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. $M_{\text{BH}}$
- 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
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 quiet

- NLR
- AD + corona
- torus
- BLR
- no jets

D. Torres and L. Anchordoqui, 2004
Radio quiet

D. Torres and L. Anchordoqui, 2004
Radio loud

D. Torres and L. Anchordoqui, 2004
Radio loud

NLR

AD + corona

torus

BLR

jet

RADIO, INFRARED, OPTICAL, X-RAYS

INFRARED

INFRARED

X-RAYS

OPTICAL

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

Lack of (simultaneous) data is a problem!

Metsähovi NLS1 survey

Let's do more observations then!
Principal component analysis

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

What's wrong with our data? EVs reversed?
Narrow $\text{H}\beta$
Strong $\text{FeII}$

Broad $\text{H}\beta$
Weak $\text{FeII}$

Strong optical + IR
Low $M_{\text{BH}}$

Weak optical + IR
High $M_{\text{BH}}$

AGN of the Universe!
AGN of the Universe!

Strong optical + IR, Low $M_{\text{BH}}$

NLS1s

Narrow H$\beta$, Strong Fell

Weak optical + IR, High $M_{\text{BH}}$

EV1

EV2

Broad H$\beta$, Weak Fell
Taking only a slice of the continuum causes much more variance along EV2 than EV1!
Large-scale environment
(some preliminary results)

- 960 NLS1 galaxies with SDSS density field data
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NLS1s:
- RS 1.48
- RQ 1.52
- RL 1.65

Sy2 1.65
Sy1 1.73
RLQ 1.80

FSRG 2.60

VOID
FILAMENT
SUPERCLUSTER
Large-scale environment
(some preliminary results)

- 960 NLS1 galaxies with SDSS density field data

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

Stay tuned for more results early next year!
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: $16/78 = \sim 21\%$
  - Samples 3 & 4: $6/67 = \sim 9\%$
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!

- VLA
- EVN
- Metsähovi
- ALMA
- ???
Thank you!
References