Multiwavelength analysis of PBC J2333.9-2343

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Mirjana Povic
Pietro Ubertini
Angela Bazzano

Shining from the heart of darkness: black hole accretion and jets
Kathmandu, October 16 – 21, 2016

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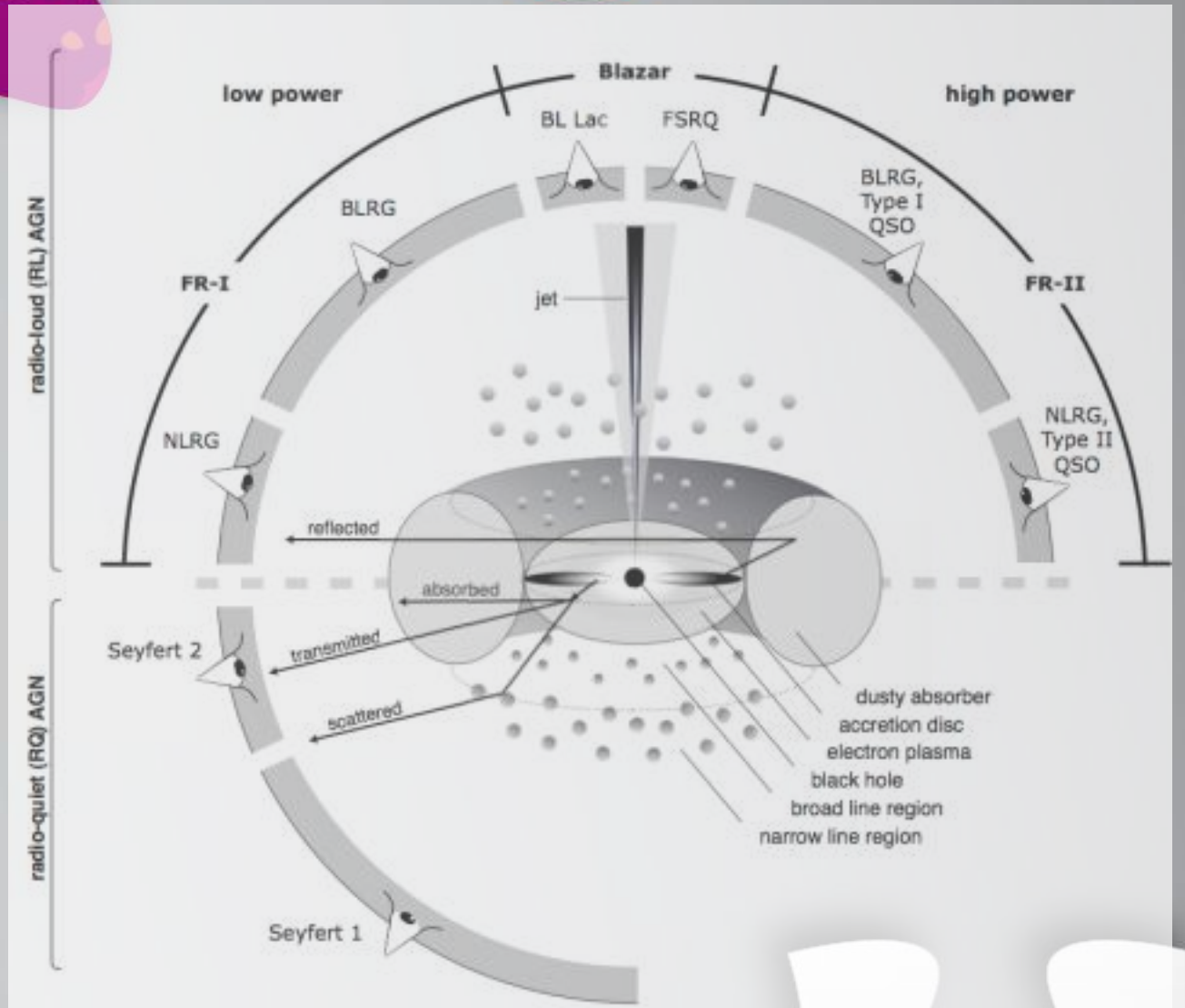
Introduction

Antonucci (1993)

Urry & Padovani (1995)

Unified model of active galactic nuclei (AGN)



Credit: Beckmann & Shrader (2012), image courtesy of Marie-Luise Menzal (MPE)

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Introduction

PBC J2333.9-2343

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

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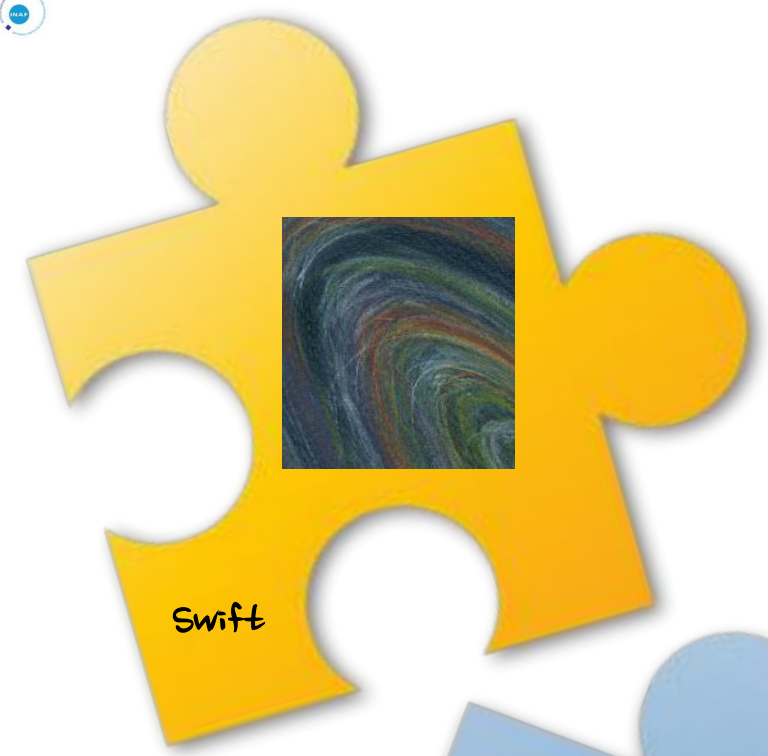
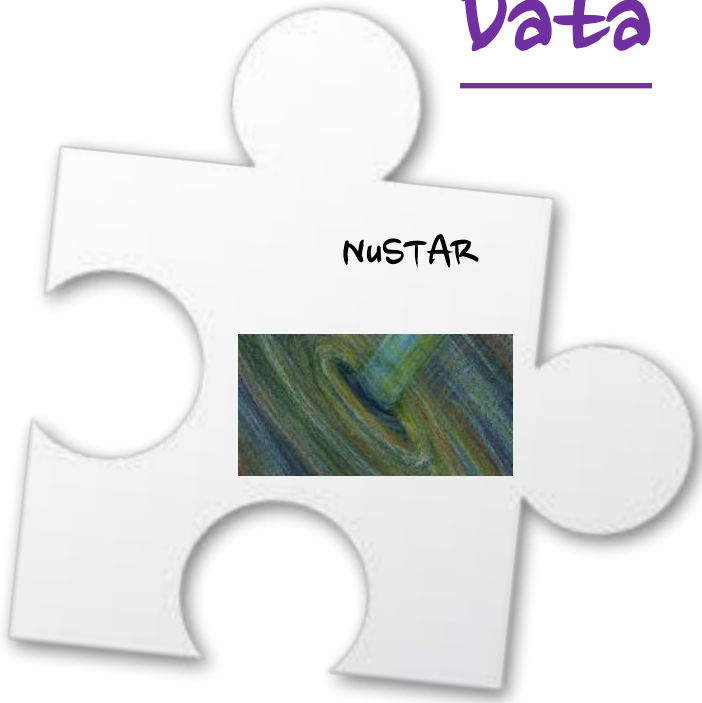
Data





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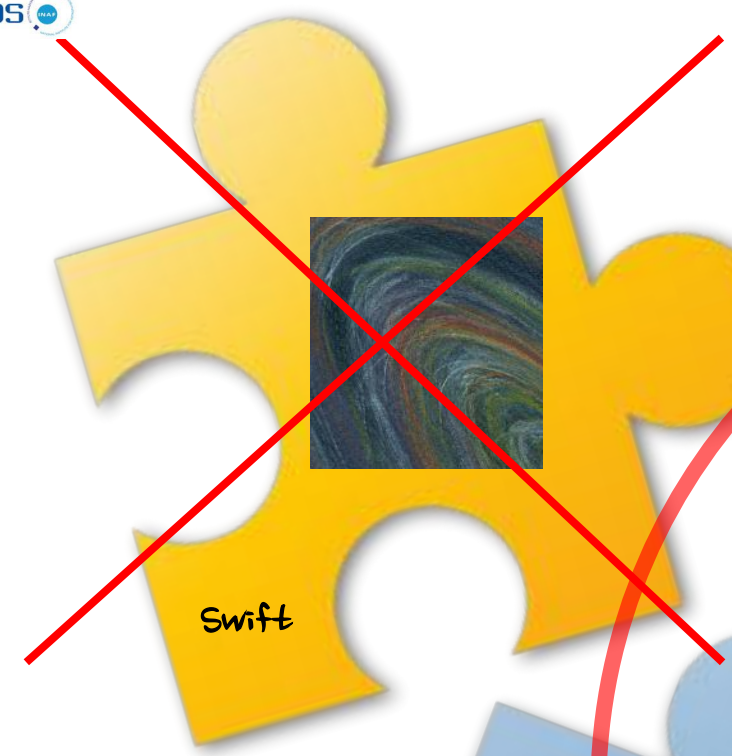
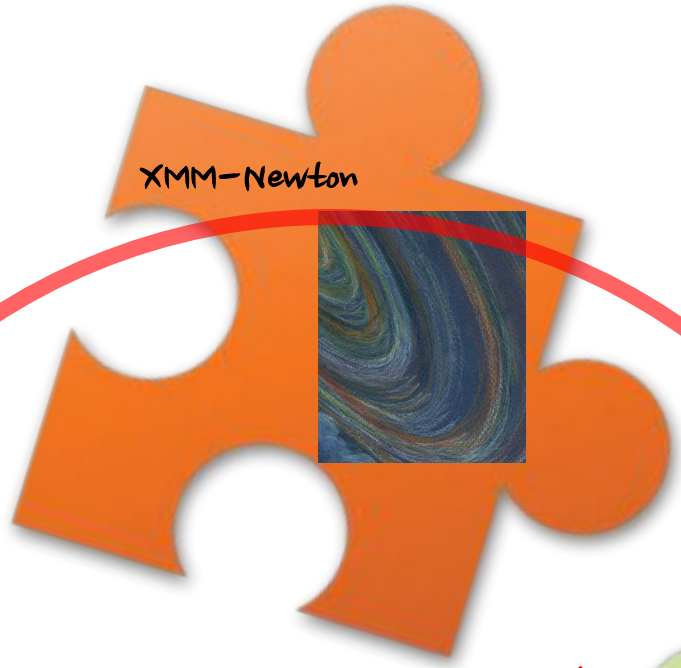
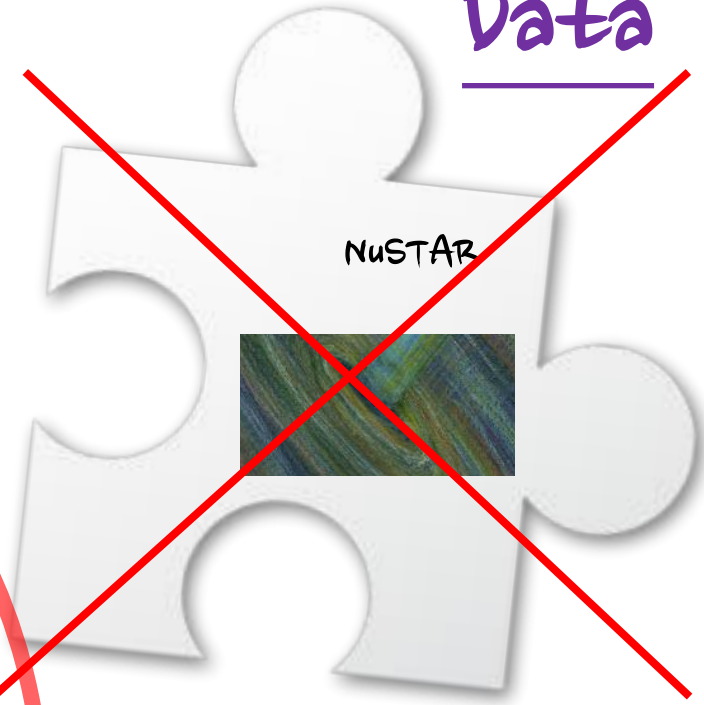
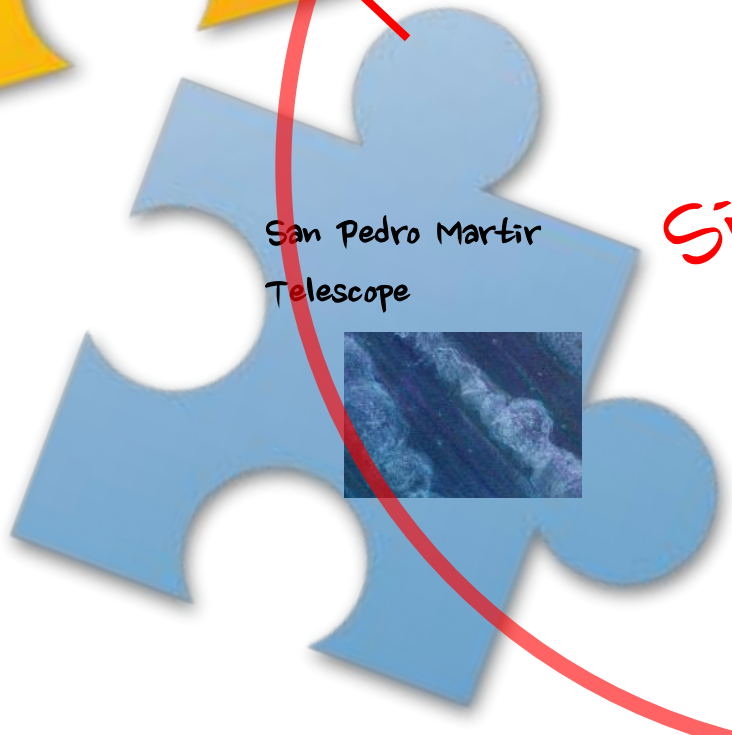
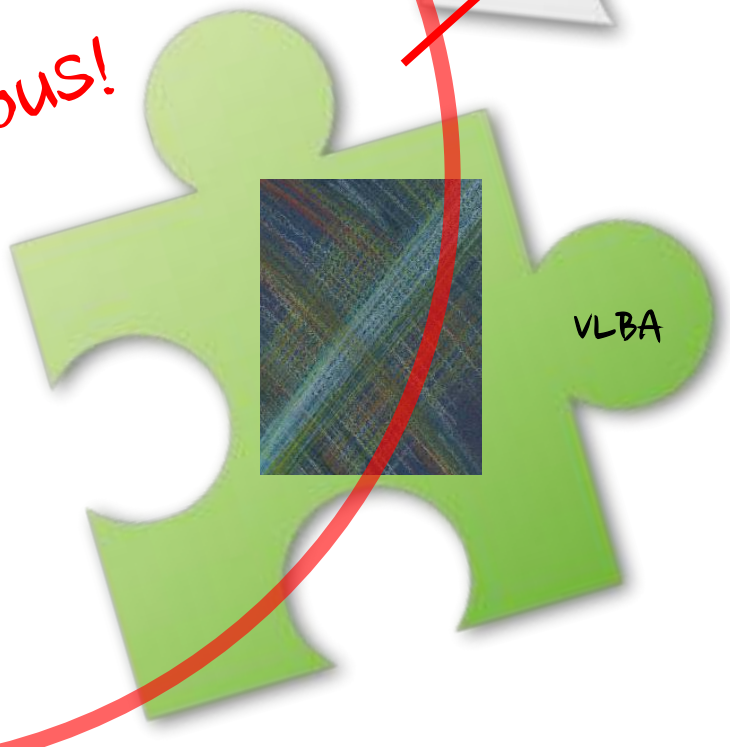
Data











Simultaneous!

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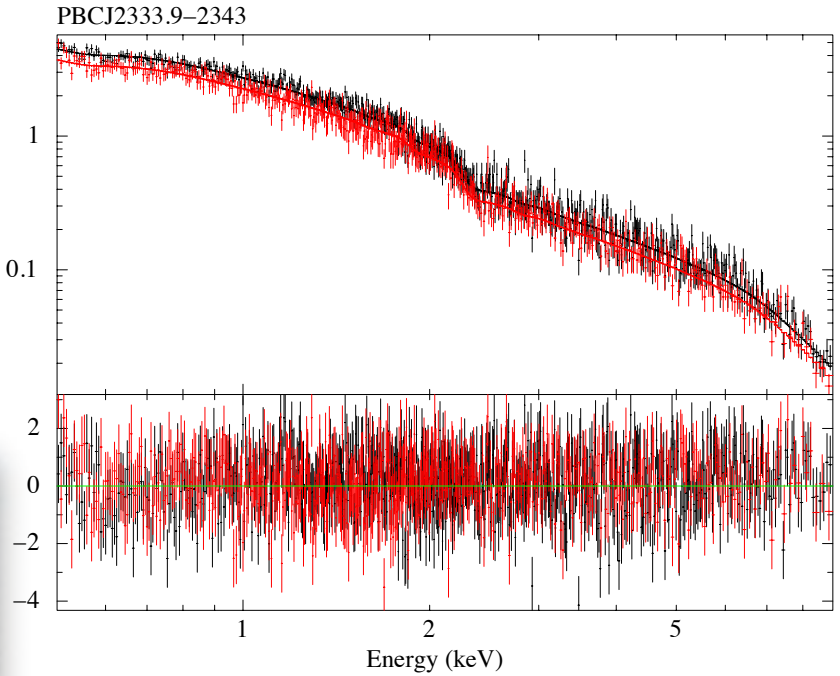
Results

XMM-Newton

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



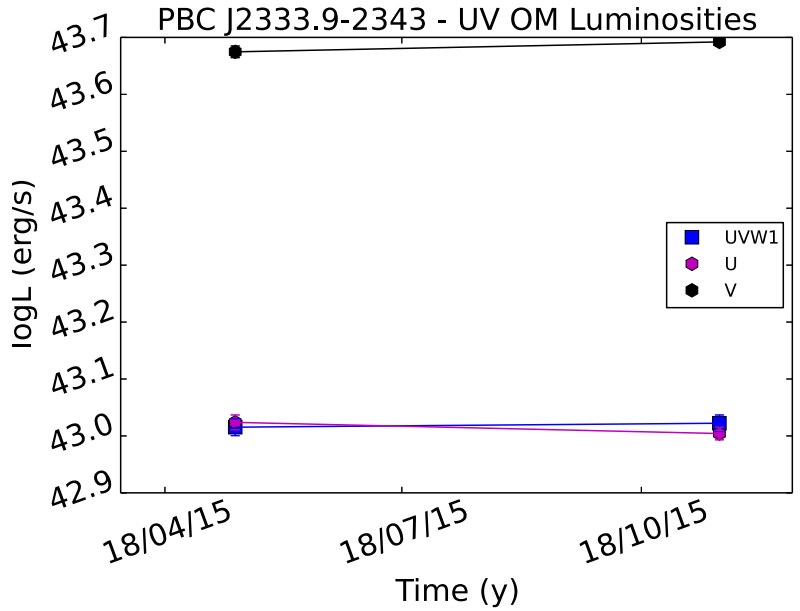
Power law model with varying normalization (16%):

$\Gamma = 1.78[1.77-1.80]$

$N_H = 2.4[2.1-2.7] \times 10^{20} cm^{-2}$

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

UV variations from the OM are NOT detected



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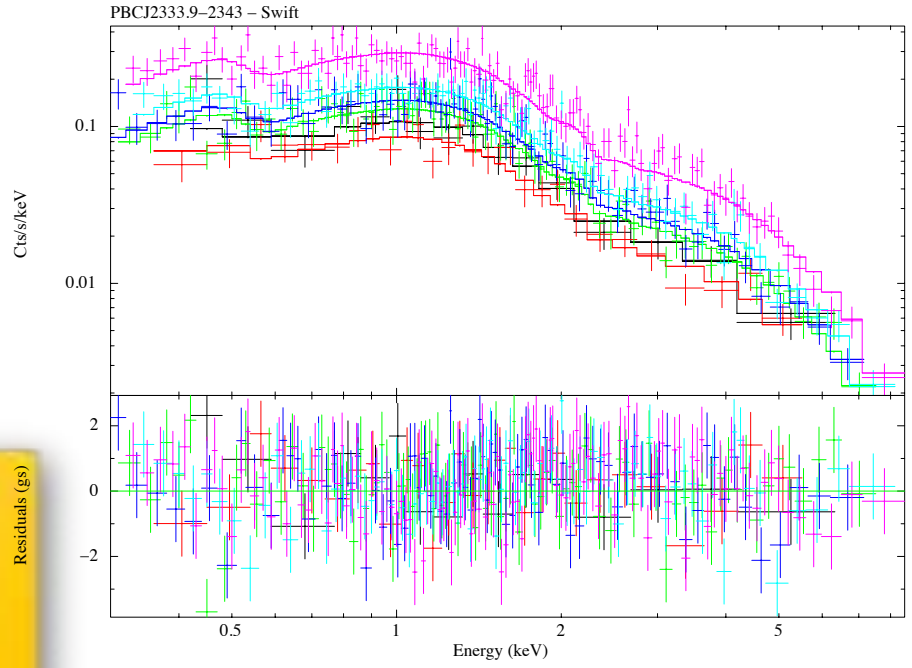
Results

Swift

- Public data
- Six 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)



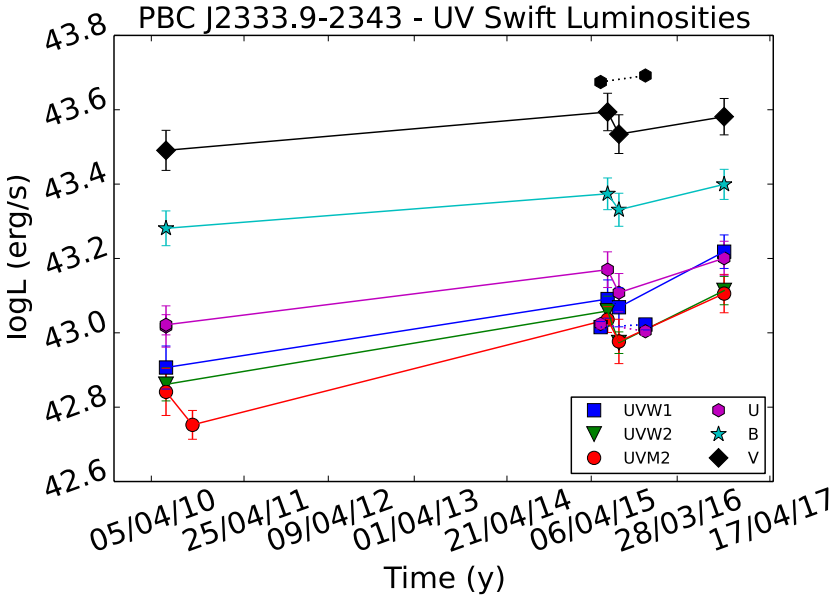
Power law model with varying normalization (62%):

$\Gamma = 1.65[1.60-1.70]$

$N_H = 4.1[2.8-5.5] \times 10^{20} cm^{-2}$

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

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



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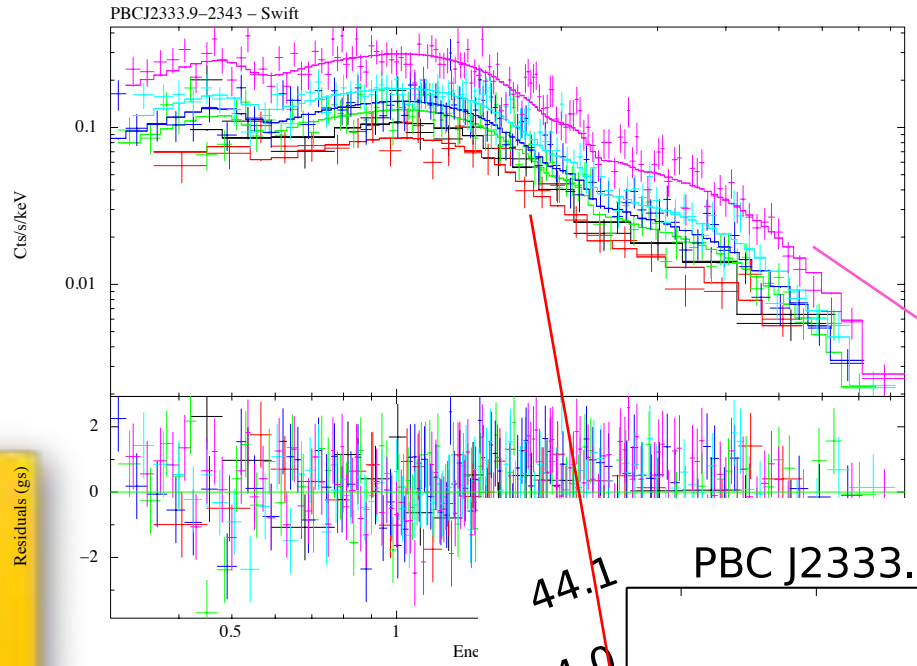
Results

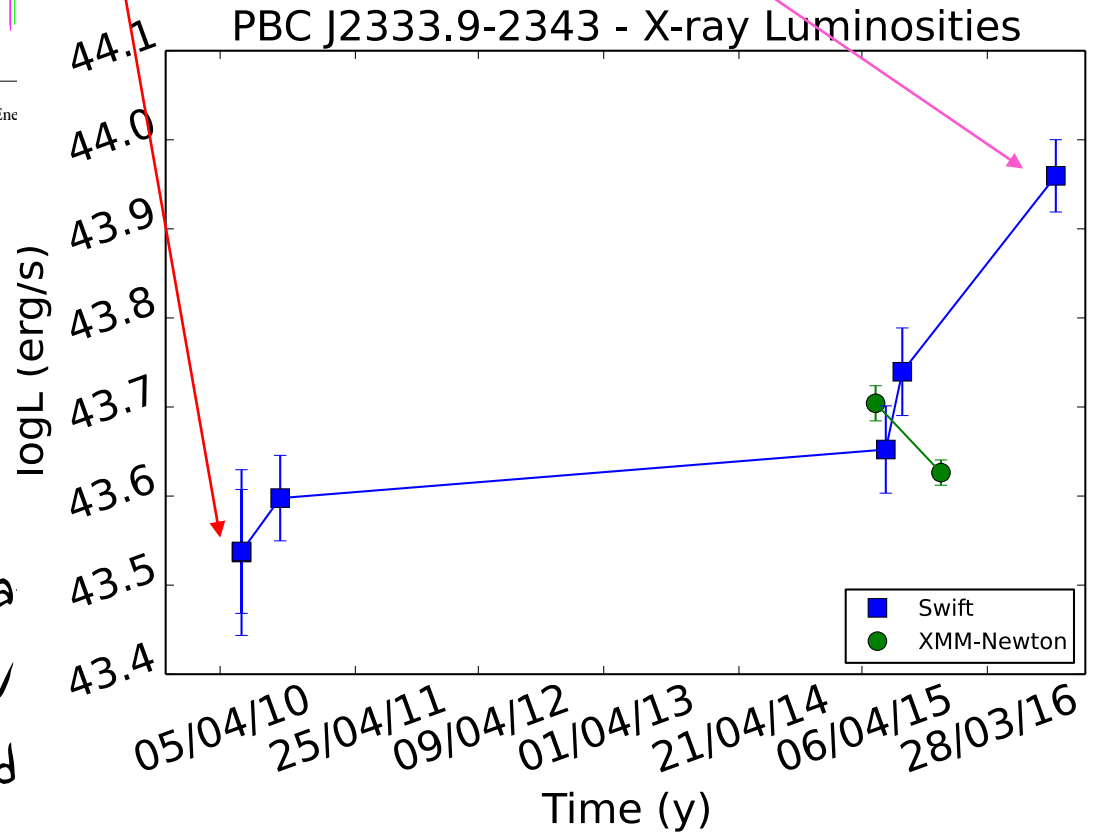
Swift

- Public data
- Six 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)



Power law model with varying normalization (62%):

$\Gamma = 1.65[1.60-1.70]$



UV varia
from UV
detected

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Results

NuSTAR (+ Swift)

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

Partial covering model:

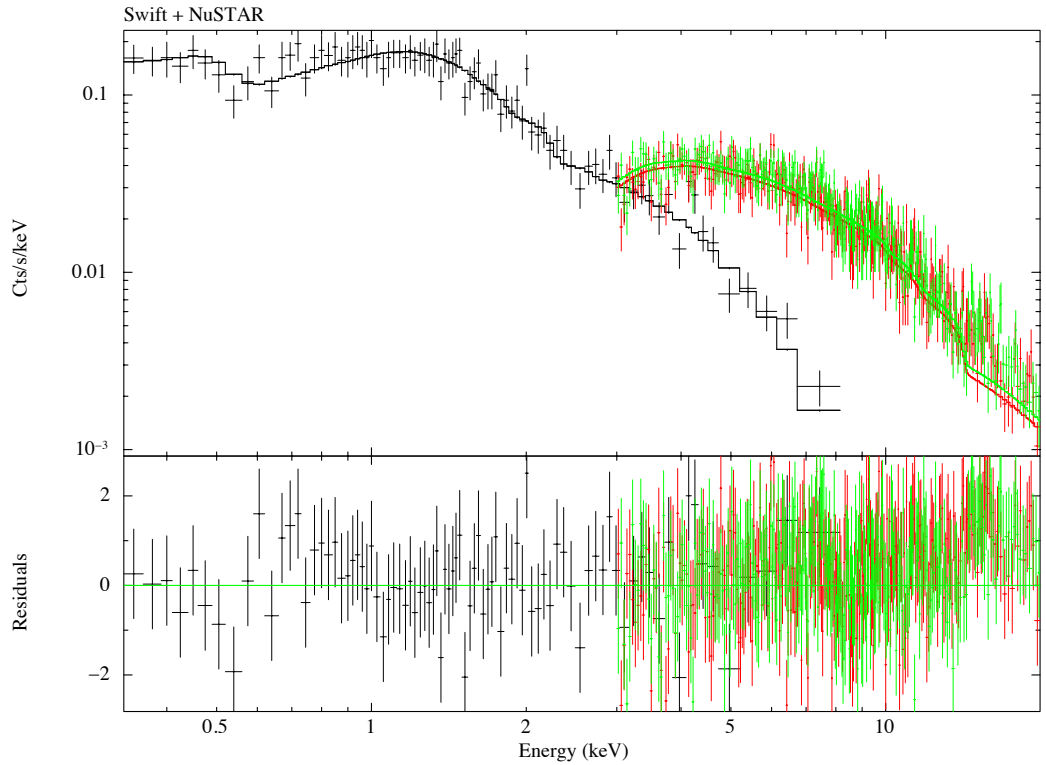
$\Gamma = 2.01[1.96-2.05]$

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

$f = 0.66[0.60-0.70]$

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

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



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Results

NuSTAR (+ Swift)

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

Partial covering model:

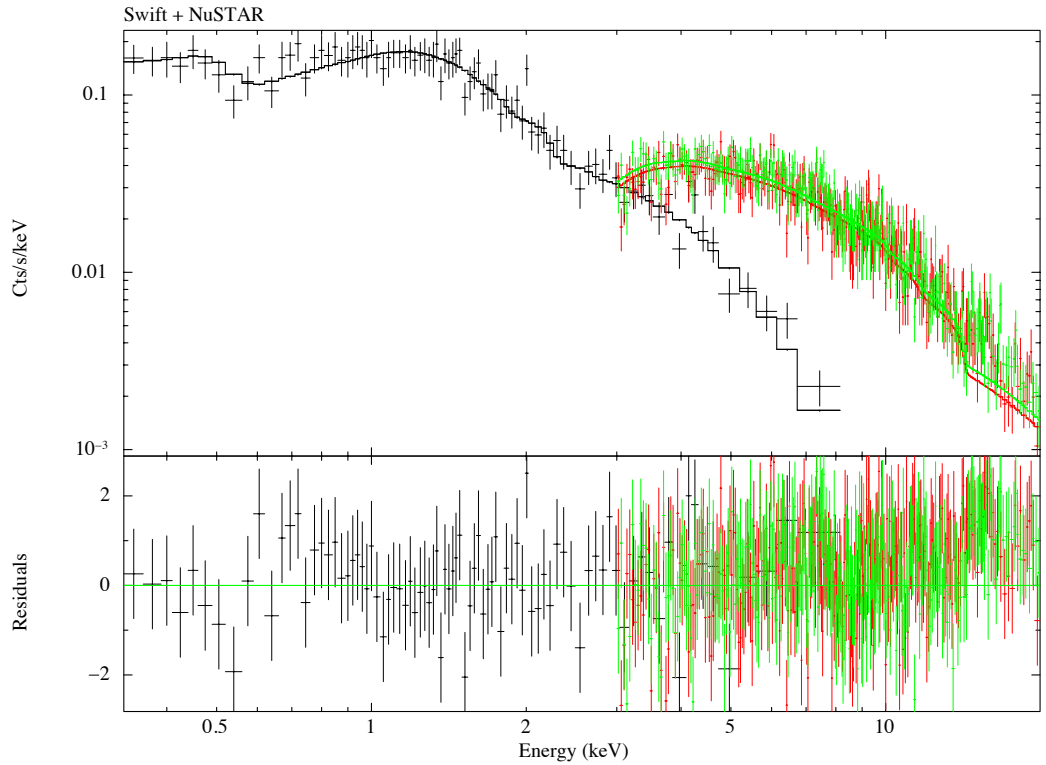
$\Gamma = 2.01[1.96-2.05]$

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

$f = 0.66[0.60-0.70]$

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

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



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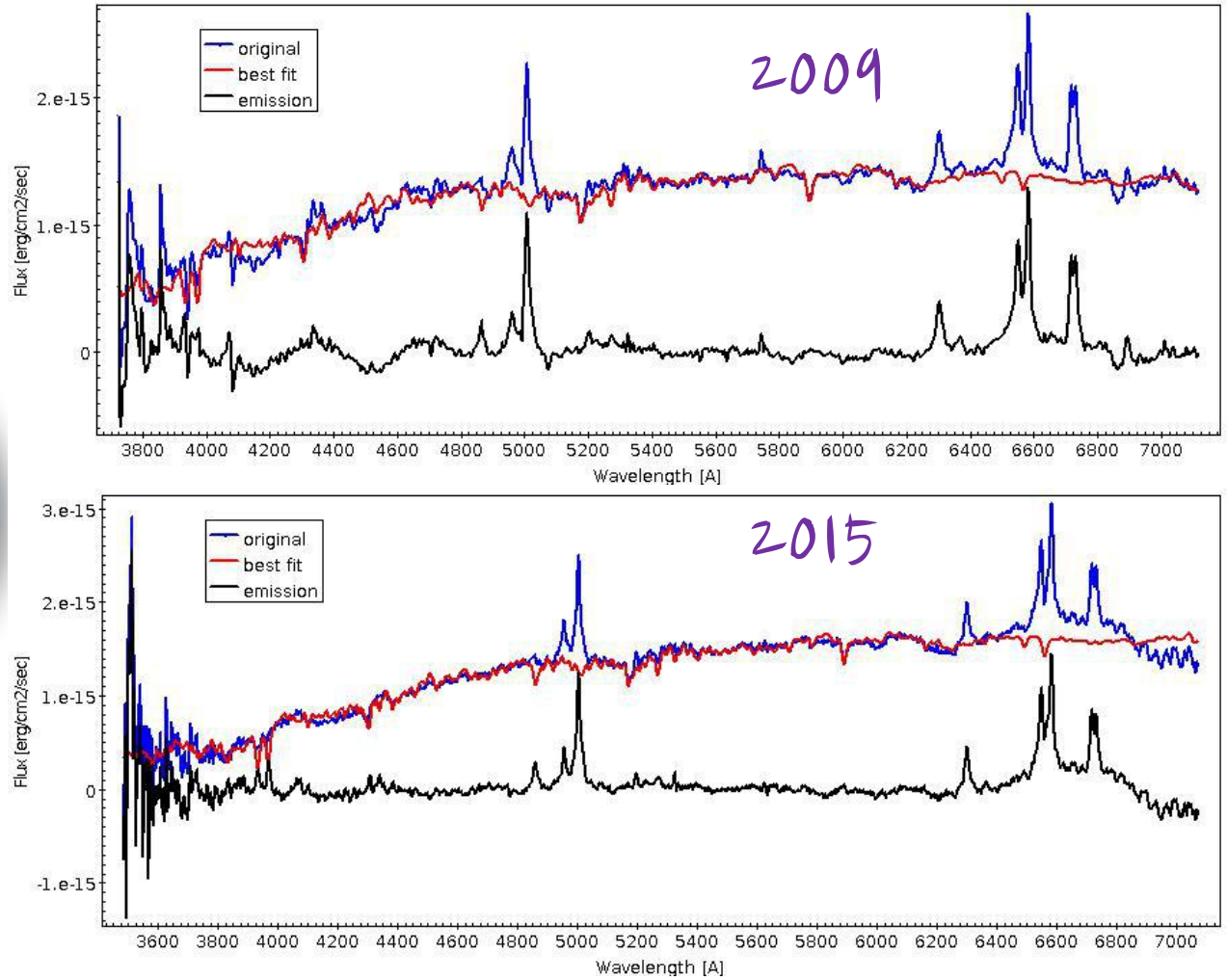
Results

Broad H_α component -> Seyfert 1.9

(Osterbrock 1981)

San Pedro Martir Telescope

- Propietary data
- Two observations:
  - 2009-09-18 (3.6 ksec)
  - 2015-11-07 (5.4 ksec)
- Subtraction of the stellar population with STARLIGHT code



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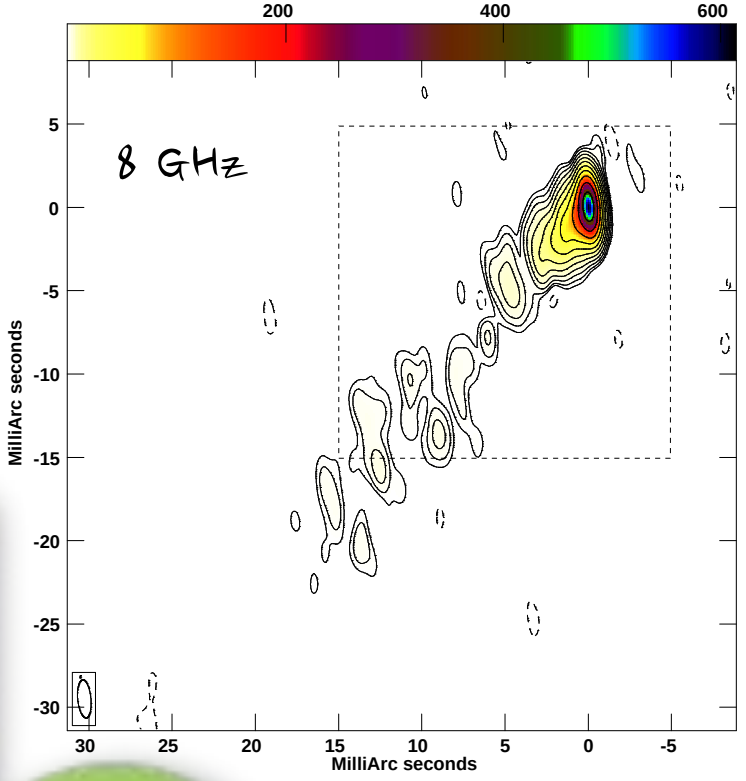
Results

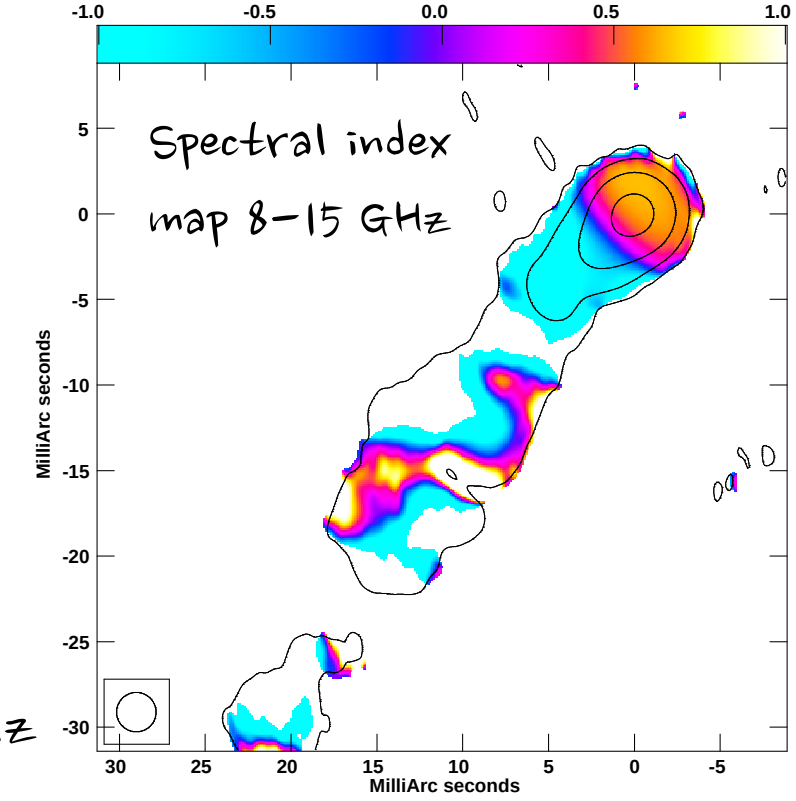
VLBA

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



- Compact bright core
  - $\alpha_c = 0.40$ ($S(\nu) \sim \nu^{+\alpha}$)
  - Optically-thick regime

- One sided jet:
  - $\alpha_{j,8-15} = -0.5$
  - Optically-thin synchrotron
  - $\Theta < 40°$
- Variability at 8 GHz (Ojha et al. 2004)



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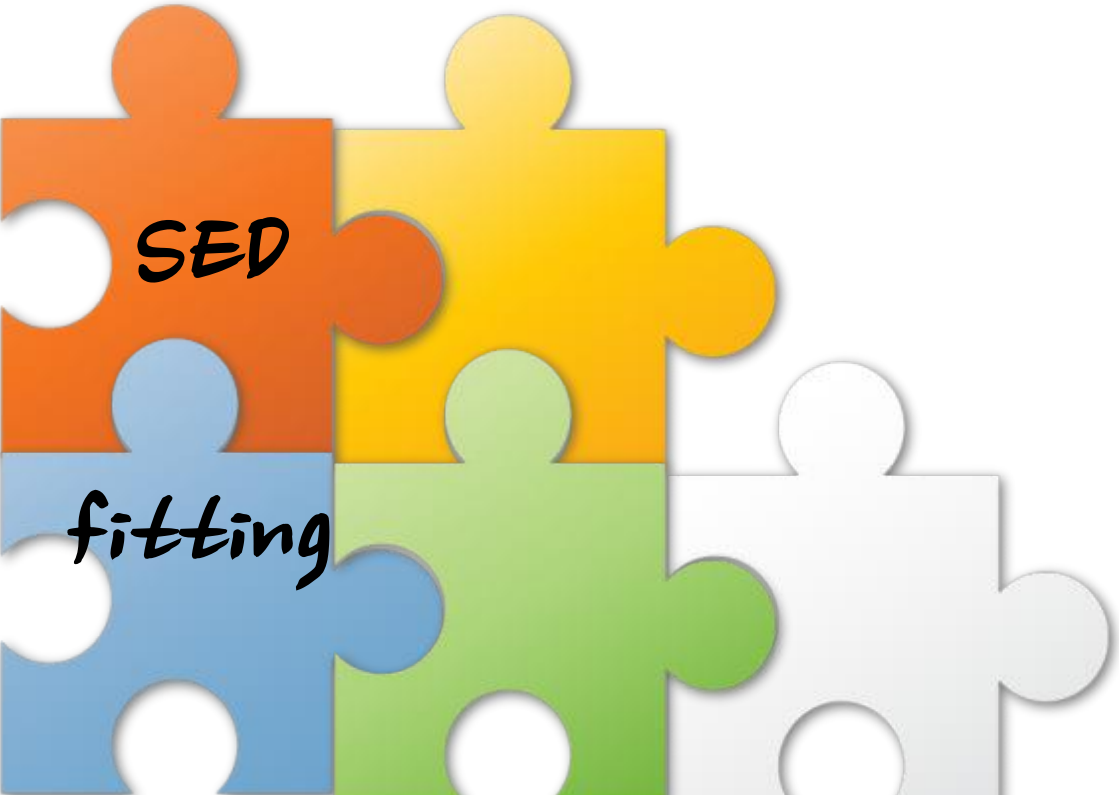
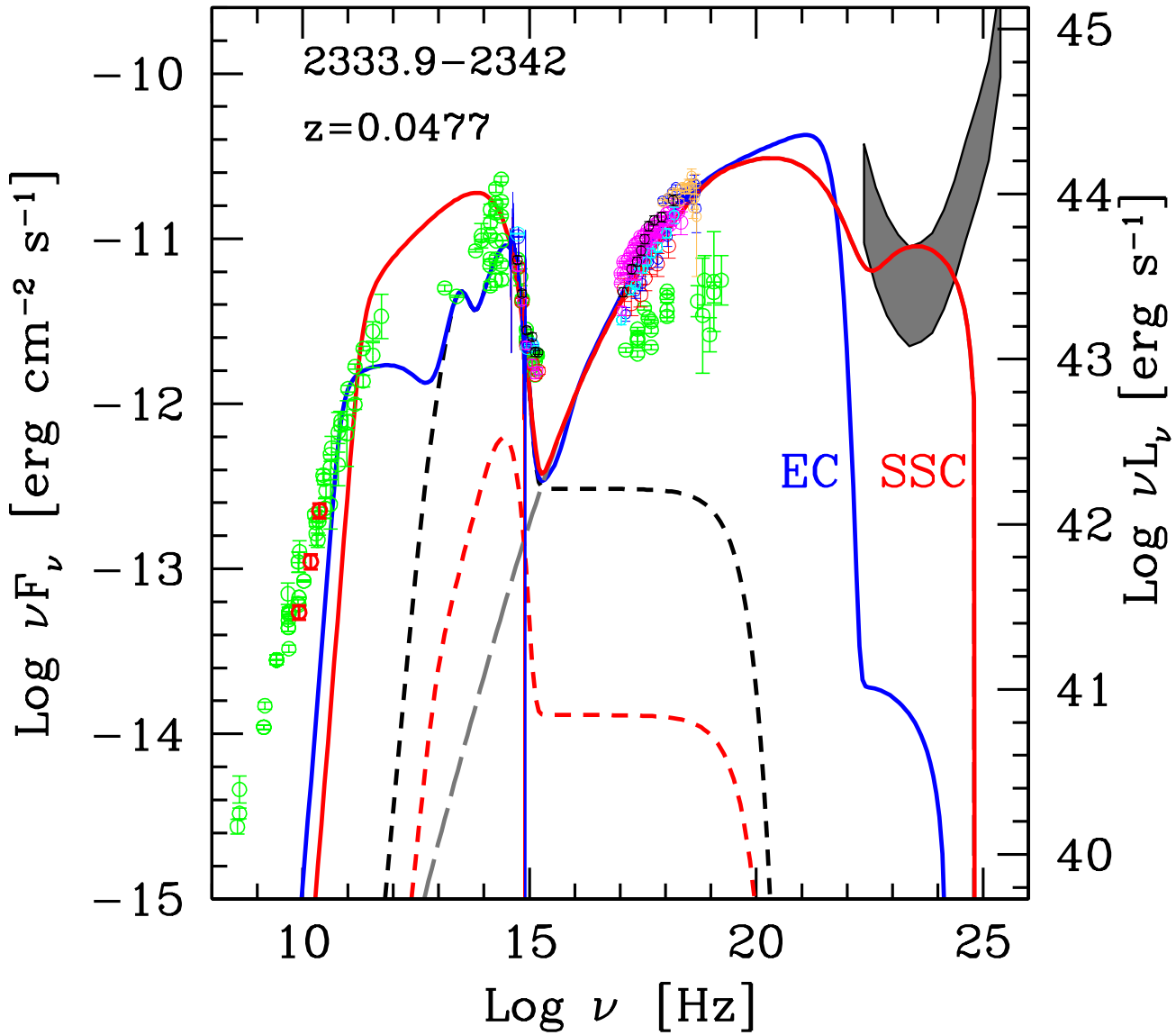
Results

- Blazar template (Ghisellini & Tavecchio 2009) → External Compton (EC) is preferred
- Jet observed at small angles: $\Theta = 3-6°$
- $\log M_{BH} = 9.5$ (Greene & Ho 2005, Tremaine et al. 2002)
- $\log R_{Edd} = L_{disk}/L_{Edd} = -3.9$





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Discussion

Different classifications are **not** due to variability:

- Seyfert 1.9
- Unsobscured
- Blazar

} Misaligned blazar

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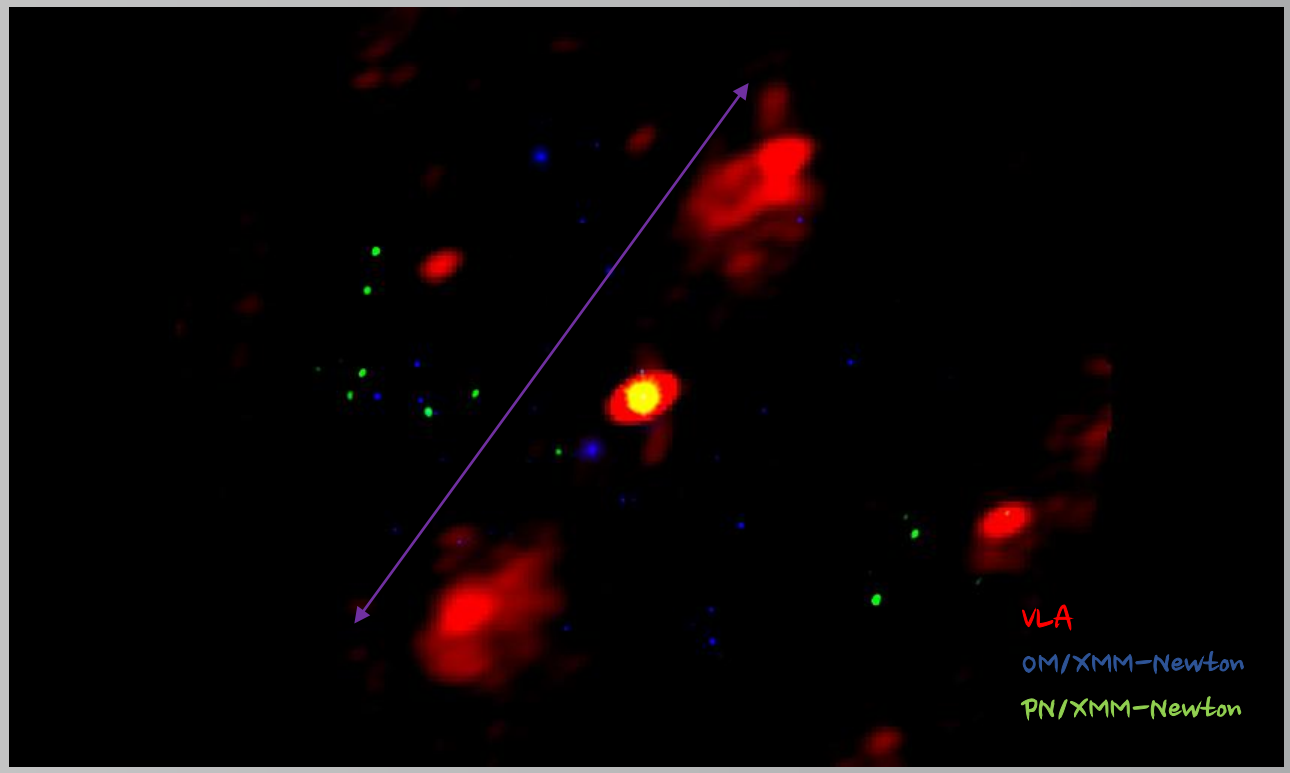
Discussion

SED + VLBA -> Super giant radio galaxy

-> Change in the direction of the jet

-> Restarting activity



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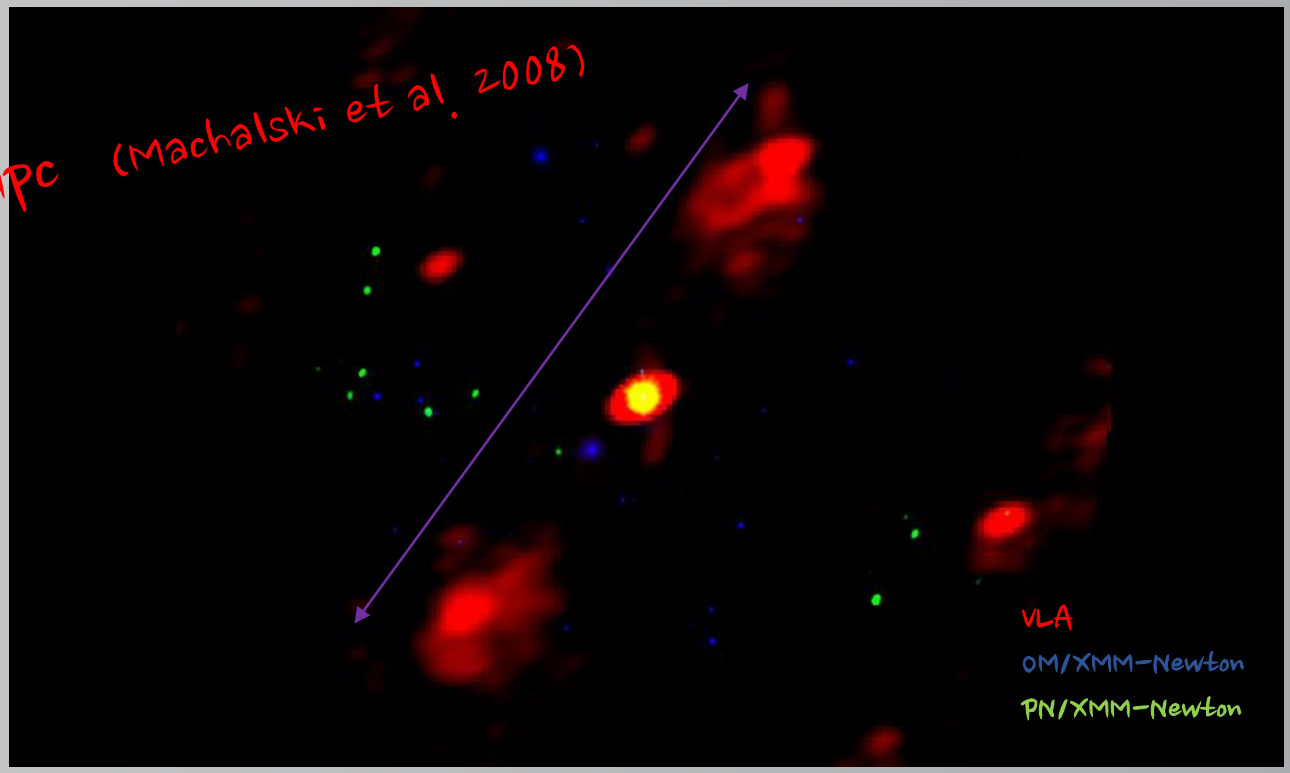
Discussion

SED + VLBA -> ~~Super giant radio galaxy~~

-> Change in the direction of the jet

-> Restarting activity

Largest giant radio galaxy 4.69 Mpc (Machalski et al. 2008)



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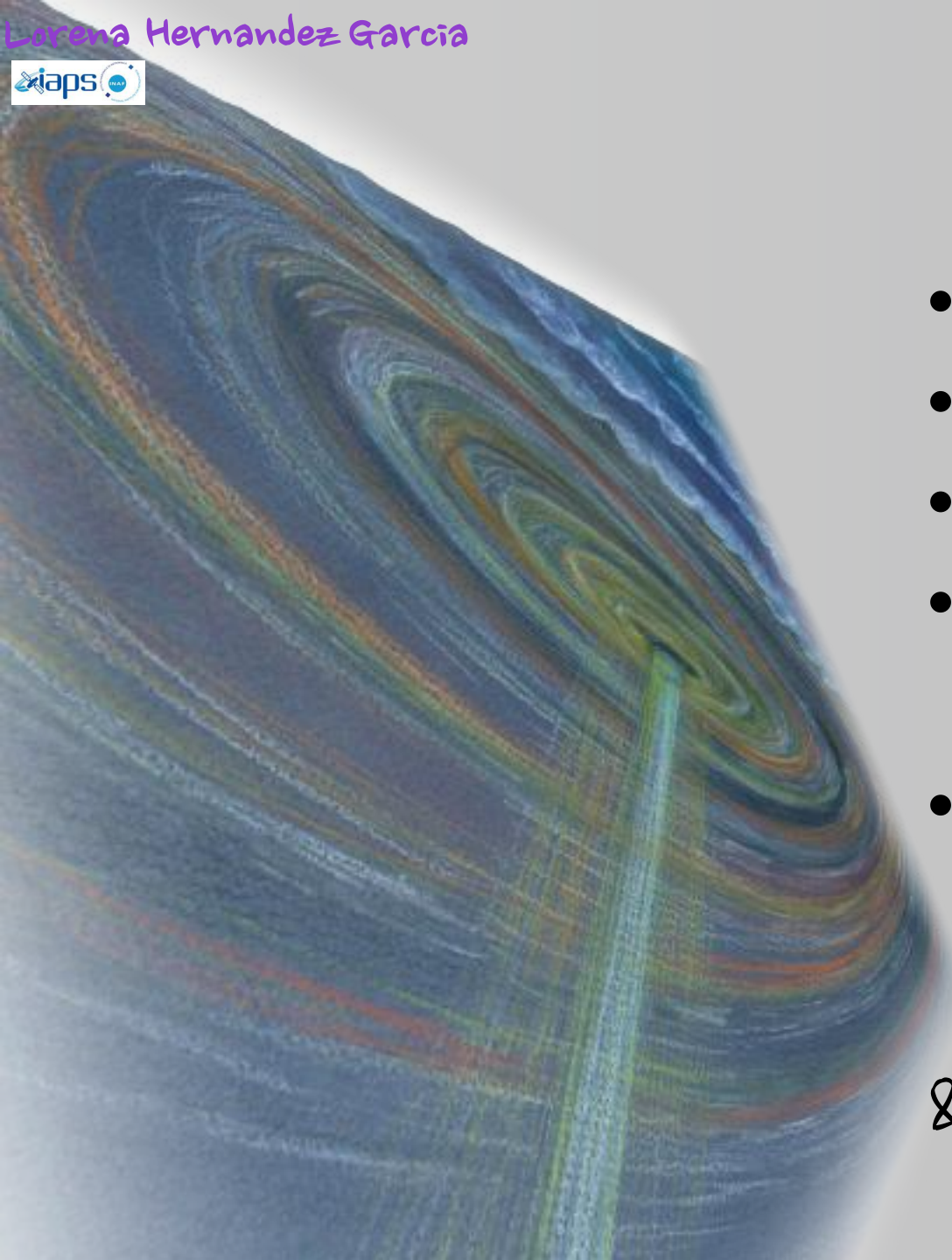

Discussion

- Low L_{edd} (ADAF?)
- Low L_{disk}
- High L_{lines}:

Weak broad lines compared to narrow lines (Francis et al. 1991)

- BPT diagram (Baldwin et al. 1981) in the borderline between a Seyfert and a LINER
- Very high X-ray luminosity

Transition from inneficient (ADAF, Narayan & Yi 1994) to efficient accretion (Shakura et al. 1973)

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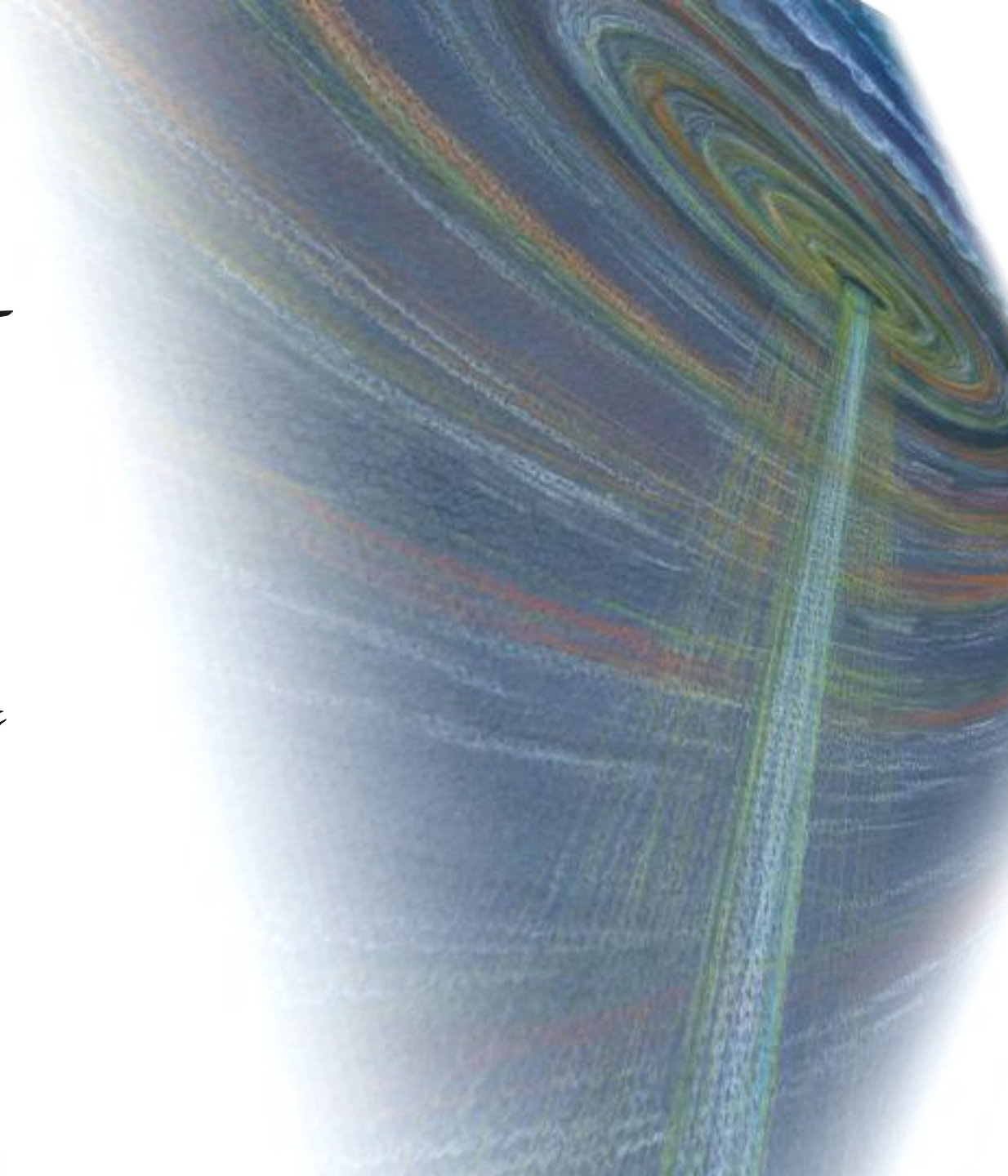
Conclusions

- We propose that PBC J2333.9-2343 is a misaligned blazar that restarted its nuclear activity
- It changed the angle of the jet
- The accretion disk is evolving from an ADAF to a standard disk



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