Narrow-line Seyfert 1 galaxies - rebels of the AGN family

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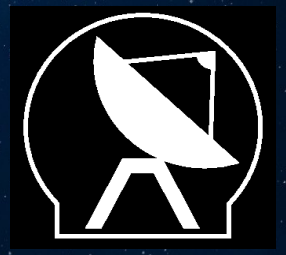


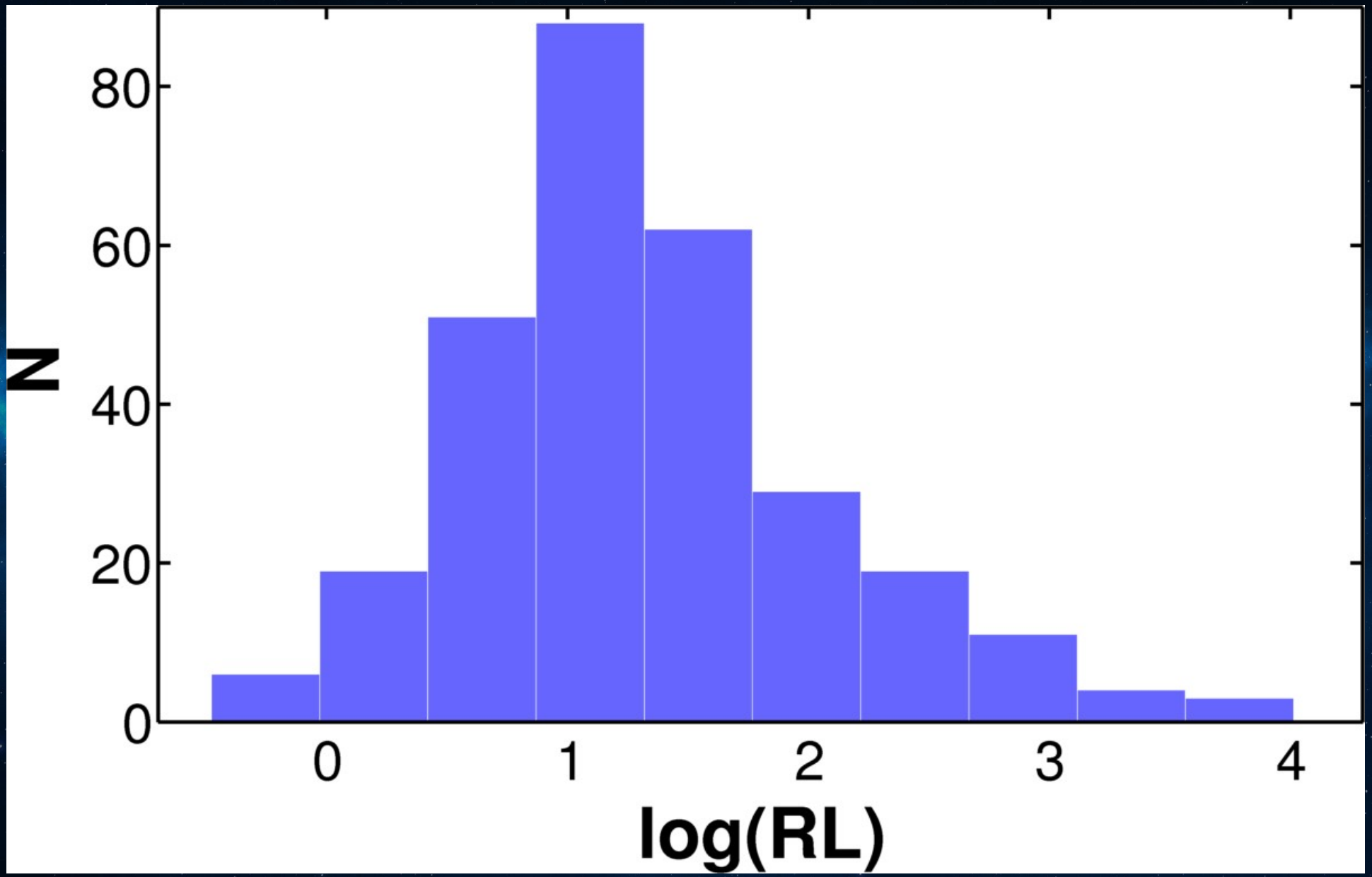
Why should we care?

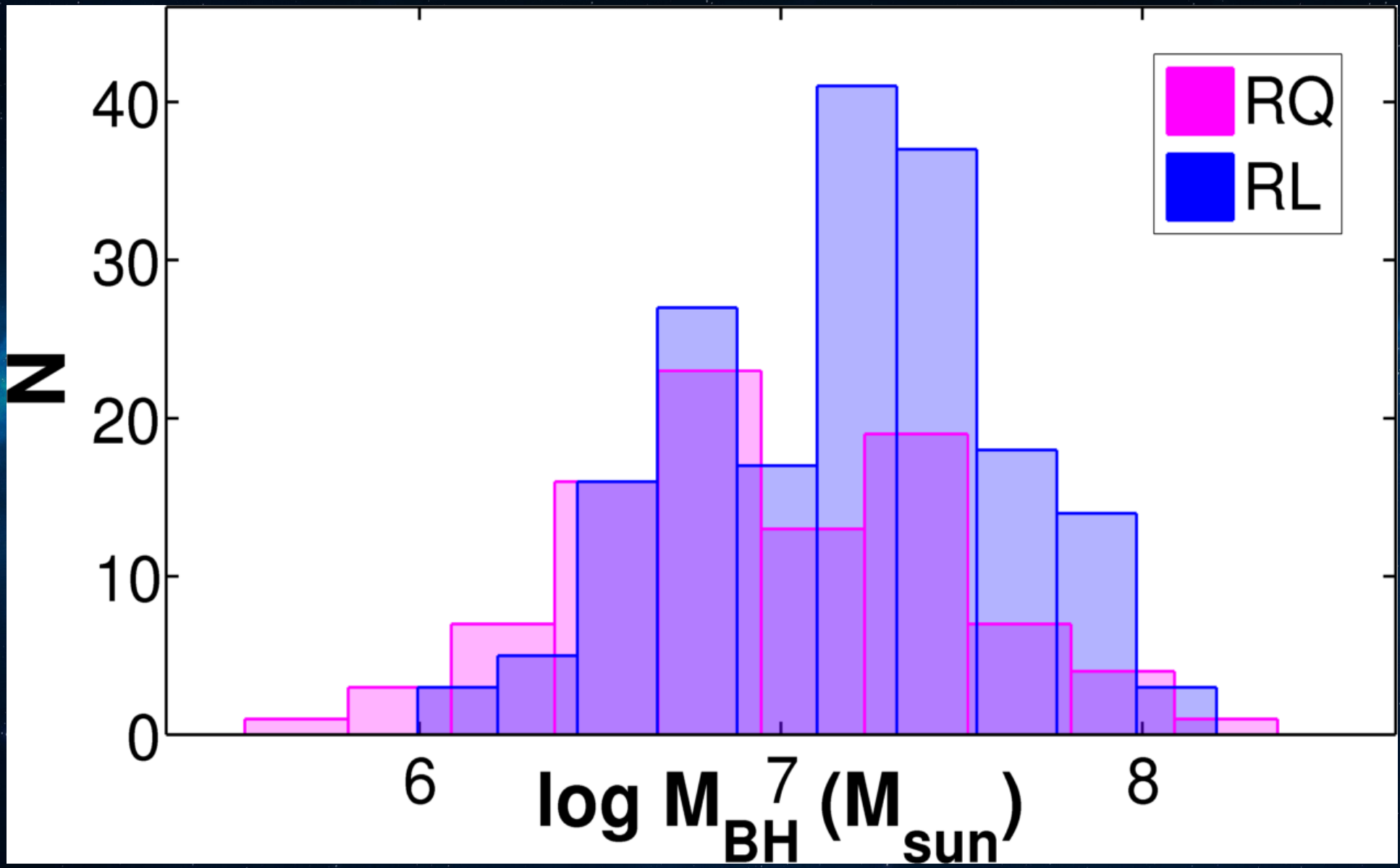
- Jets in NLS1s!
  - NLS1s differ from other gamma-ray emitting AGN
- So what?
  - NLS1s do not fit in the AGN unification schemes – where to put them?
  - AGN evolution does not work like we thought – what are the evolutionary lines?
  - What triggers and maintains the AGN activity?
- NLS1 are peculiar as a class
  - Do they form a homogeneous class?
  - What is the parent population?

The road so far...

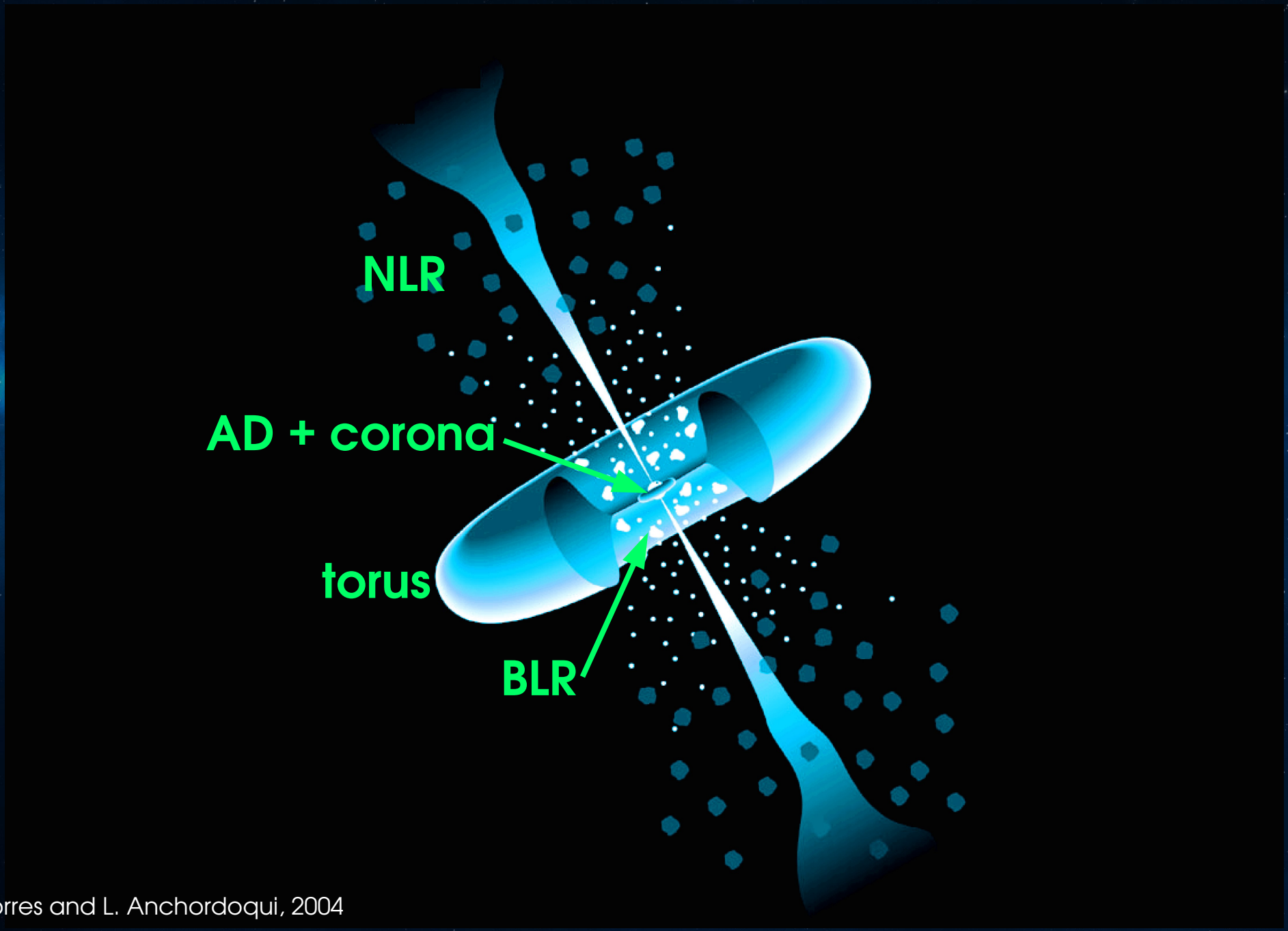
- Statistical study of a large sample of NLS1 galaxies
  - Via which processes and where different kinds of radiation are produced in NLS1s
  - How the emission properties are connected to other properties, e.g. M_{BH}
- 292 radio-detected NLS1s
- 11 wavebands from radio to X-rays
- Subsamples by radio-loudness:
  - Radio quiet (RL<10): 97
  - Radio loud (RL>10): 195

Järvelä et al. 2015


80
60
40
20
0
N
0
1
2
3
4
log(RL)

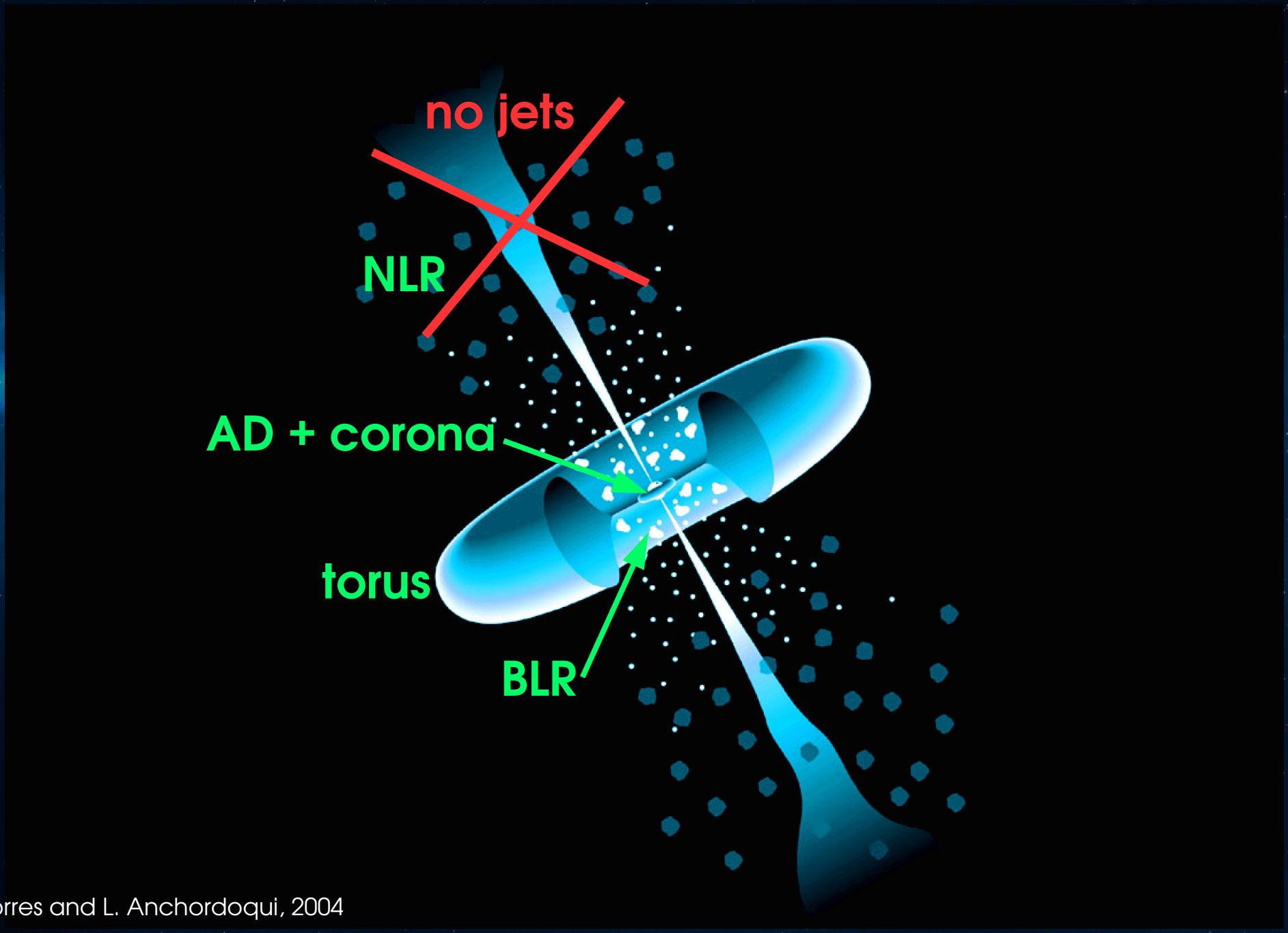

RQ
RL
N
0
10
20
30
40
6
7
8
log M_BH (M_sun)

Radio quiet



D. Torres and L. Anchordoqui, 2004

Radio quiet



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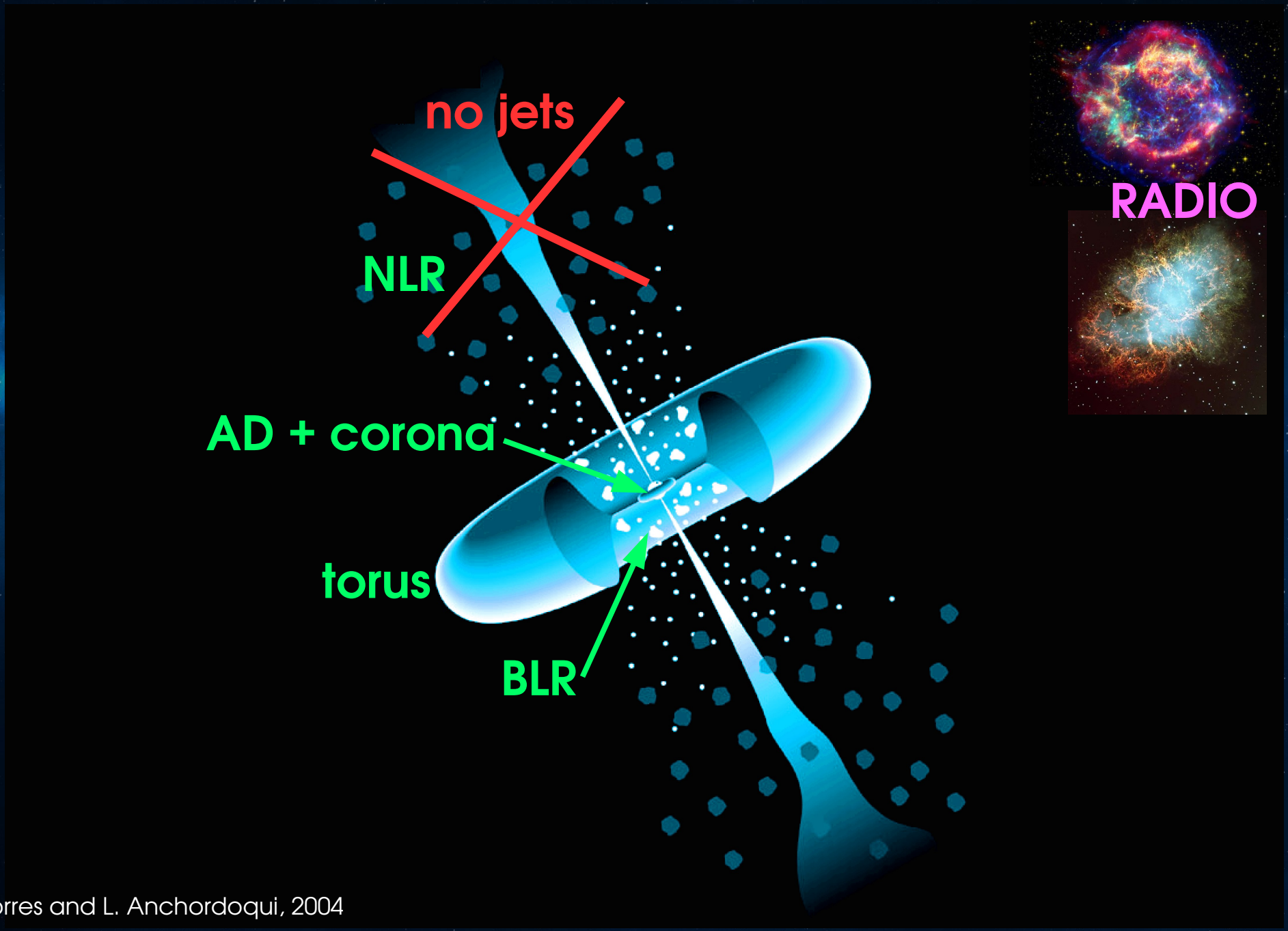
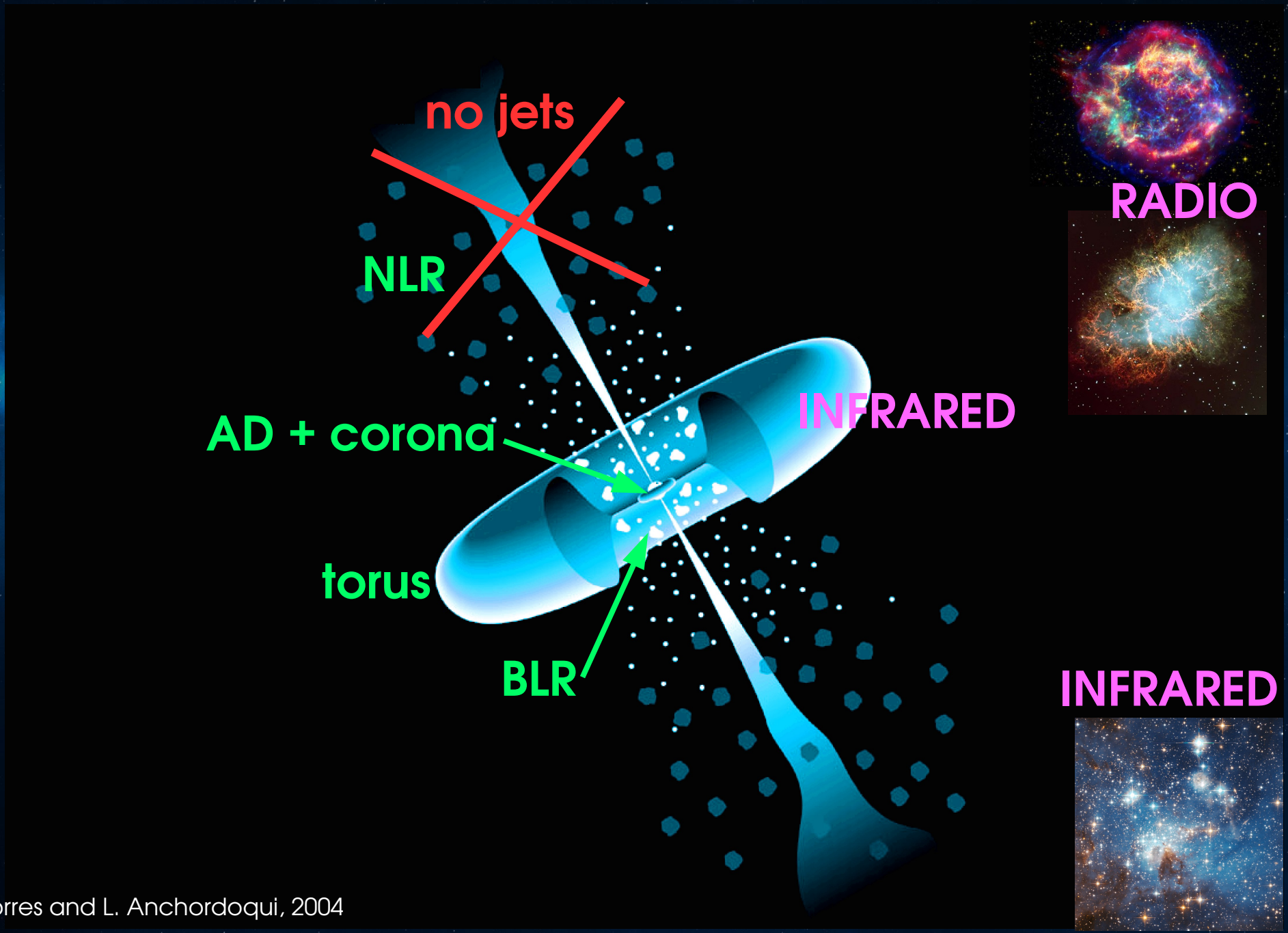
Radio quiet



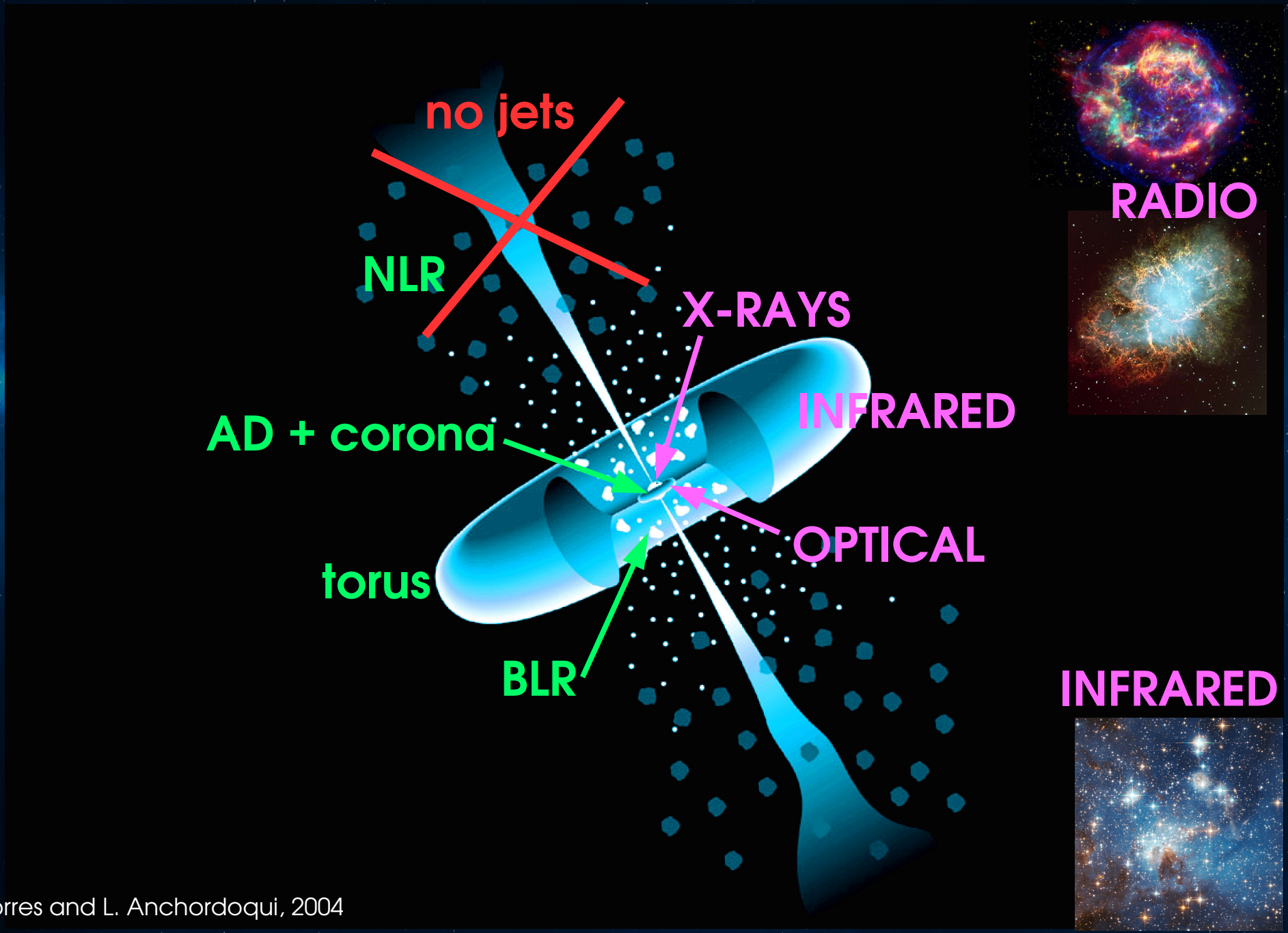
D. Torres and L. Anchordoqui, 2004

Radio quiet



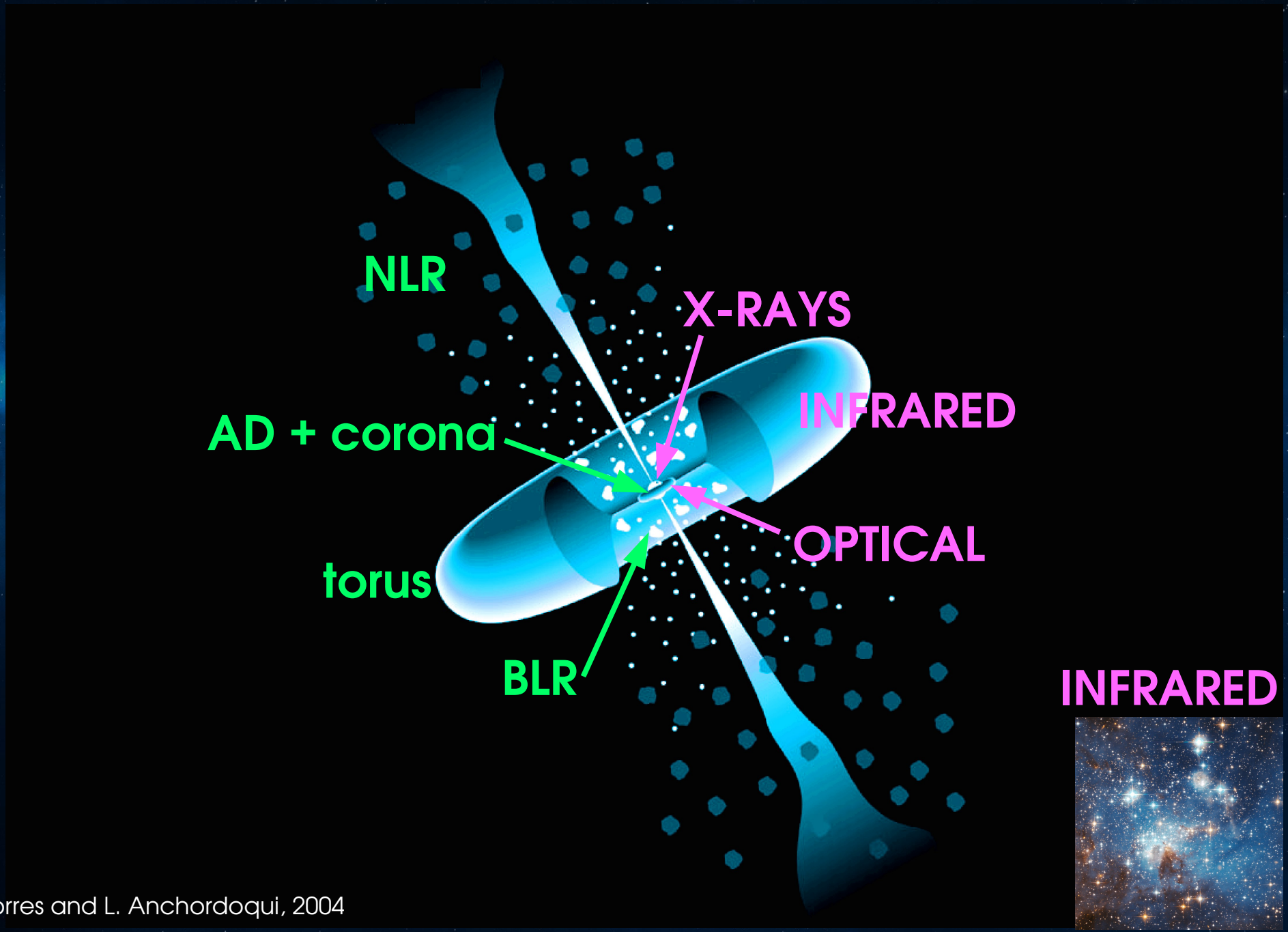
D. Torres and L. Anchordoqui, 2004

Radio quiet



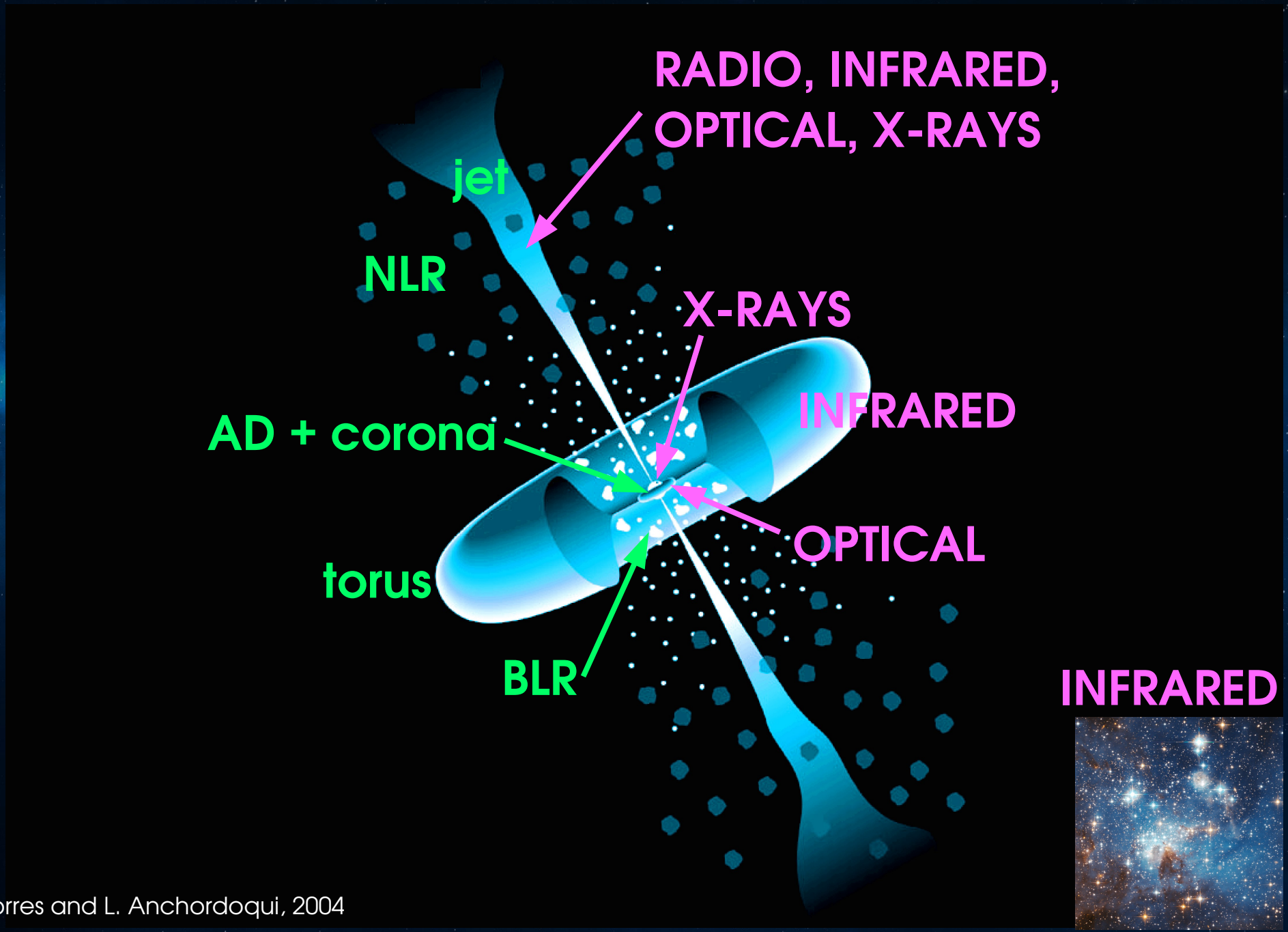
D. Torres and L. Anchordoqui, 2004

Radio loud



D. Torres and L. Anchordoqui, 2004

Radio loud



D. Torres and L. Anchordoqui, 2004

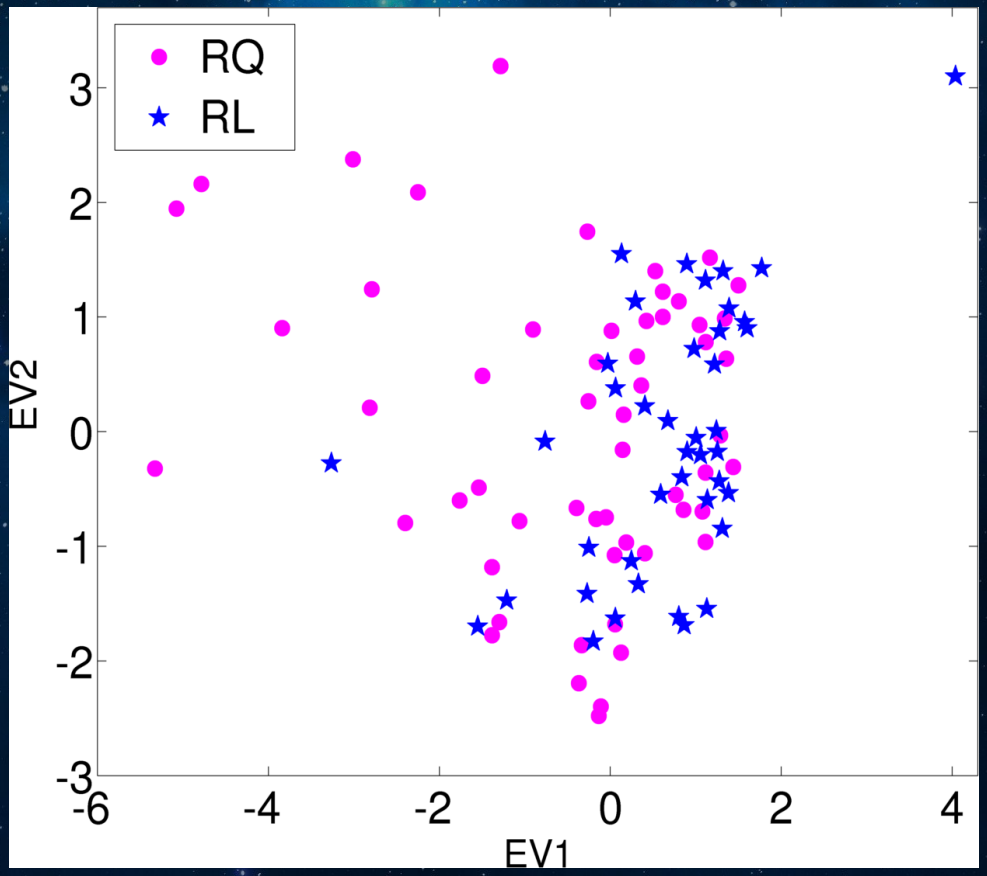
What's the problem then?

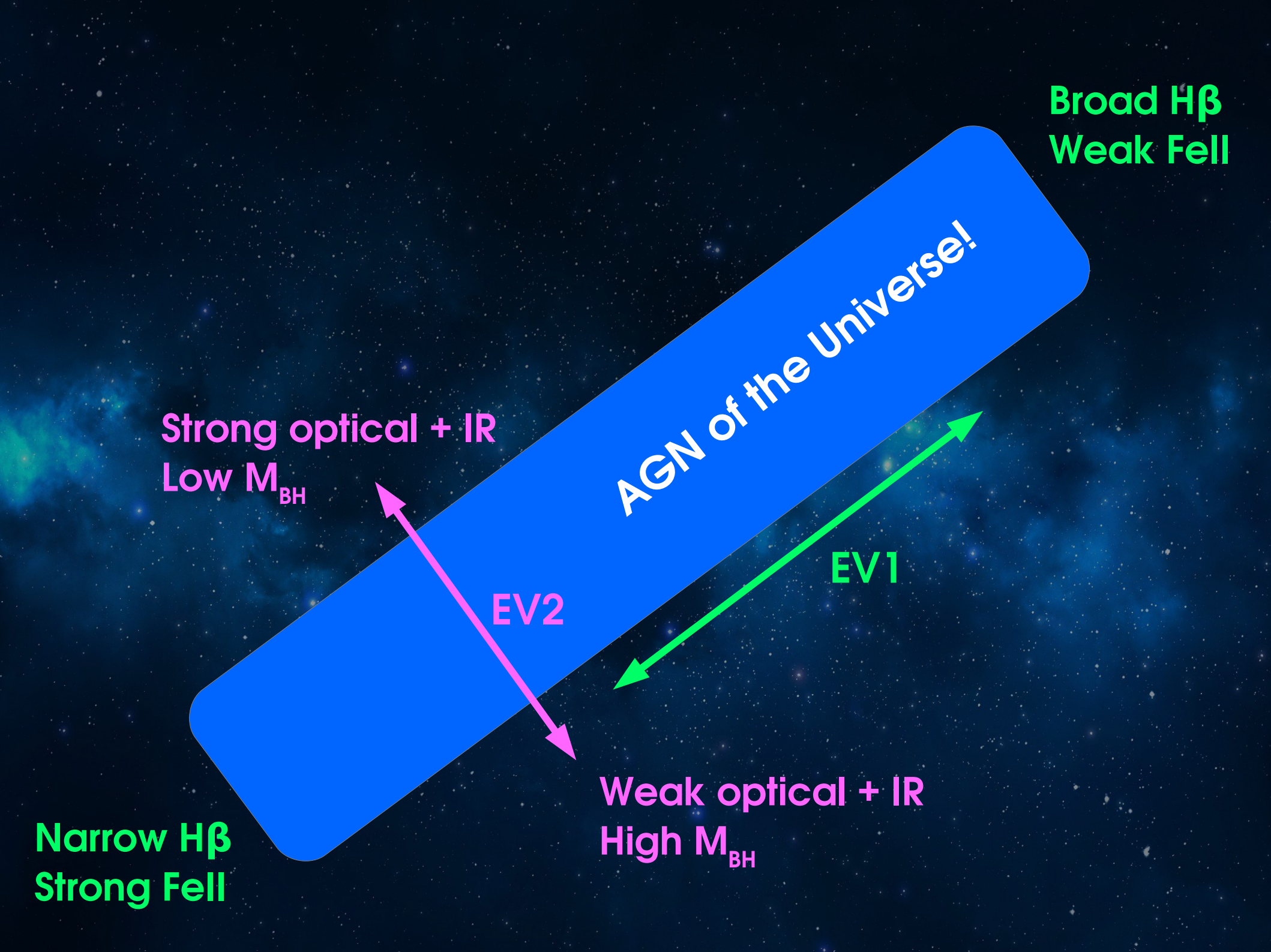
- Radio observations are very very scarce
- Results about the origin of infrared emission are confusing and inconclusive
- At X-rays NLS1s are variable at short timescales
  - Using non-simultaneous data should be treated cautiously

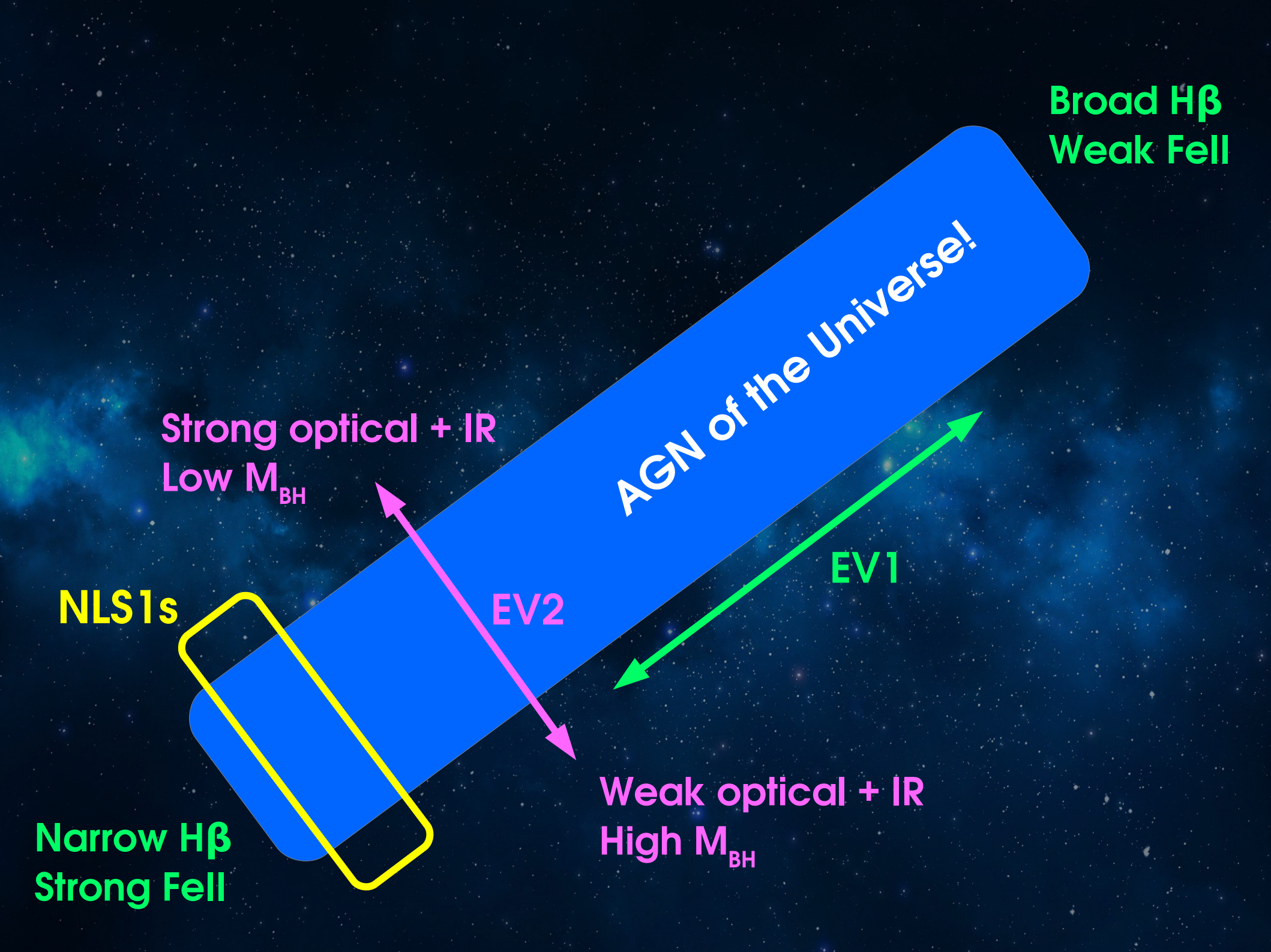
Principal component analysis

- PCA using MF data, M_{BH}, R4570 and FWHM(Hβ)
- Eigenvector 1 **M_{BH}** ⟷ **OPTICAL, IR**
  - Similar to EV2 in some previous studies
- Eigenvector 2 **R4570** ⟷ **FWHM(Hβ)**
  - The 'traditional' EV1
  - Correlates strongly with the Eddington ratio

EVs reversed?
What's wrong with our data?




Broad Hβ
Weak FeII
AGN of the Universe!
Strong optical + IR
Low M_{BH}
EV2
EV1
Weak optical + IR
High M_{BH}
Narrow Hβ
Strong FeII


Broad Hβ
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EV2
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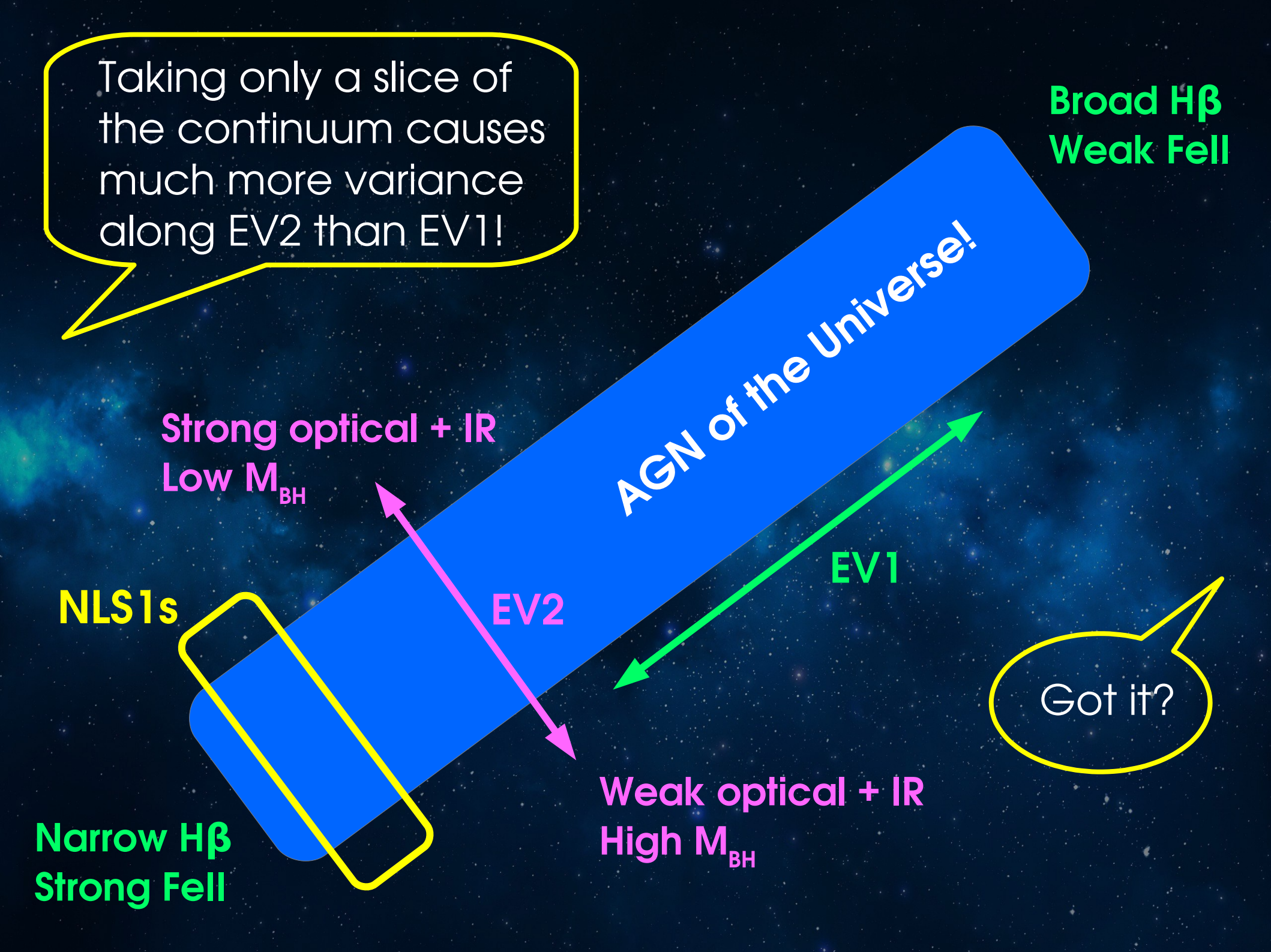
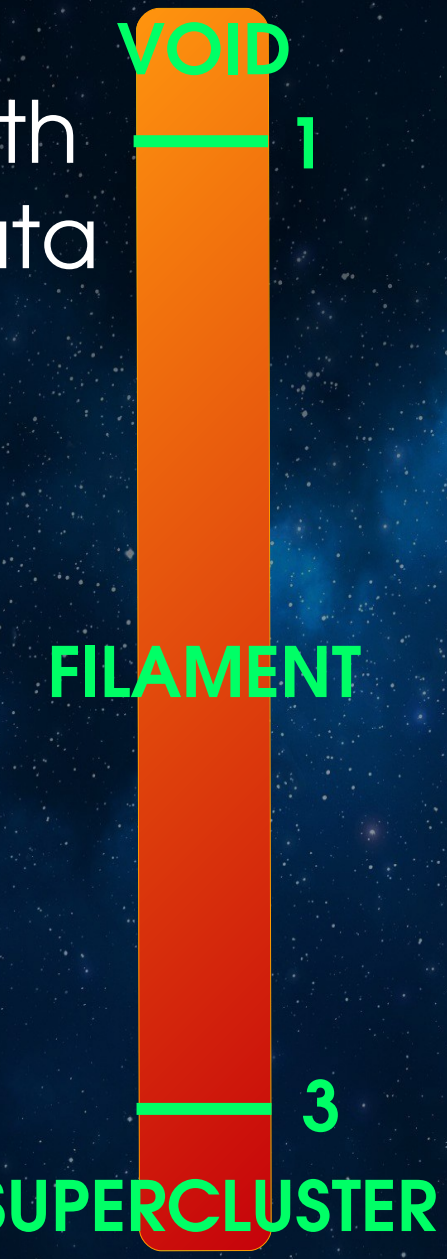

Taking only a slice of the continuum causes much more variance along EV2 than EV1!
Broad Hβ
Weak FeII
AGN of the Universe!
Strong optical + IR
Low M_{BH}
NLS1s
EV2
EV1
Got it?
Weak optical + IR
High M_{BH}
Narrow Hβ
Strong FeII

Teaser

Large-scale environment

(some preliminary results)

- 960 NLS1 galaxies with SDSS density field data



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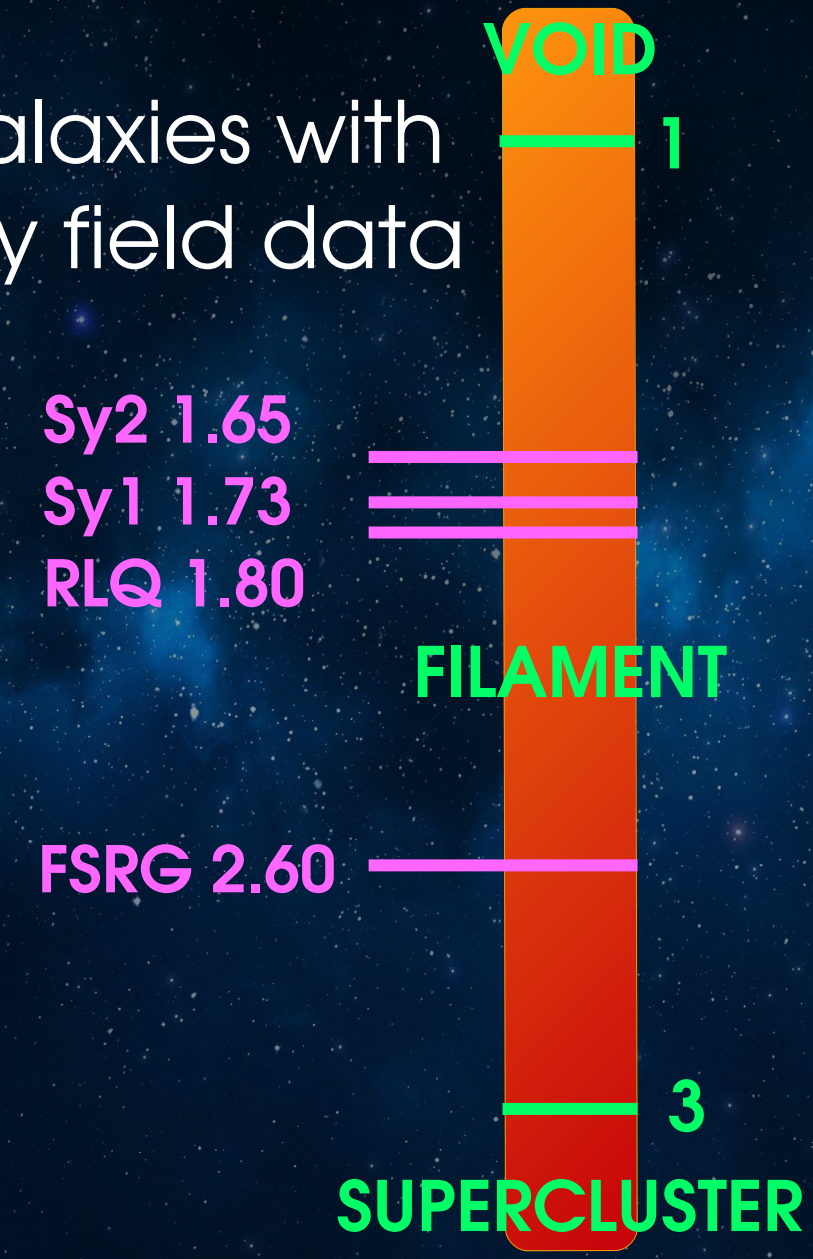

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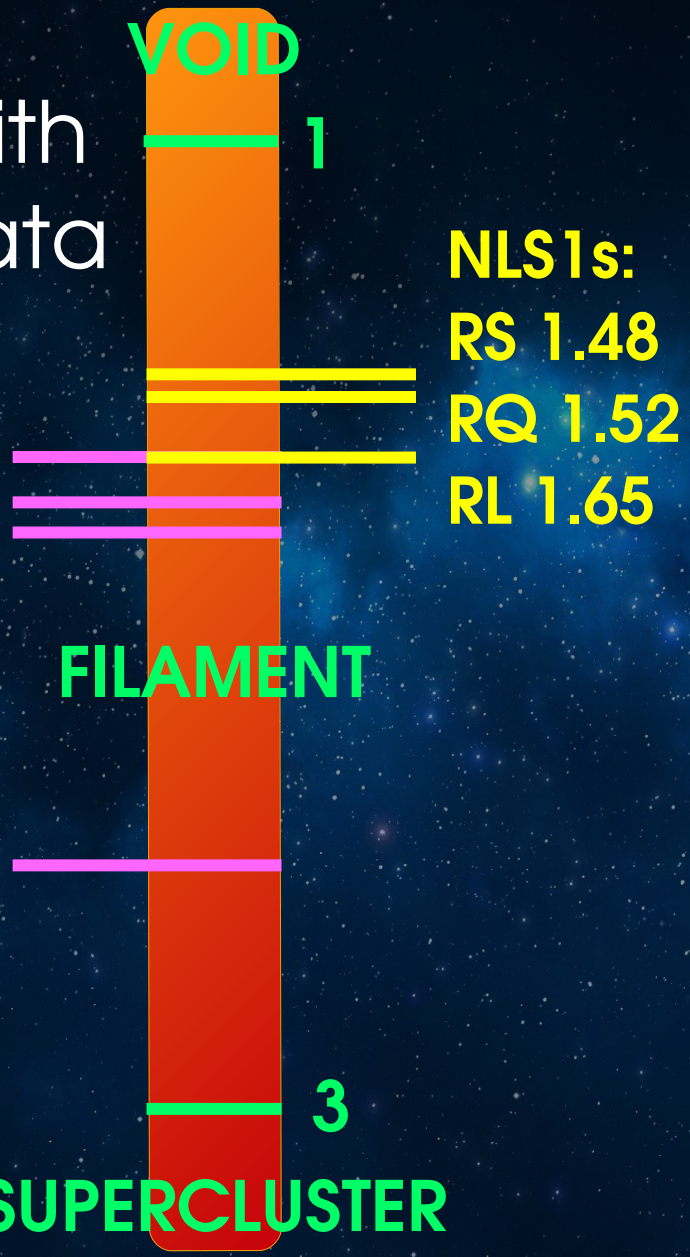

Teaser

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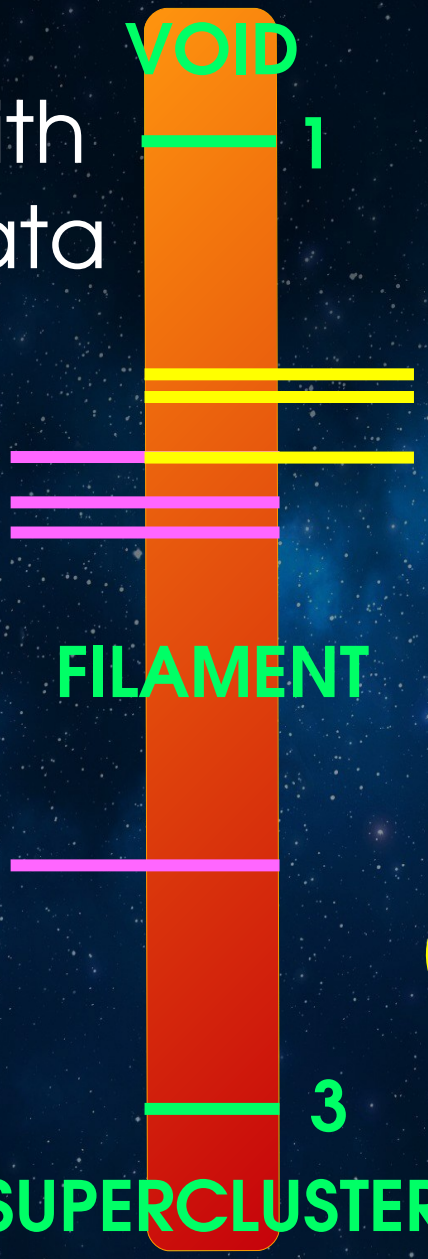


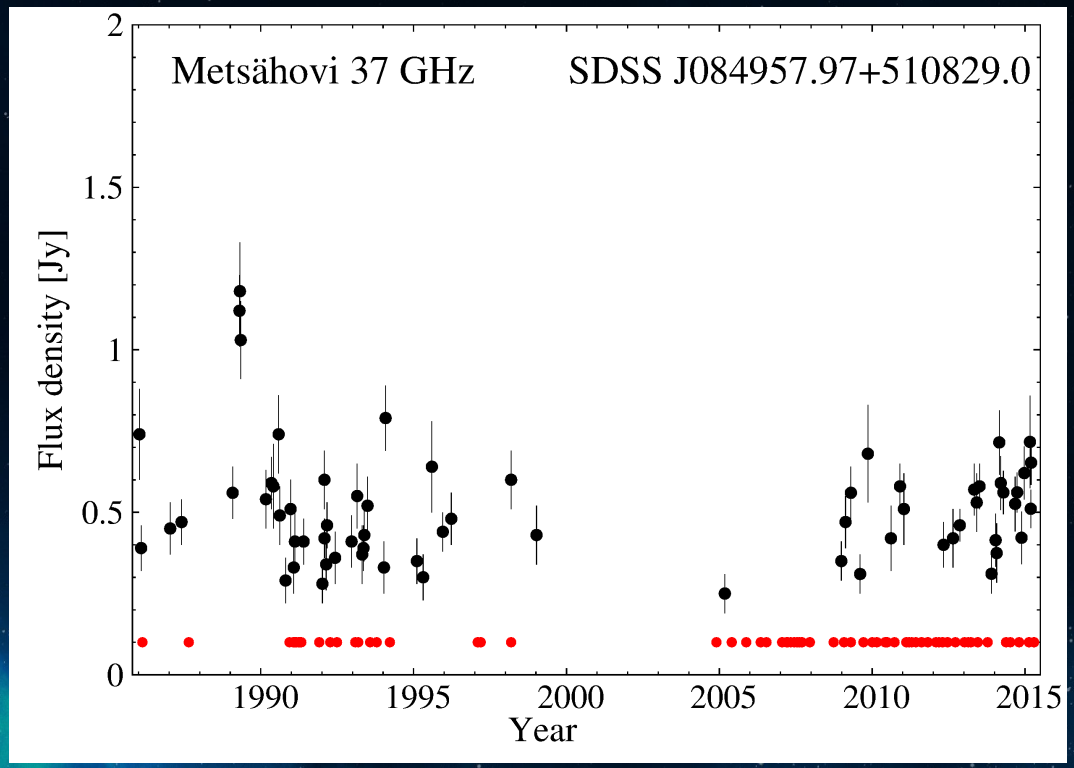
Stay tuned for more results early next year!

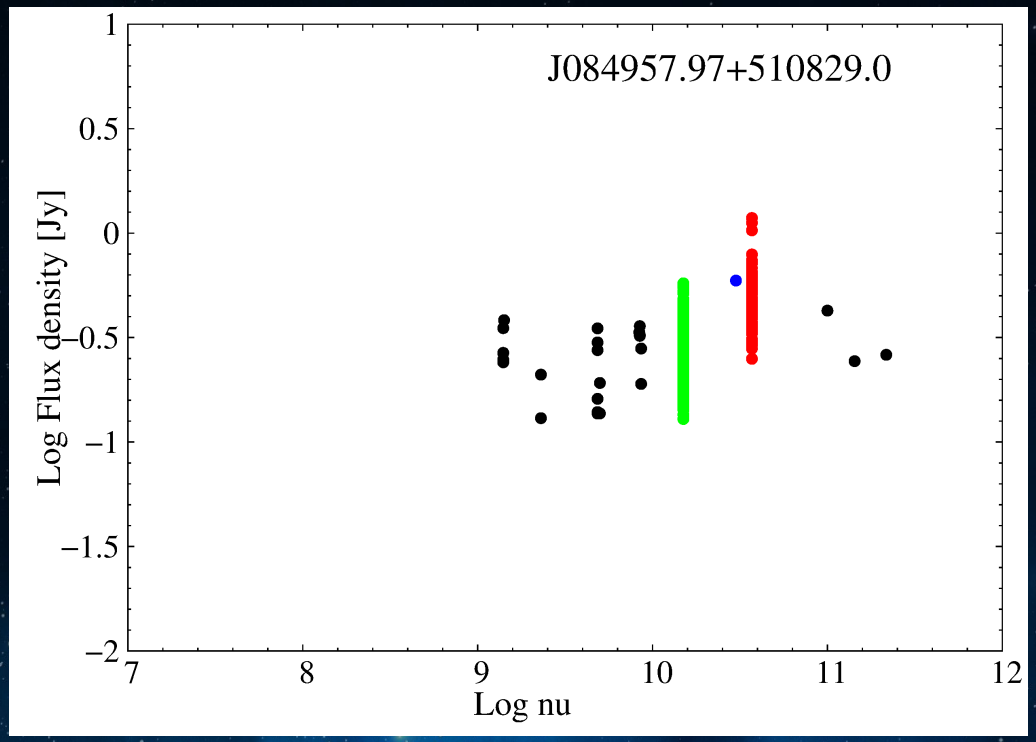
NLS1s reside in less dense large-scale environments than Sy1 and Sy2 galaxies

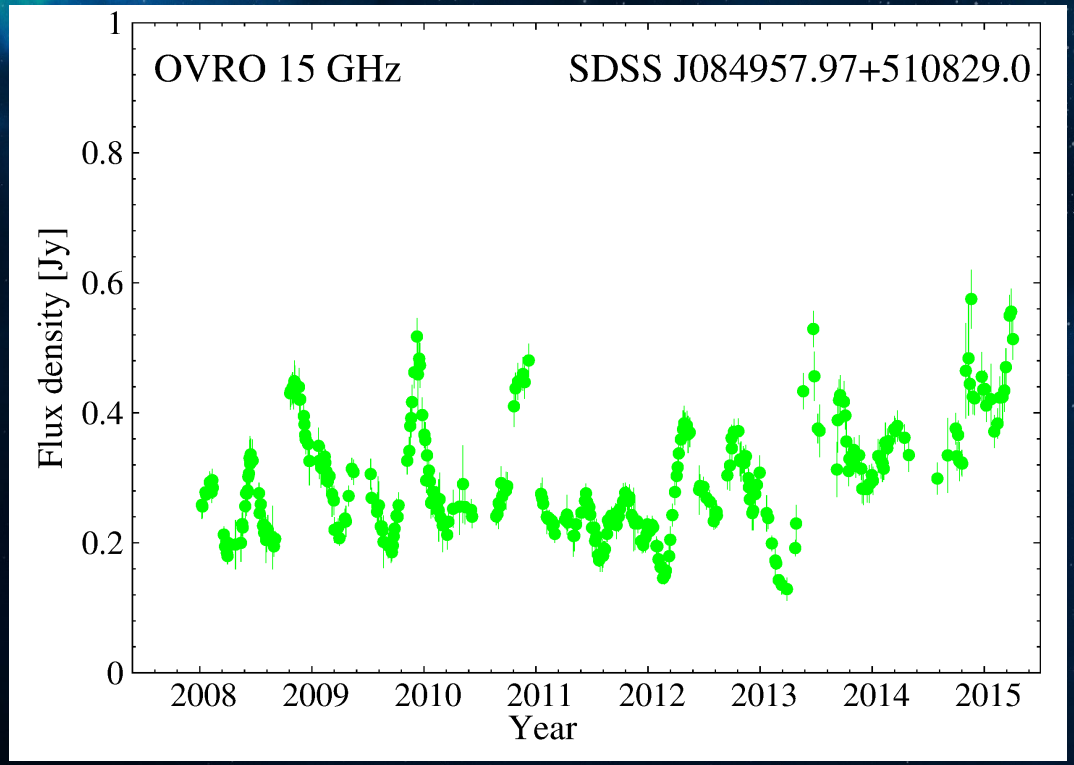
RL NLS1s in denser environments than RQ

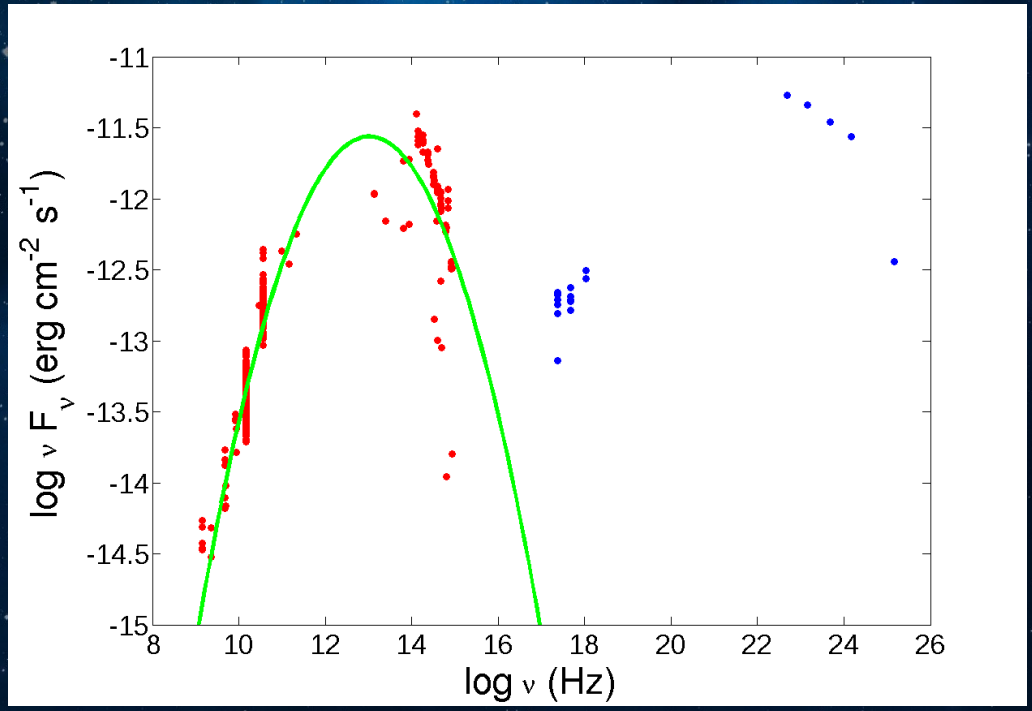
Metsähovi NLS1 survey

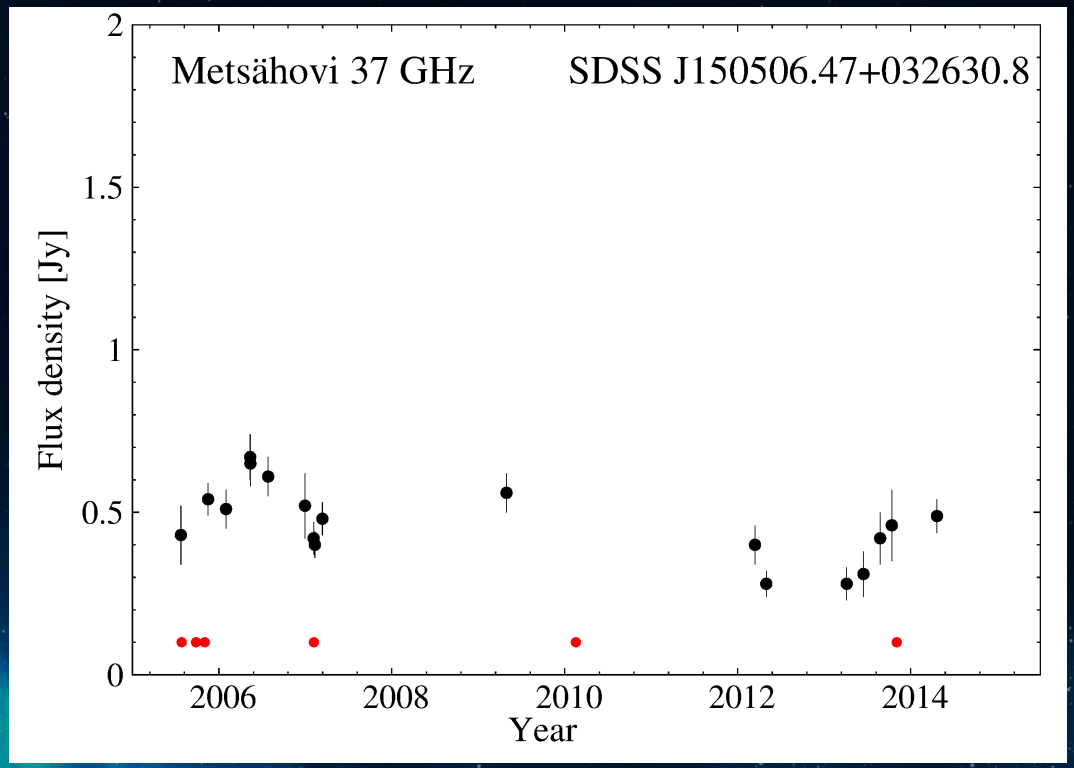
- Metsähovi radio telescope operating at 22 and 37 GHz
- Four NLS1 samples
  - 145 sources in total
  - At least three measurements separated by ~6 months of each source
  - Samples 1 & 2 completed at 37 GHz
- Detections?
  - Samples 1 & 2: 16/78 = ~21%
  - Samples 3 & 4: 6/67 = ~9%

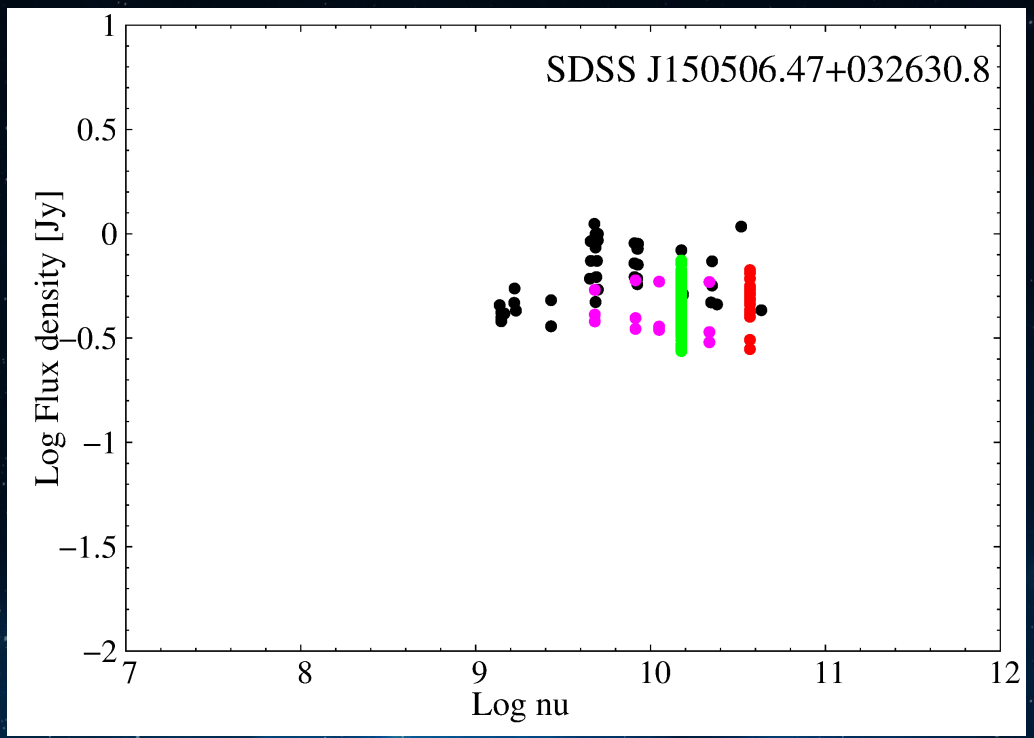

Metsähovi 37 GHz
SDSS J084957.97+510829.0
Flux density [Jy]
Year

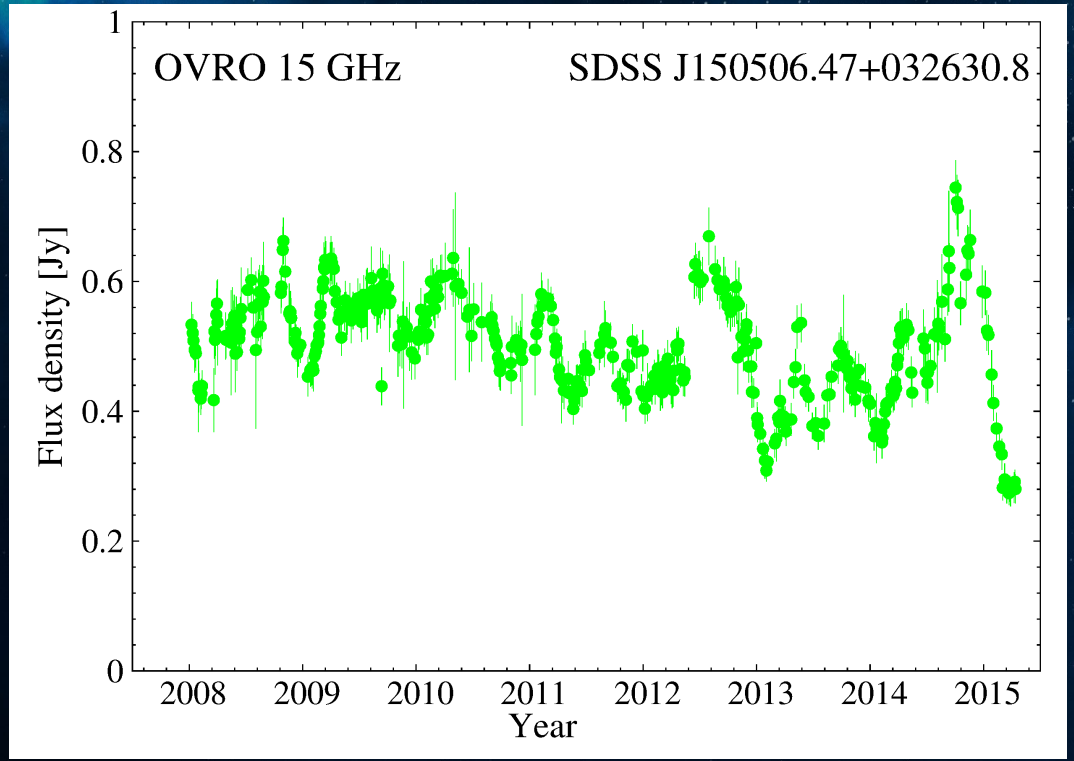

J084957.97+510829.0
Log Flux density [Jy]
Log nu

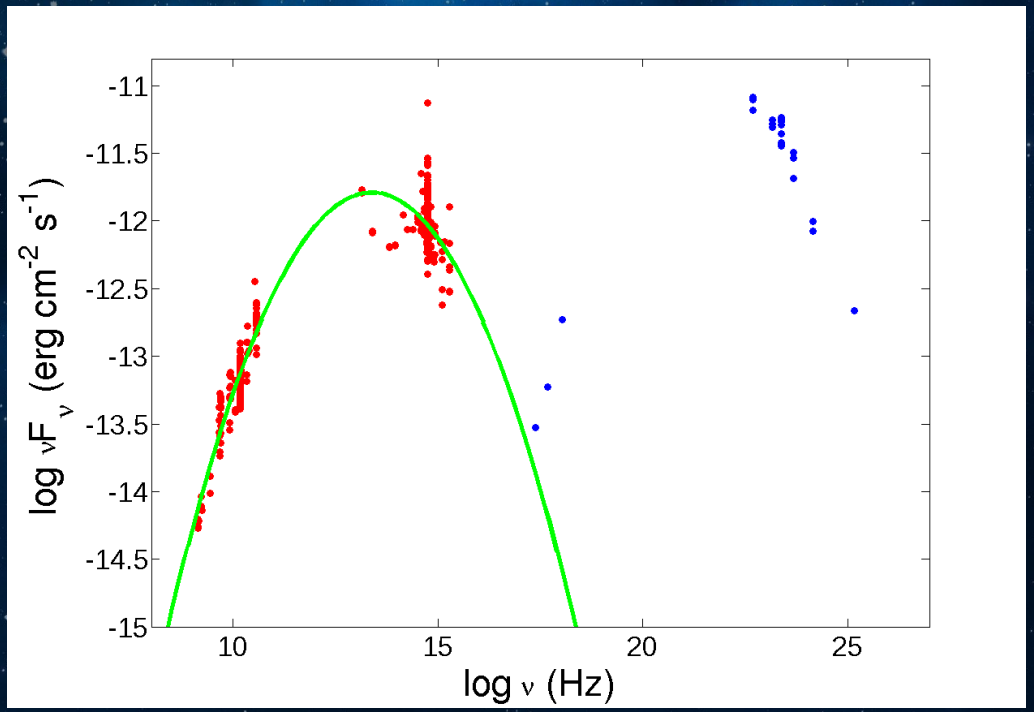

OVRO 15 GHz
SDSS J084957.97+510829.0
Flux density [Jy]
Year

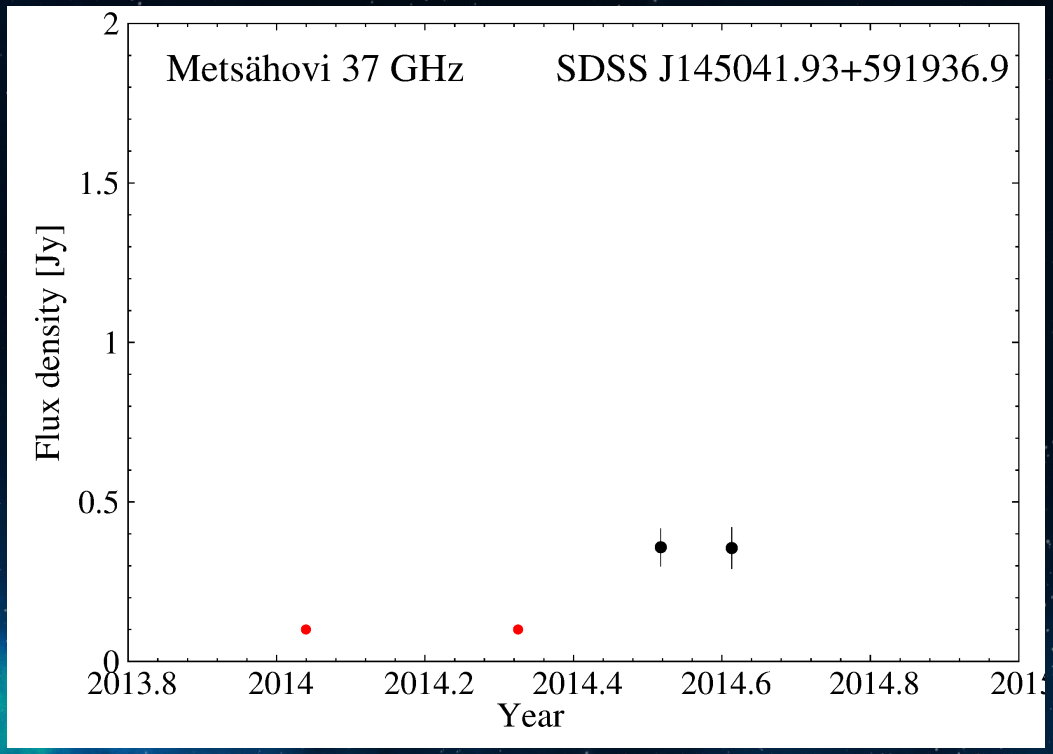

log ν F_ν (erg cm^-2 s^-1)
log ν (Hz)

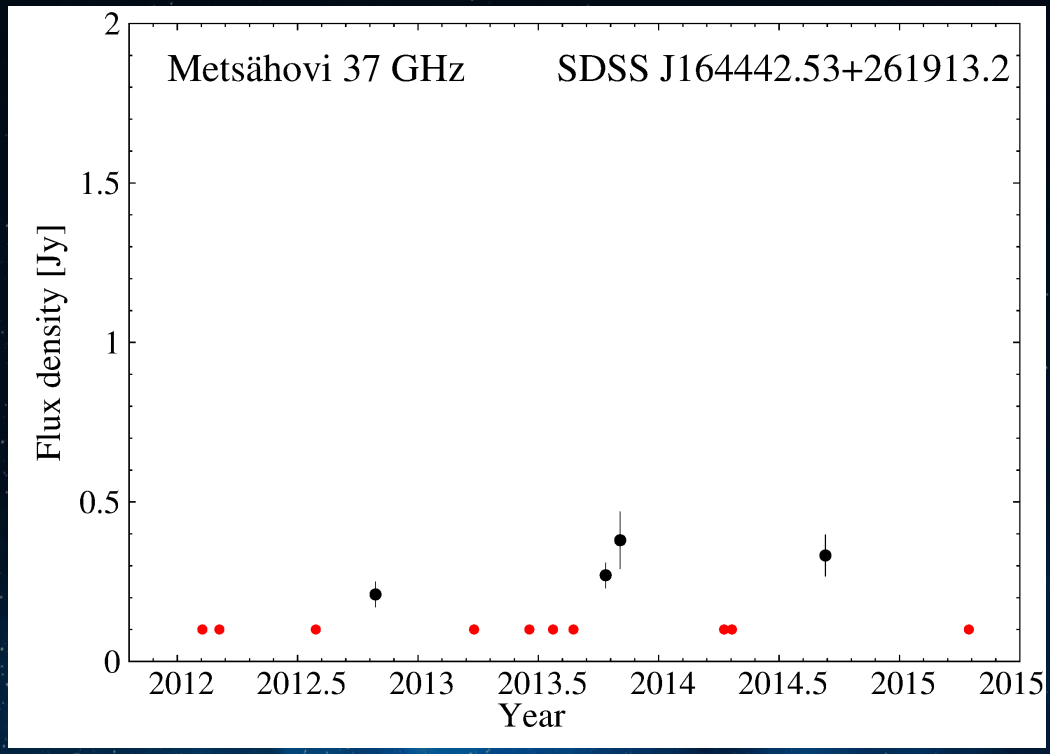

Metsähovi 37 GHz
SDSS J150506.47+032630.8
Flux density [Jy]
Year

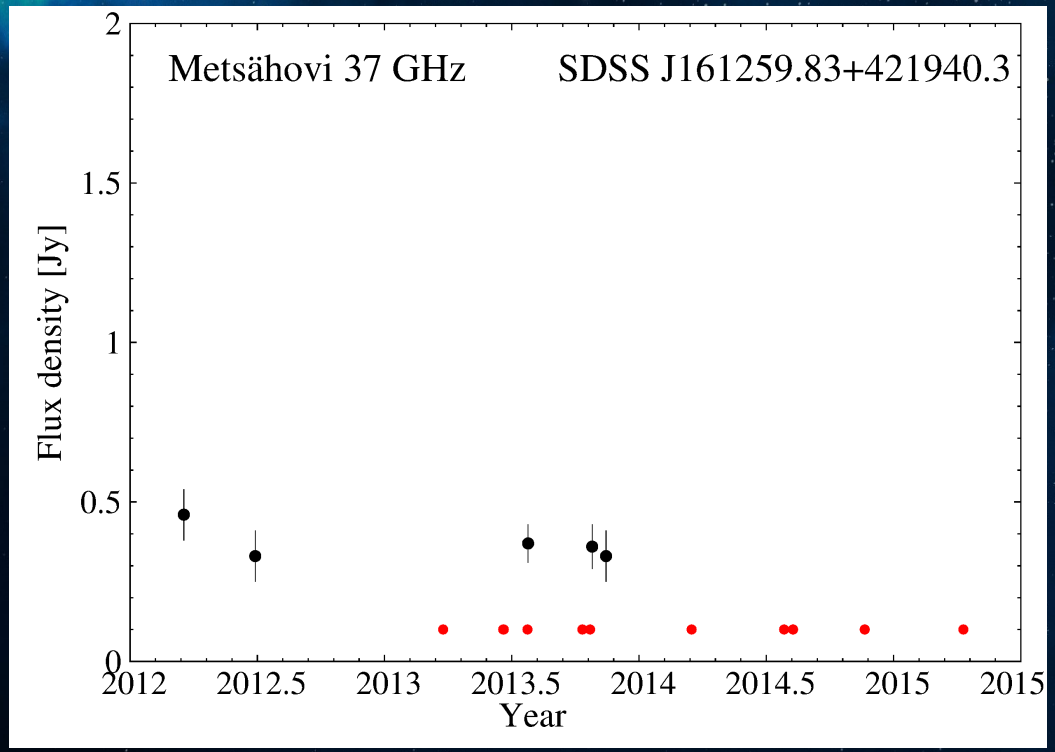

SDSS J150506.47+032630.8
Log Flux density [Jy]
Log nu


OVRO 15 GHz
SDSS J150506.47+032630.8
Flux density [Jy]
Year


log νF_ν (erg cm^-2 s^-1)
log ν (Hz)







First results will be published early next year!

Future work

- Large-scale environment data for 2000+ sources
- NLS1s in filaments & groups
- PCA with bigger samples + additional data
- More detailed studies of individual sources
- More observations!


Thank you!

References

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