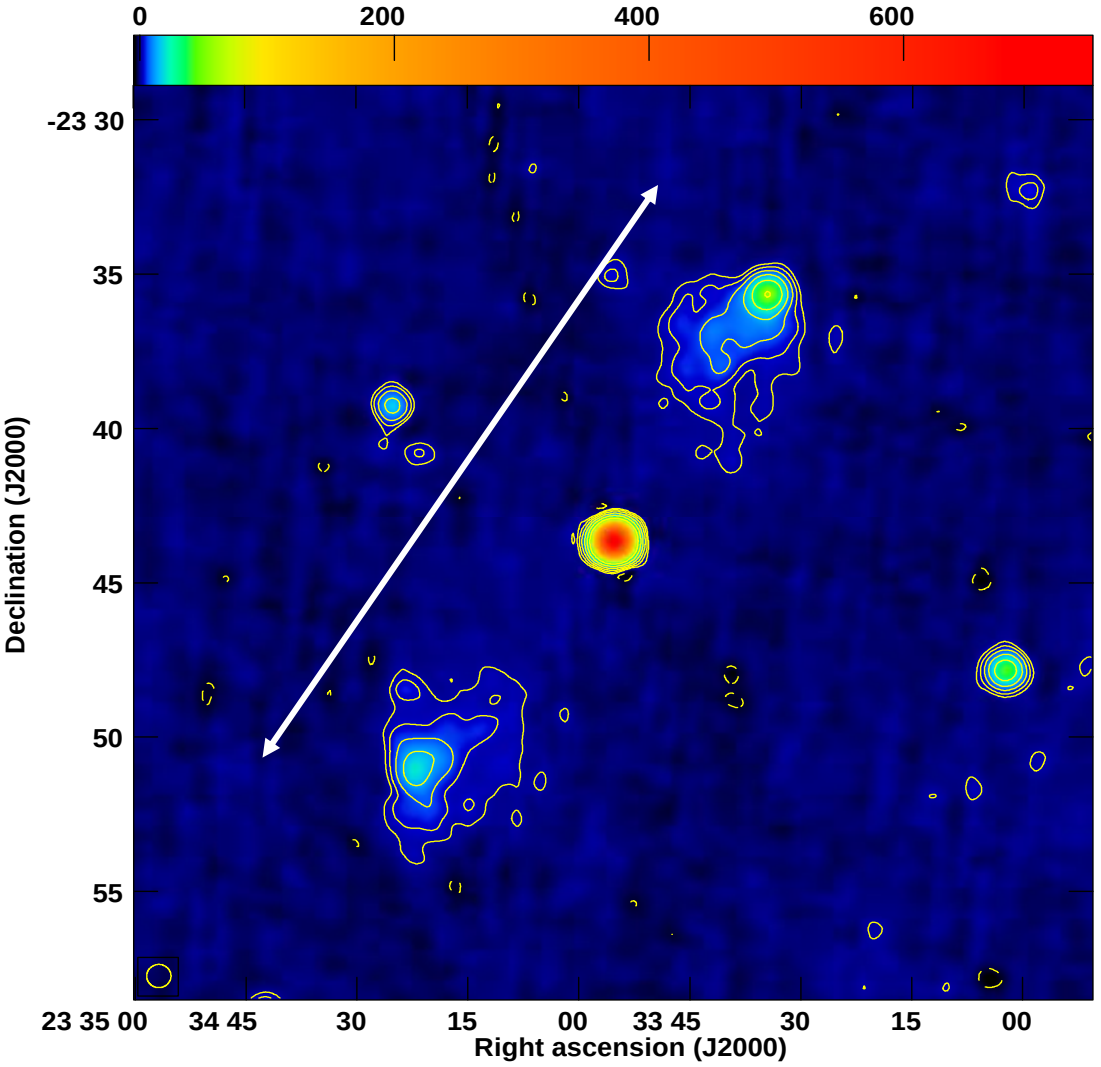
Discussion



SED + VLBA suggest θ < 10°:

-> Super giant radio galaxy?

13 Mpc!!!!!!!

NRAO VLA Sky Survey (NVSS), Condon et al. (1998)

VLA

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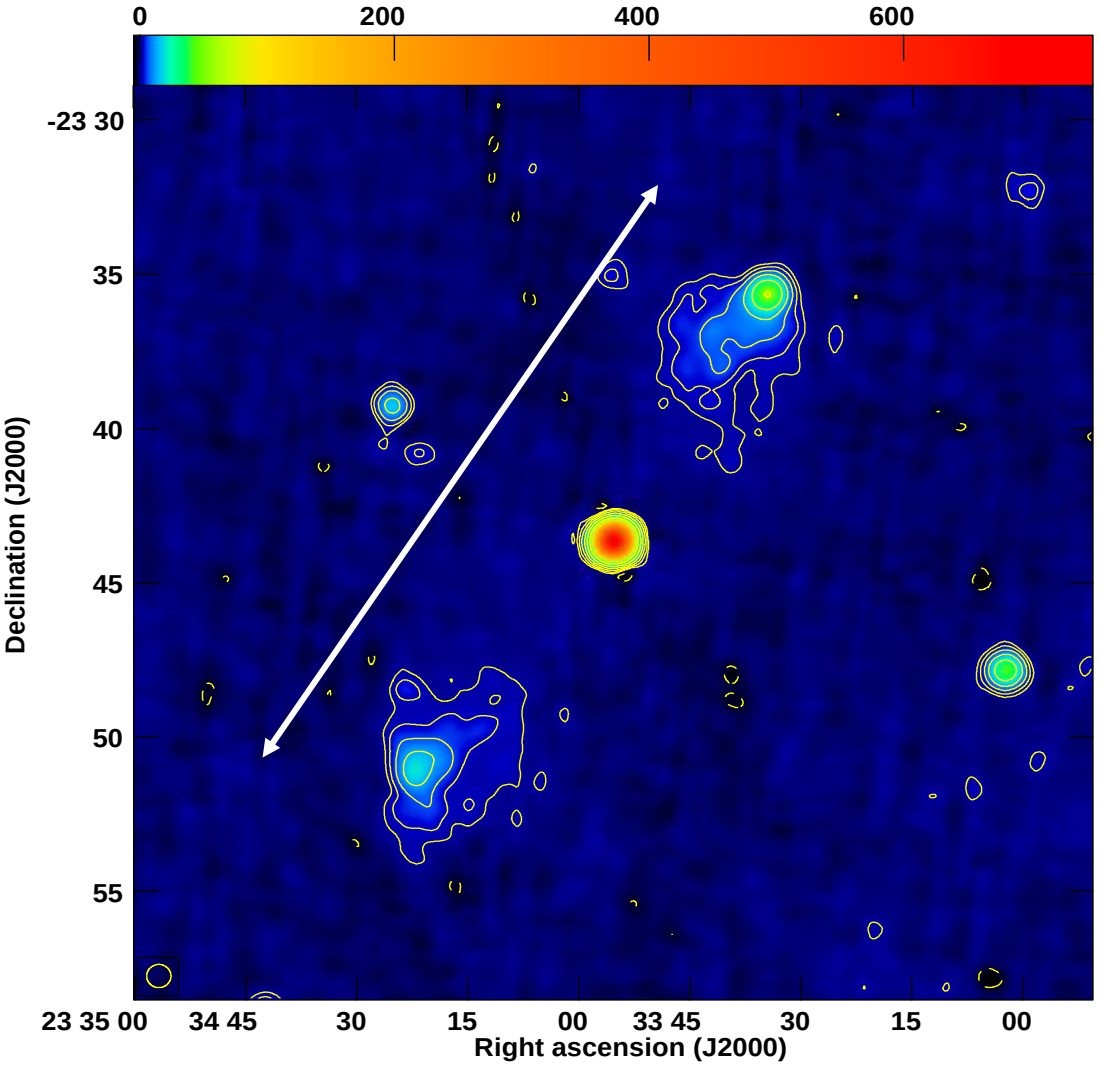
Discussion



SED + VLBA suggest θ < 10°:

~~*-> Super giant radio galaxy?*~~

Largest giant radio galaxy 4.69 Mpc

(Machalski et al. 2008)

NRAO VLA Sky Survey (NVSS), Condon et al. (1998)

VLA

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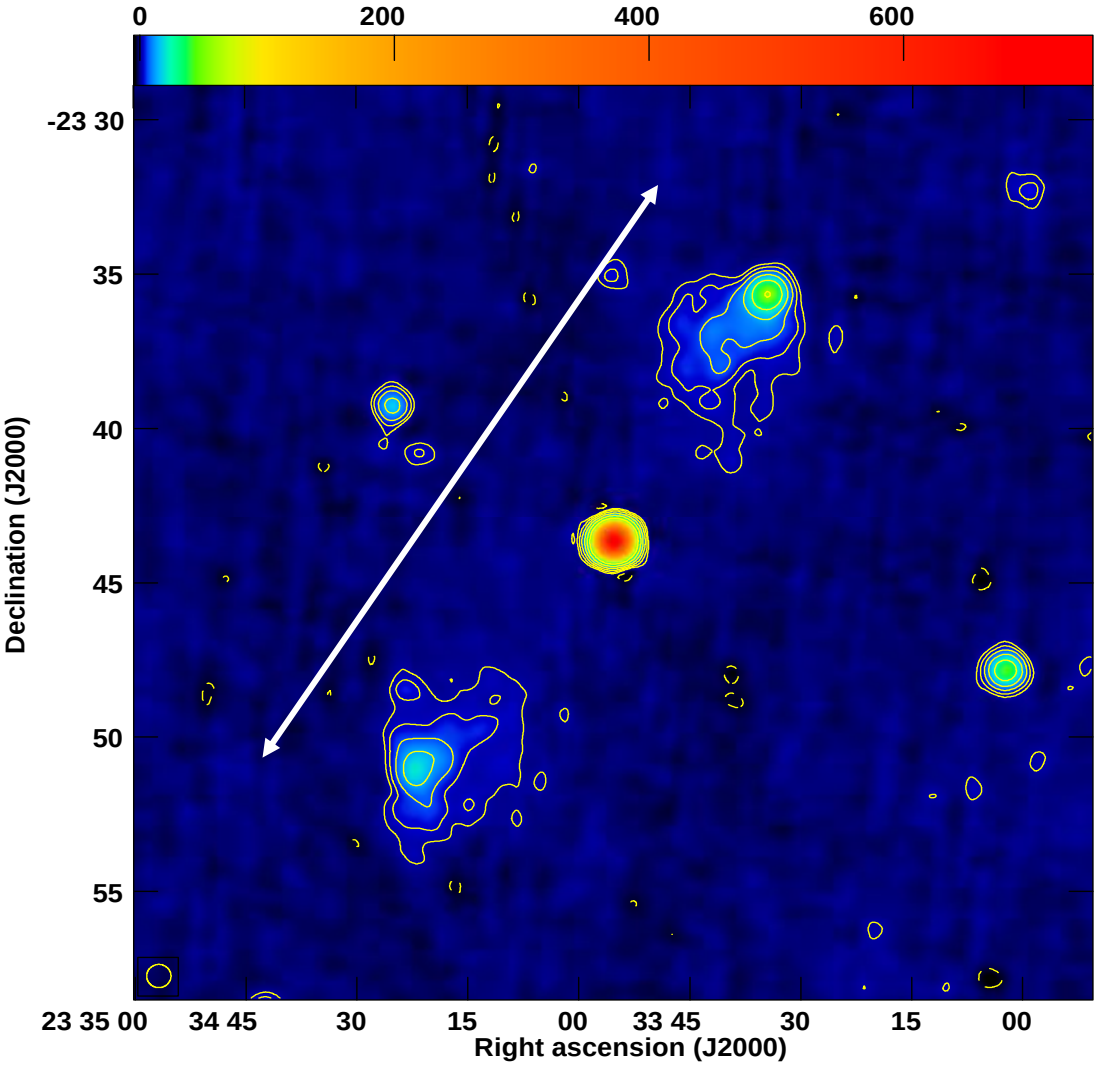
Discussion



SED + VLBA suggest θ < 10°:

-> Change in the direction of the jet

-> Restarting activity

NRAO VLA Sky Survey (NVSS), Condon et al. (1998)

VLA

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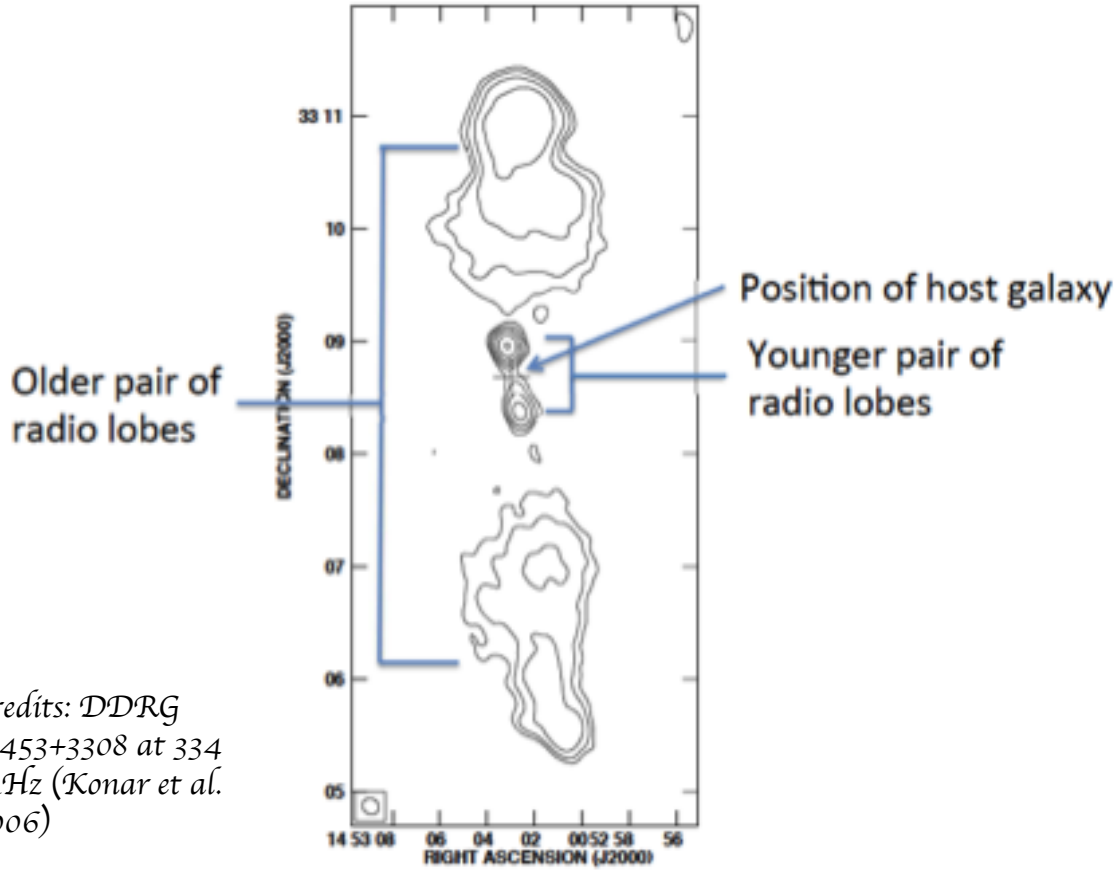
Restarting activity

Double-double radio galaxies (DDRG)

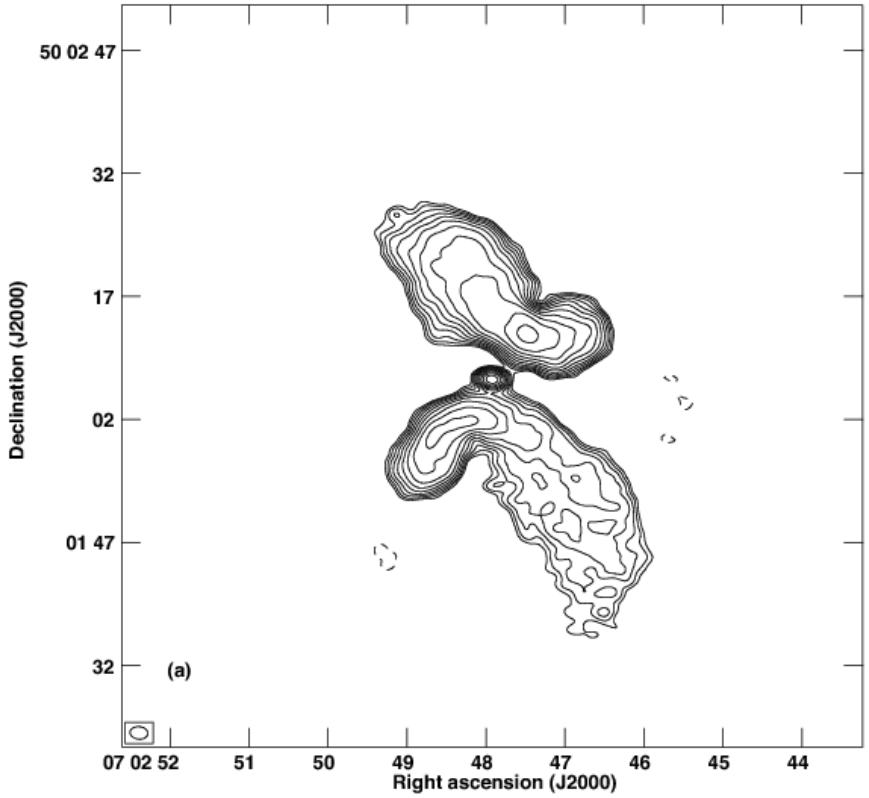
(Lara et al. 1999, Schoenmakers et al 2000)



Credits: DDRG J1453+3308 at 334 MHz (Konar et al. 2006)

X-shaped radio galaxies (XRG)

(Rottmann et al. 2001, Gopal-Krishna et al. 2012)



Credits: XRG J0702+5002 at 512 MHz (Roberts et al. 2015)

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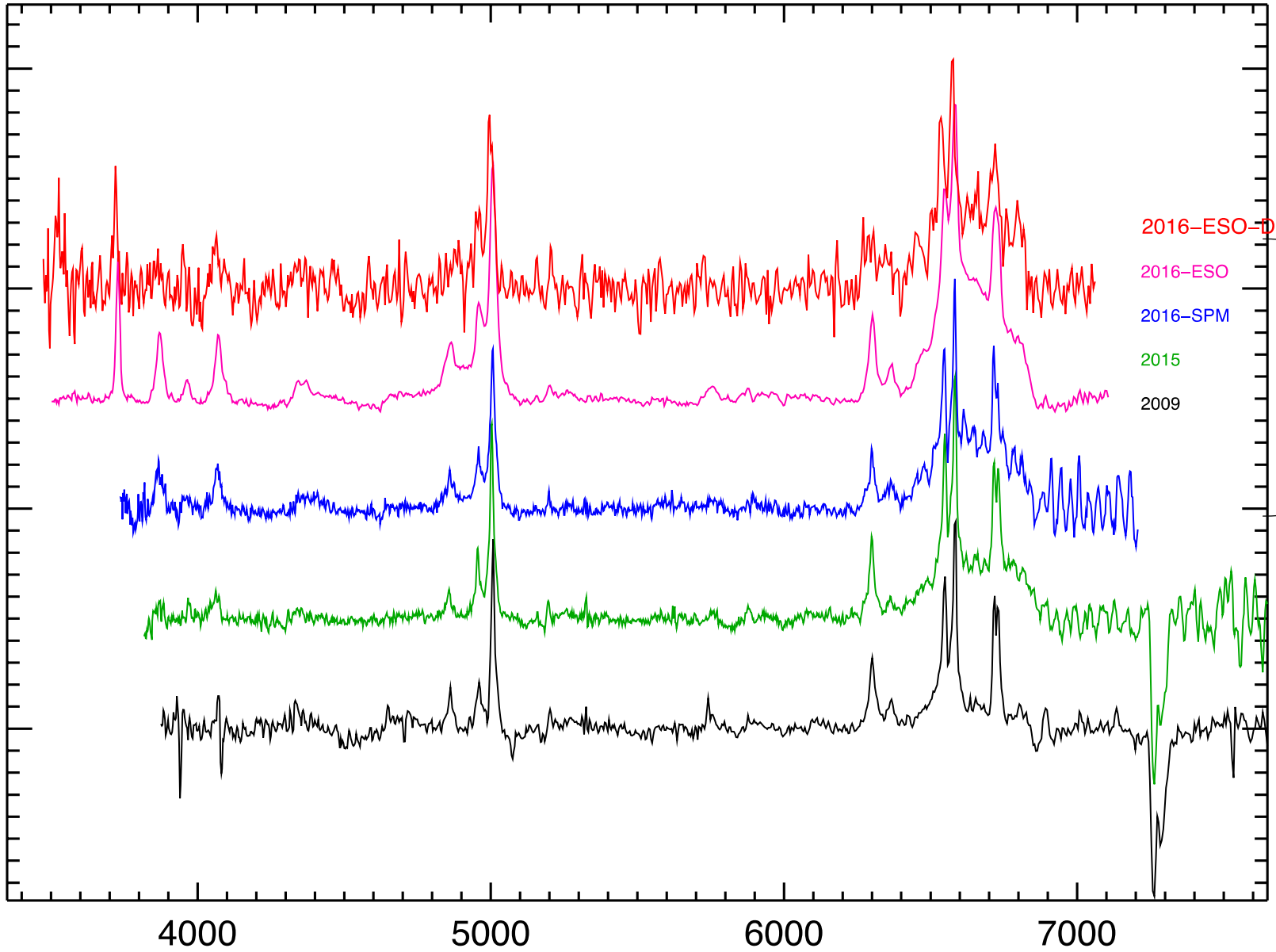
Work in progress



NTT
Chile

SPM
Mexico

2016

2015

2009

Hernández-García et al. (in prep.)

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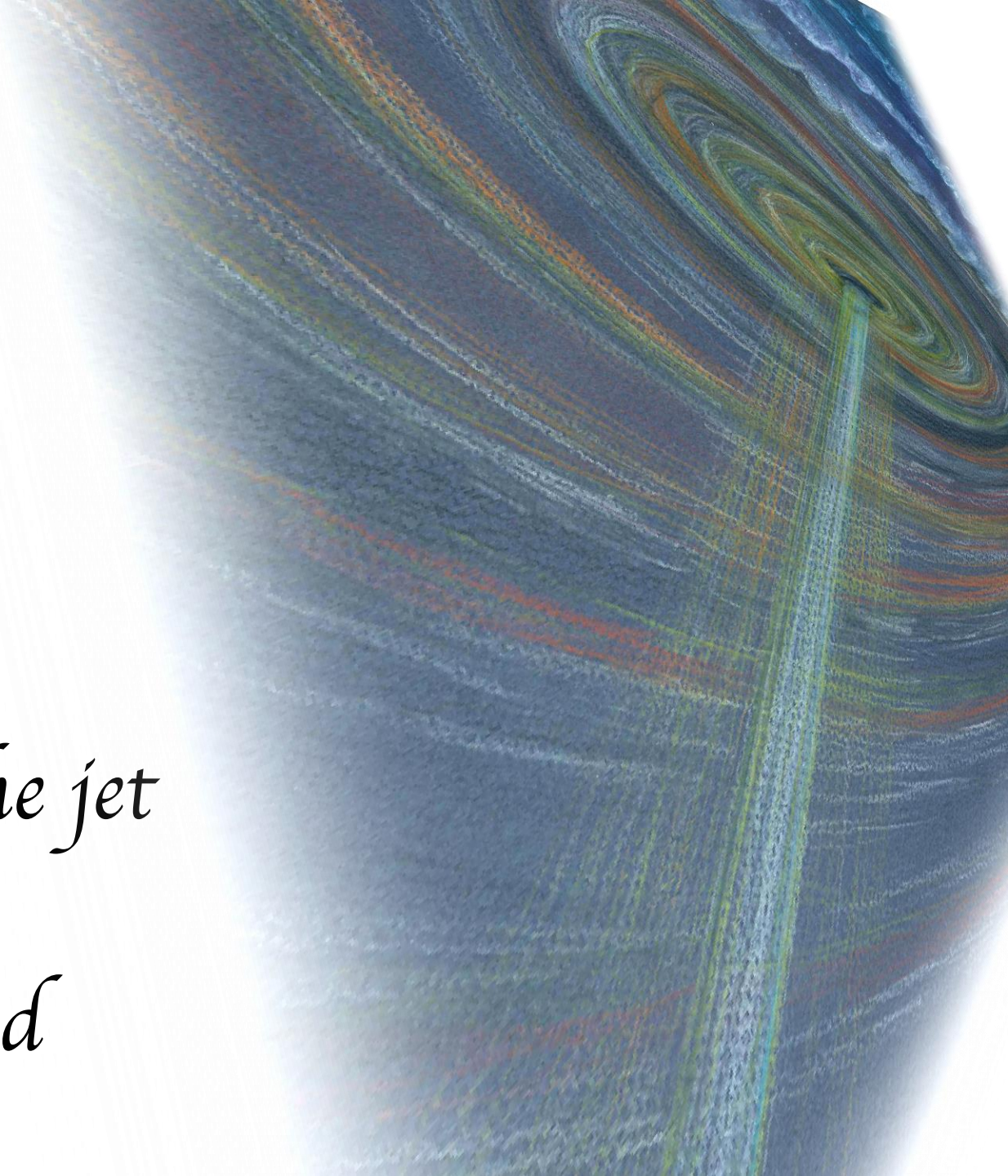
Summary

- We propose that PBC J2333.9-2343 is a blazar that restarted its nuclear activity
- It changed the angle of the jet
- The BLR is changing and shows an outflow



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Summary

- We propose that PBC J2333.9-2343 is a blazar that restarted its nuclear activity
- It changed the angle of the jet
- The BLR is changing and shows an outflow