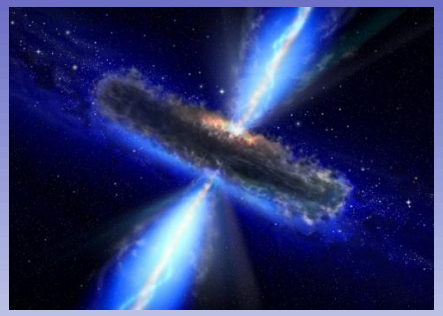
# Timur Mufakharov





## Education

Kazan Federal University, Russia

## Work

SAO RAS, Caucasus, Russia

## What I investigate

Active Galactic Nuclei

Blazars

# Simultaneous spectra and radio properties of the BL Lacertae objects

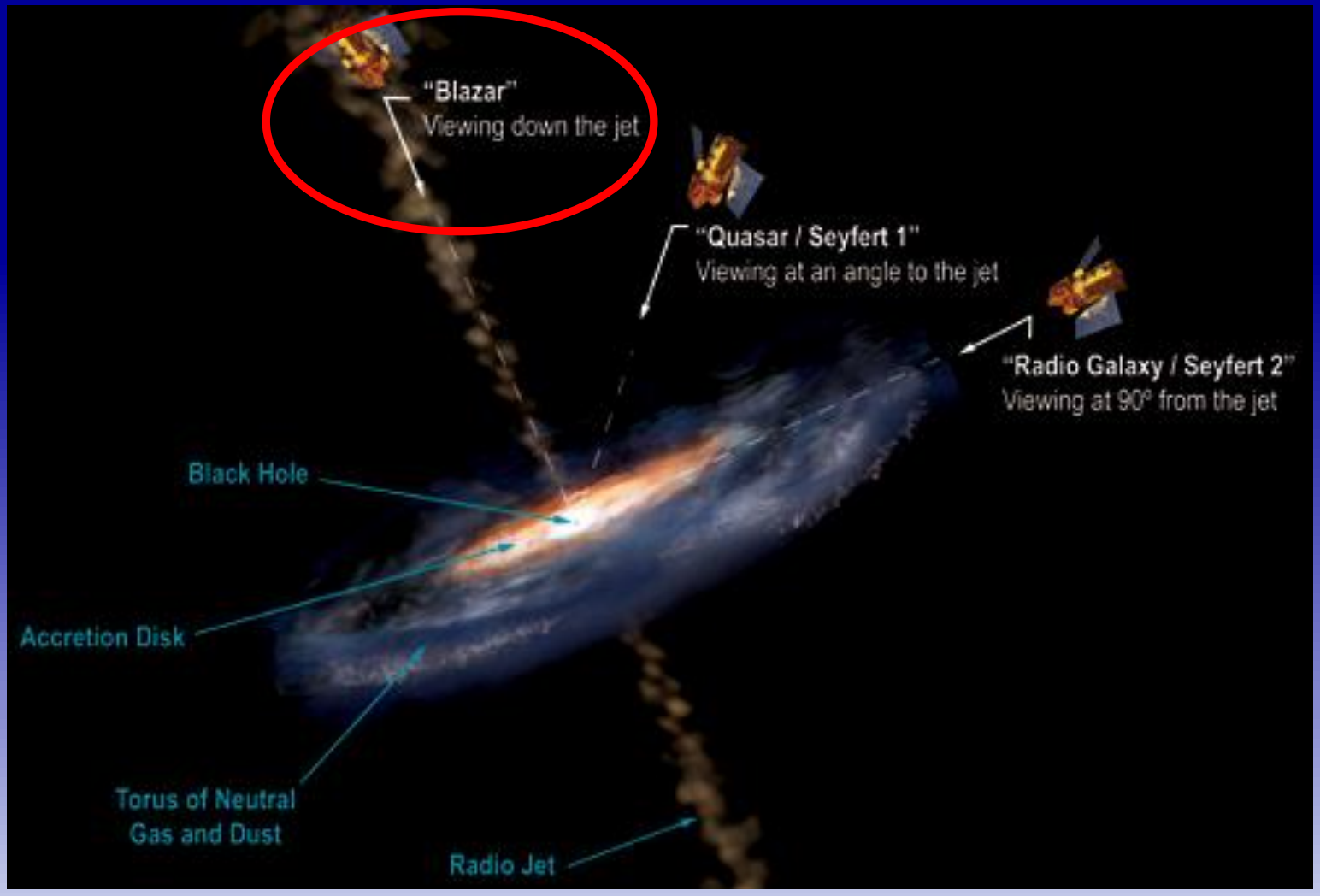
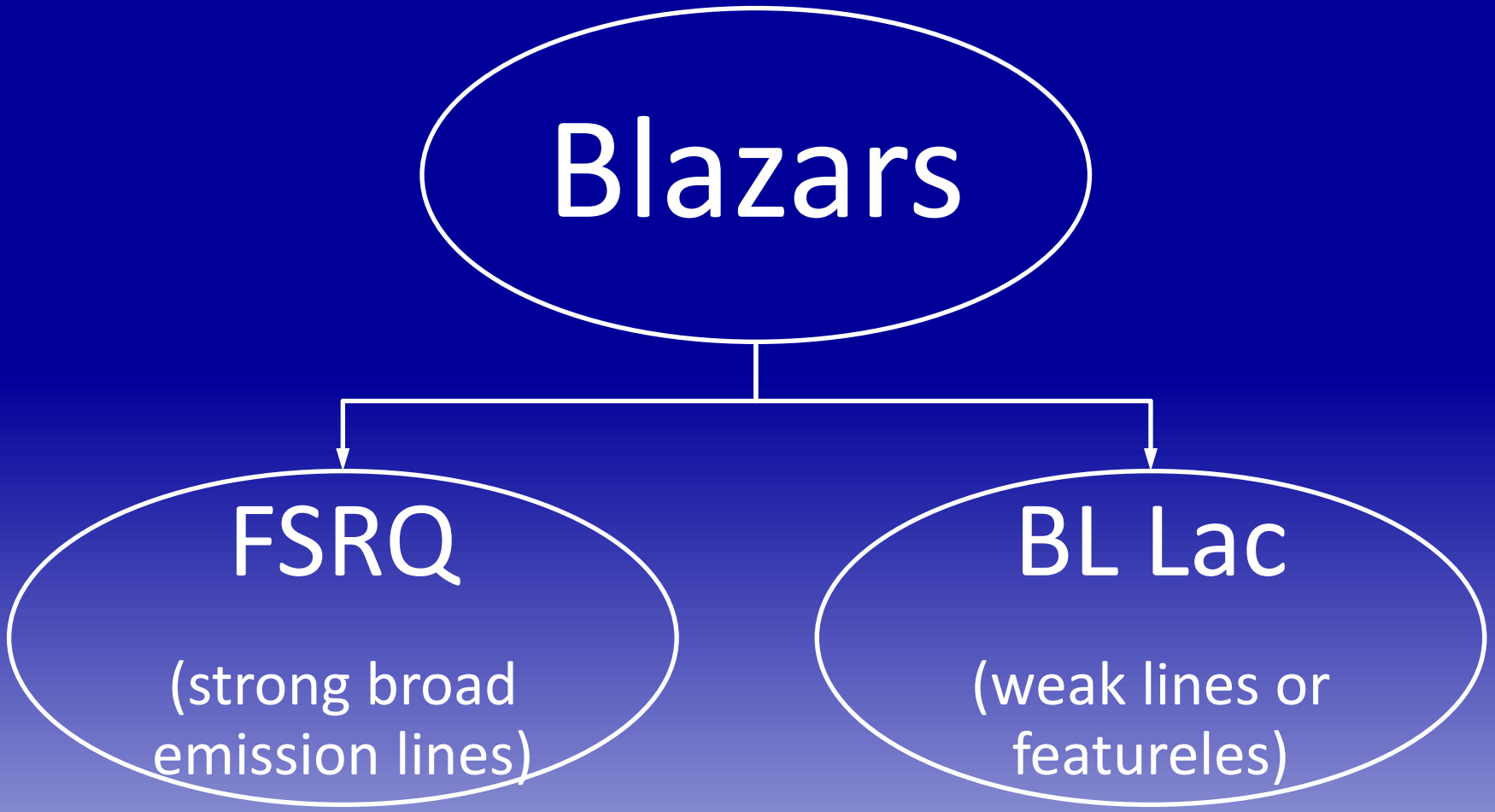
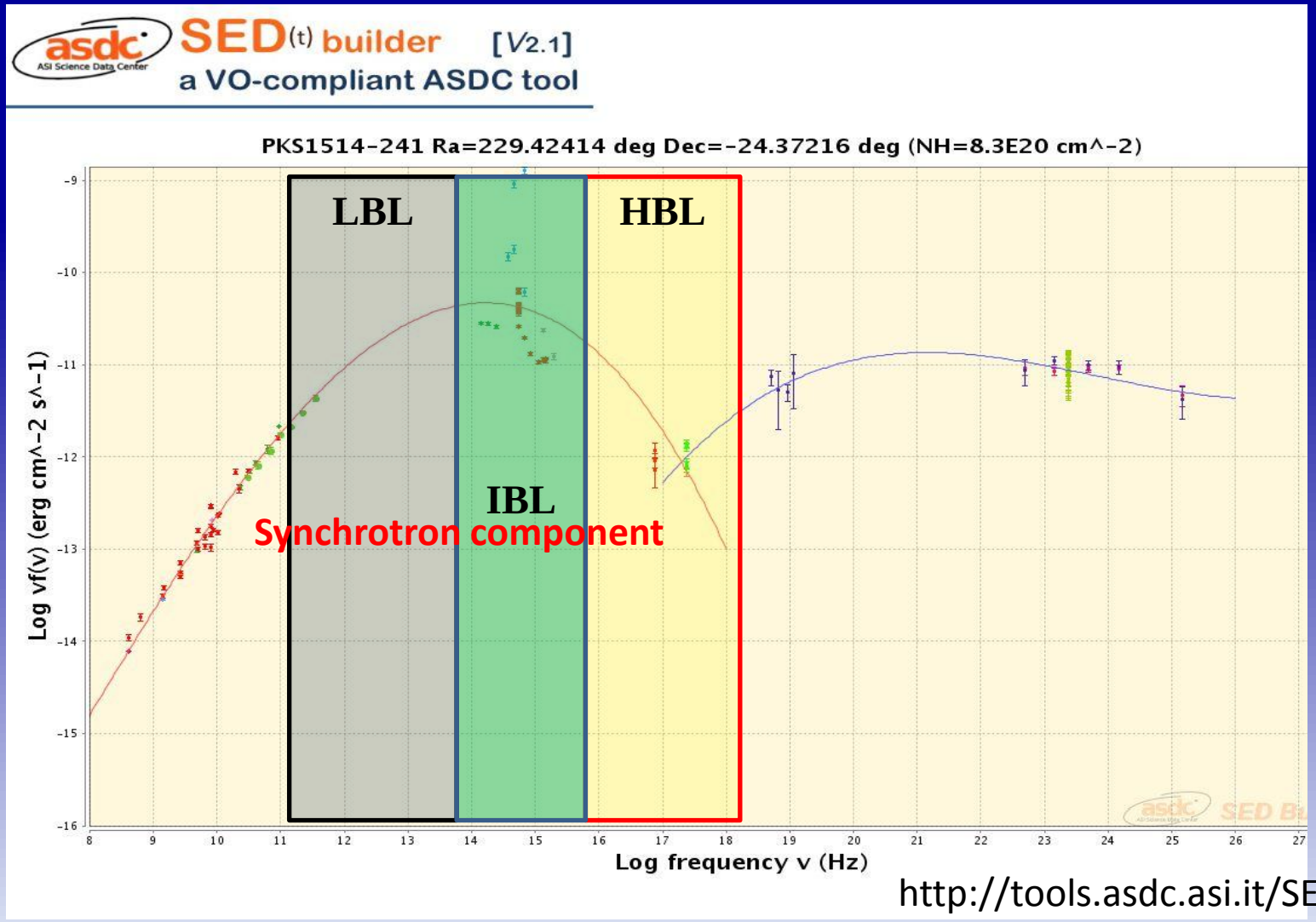



*Image credit: Aurore Simonnet, Scientific Illustrator at Sonoma State University*


Blazars
FSRQ
(strong broad emission lines)
BL Lac
(weak lines or featureles)

# BL Lac



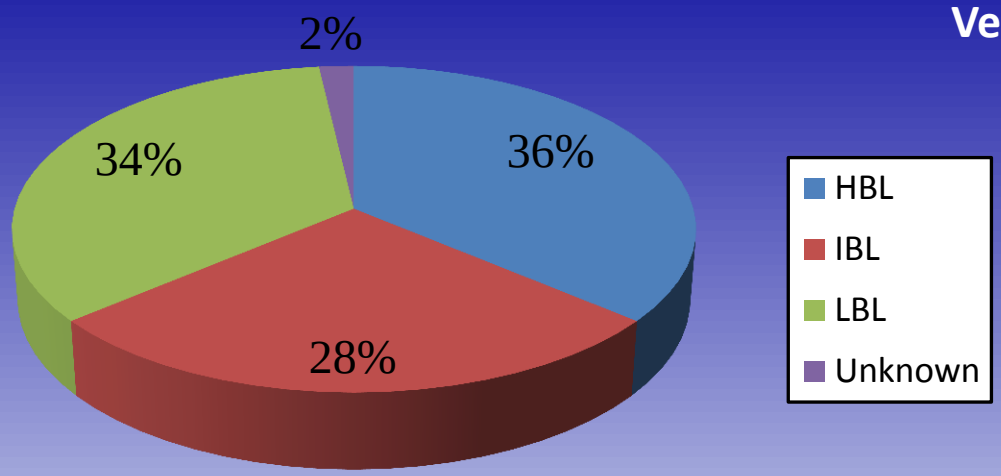

http://tools.asdc.asi.it/SED/

# Motivation

- ✓Rare class of AGN
- ✓Simultaneous observations at radio waveband
- ✓Long-duration radio data

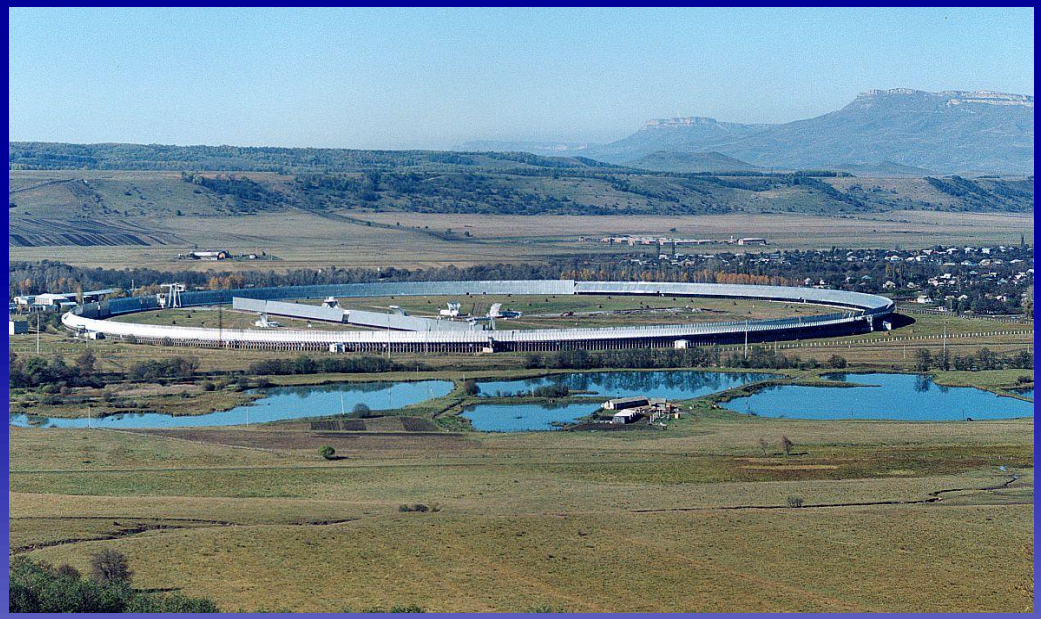
# Sample

- Contains 108 BLO from Metsähovi BL Lac sample (Nieppola 2006)




**Most of objects from:**
**Veron-Cetty & Veron BLO catalog (2010)**

# Observations



RATAN-600
Radio Telescope of Russian Academy of science.
With the diameter = 576 meters

# Observations

2006 - 2012

| Frequencies (GHz) | | | | | |
|---|---|---|---|---|---|
| **1.1** | **2.3** | **4.8** | **7.7** | **11.2** | **21.7** |

# Observations

- ✓ Redshift distribution
- ✓ Spectral indices
- ✓ Synchrotron peak frequency versus radio luminosity
- ✓ Variability

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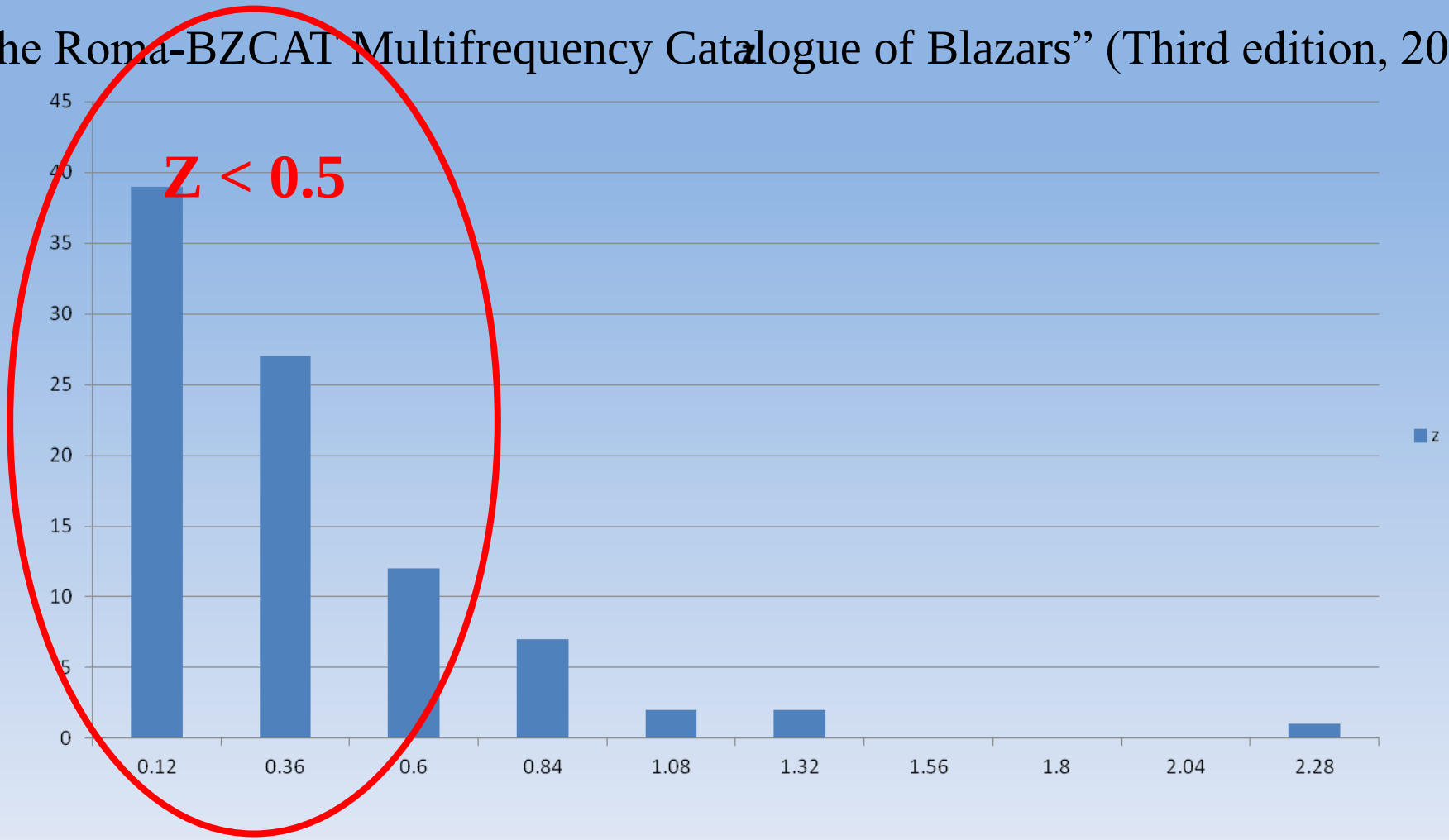
# Redshift distribution

"The Roma-BZCAT Multifrequency Catalogue of Blazars" (Third edition, 2011)



# Observations

- ✓ Spectra
- ✓ Spectral indices $S_\nu \sim \nu^\alpha$
- ✓ Variability

  At low (1.1-4.7 GHz) and high (7.7-21.7 GHz) frequencies
- ✓ Redshift distribution

  During the flare and average
- ✓ Synchrotron peak frequency versus radio luminosity

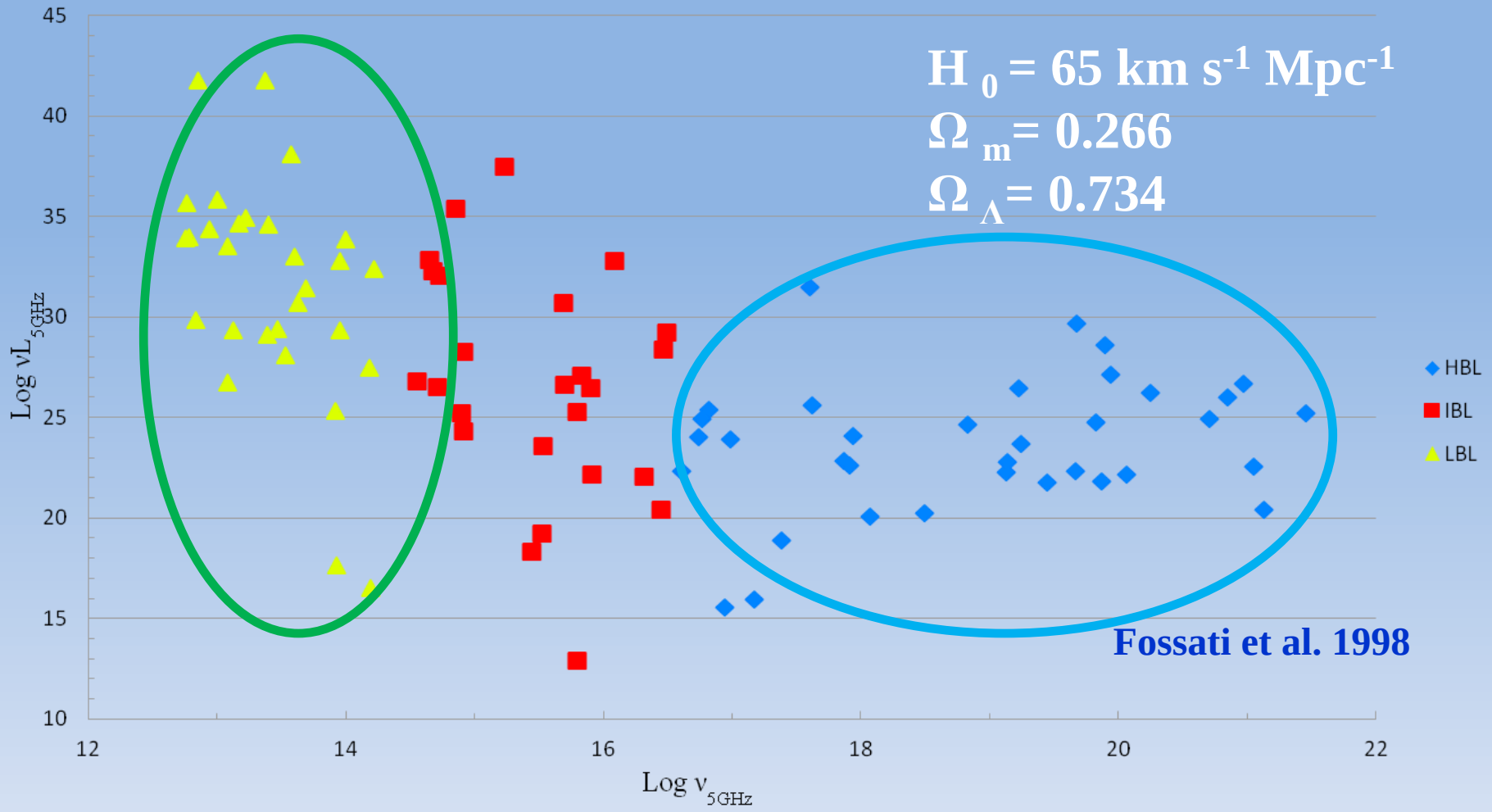
# Spectral indices

| Class | Number of sources | $\alpha_{aver}$ | $\alpha_{flare}$ |
|---|---|---|---|
| 7.7-21.7 GHz | | | |
| **HBL** | **39** | **-0.33** | **-0.33** |
| **IBL** | **30** | **-0.26** | **-0.39** |
| **LBL** | **37** | **-0.09** | **-0.08** |
| 1.1-4.7 GHz | | | |
| **HBL** | **38** | **-0.73** | **-0.53** |
| **IBL** | **27** | **-0.45** | **-0.39** |
| **LBL** | **36** | **-0.15** | **-0.08** |

# Observations

- ✓ Spectra
- ✓ Spectral indices
- ✓ Variability
- ✓ Redshift distribution
- ✓ Synchrotron peak frequency versus radio luminosity

# Synchrotron peak frequency versus radio luminosity

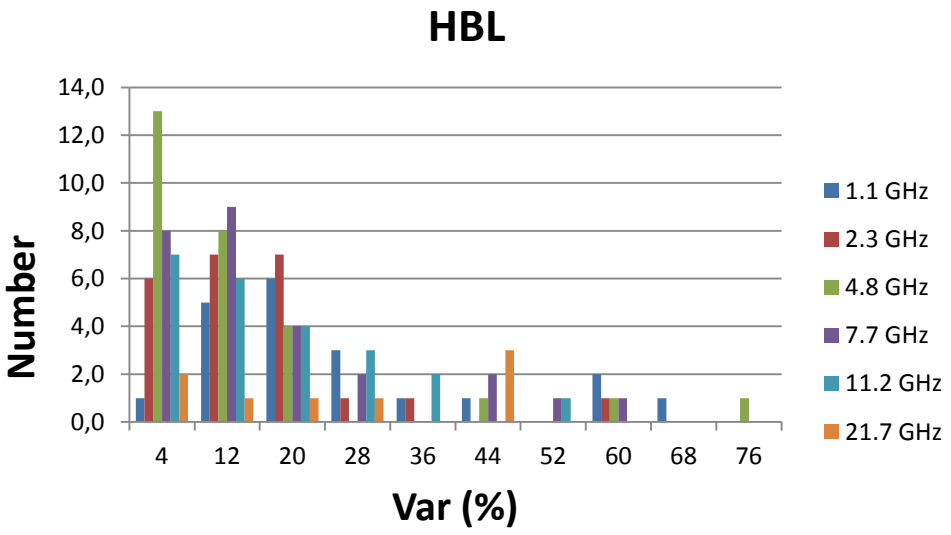


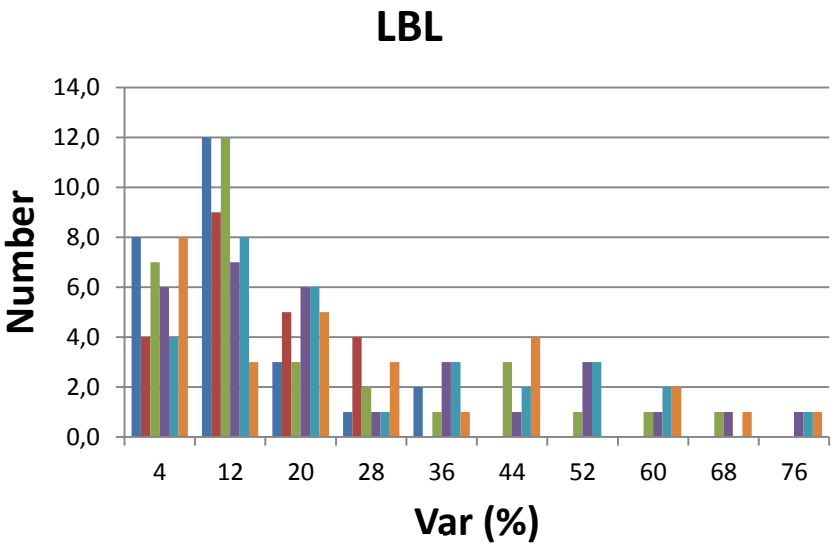
# Observations

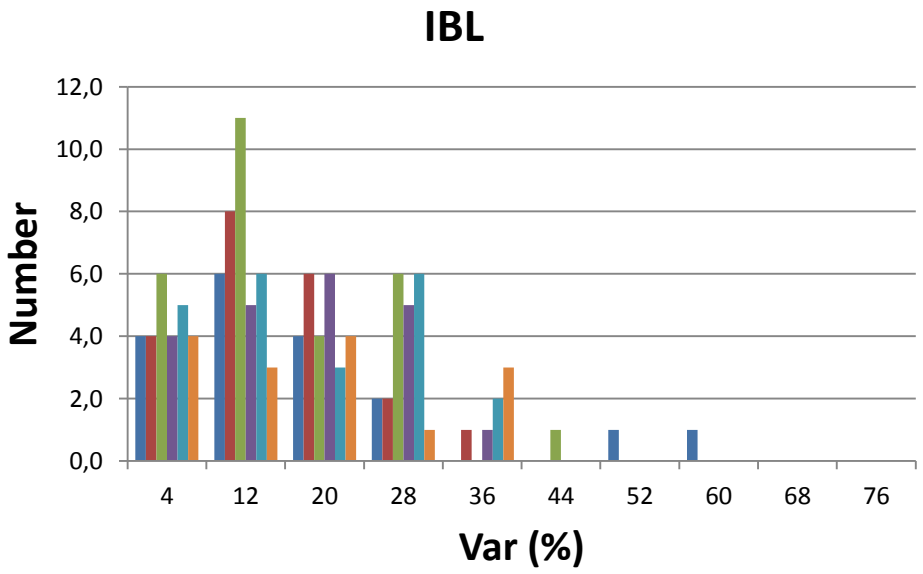
- ✓ Spectra
- ✓ Spectral indices
- ✓ Variability
- ✓ Redshift distribution
- ✓ Synchrotron peak frequency versus radio luminosity

$$Var_v = \frac{(S_{\max} - \sigma_{smax}) - (S_{\min} + \sigma_{smin})}{(S_{\max} - \sigma_{smax}) + (S_{\min} + \sigma_{smin})}$$

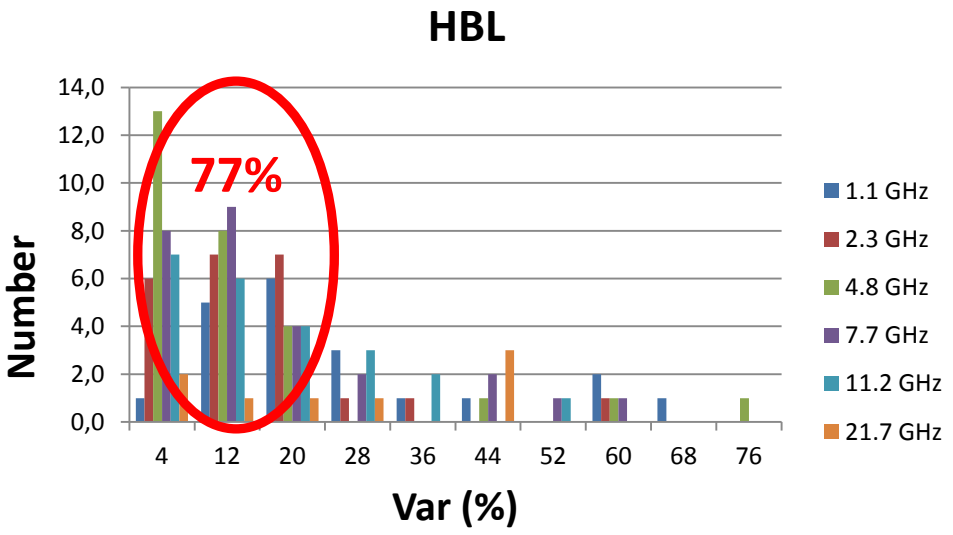
# Variability

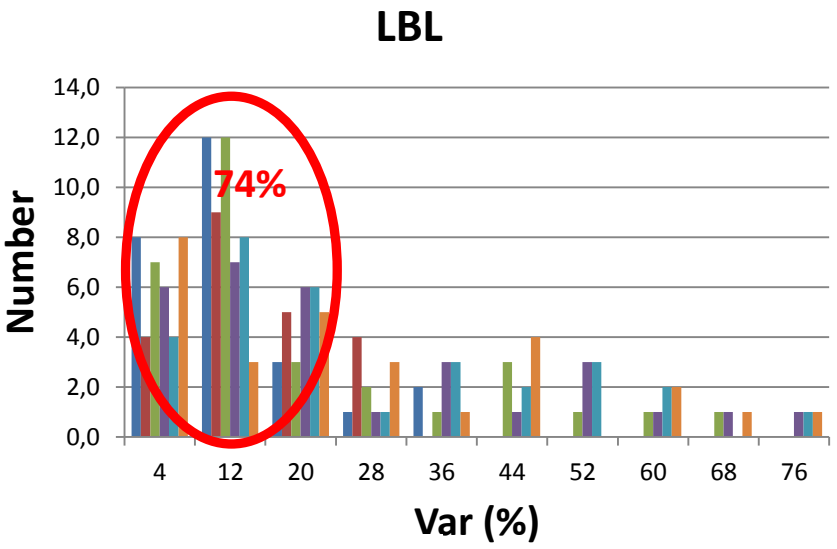


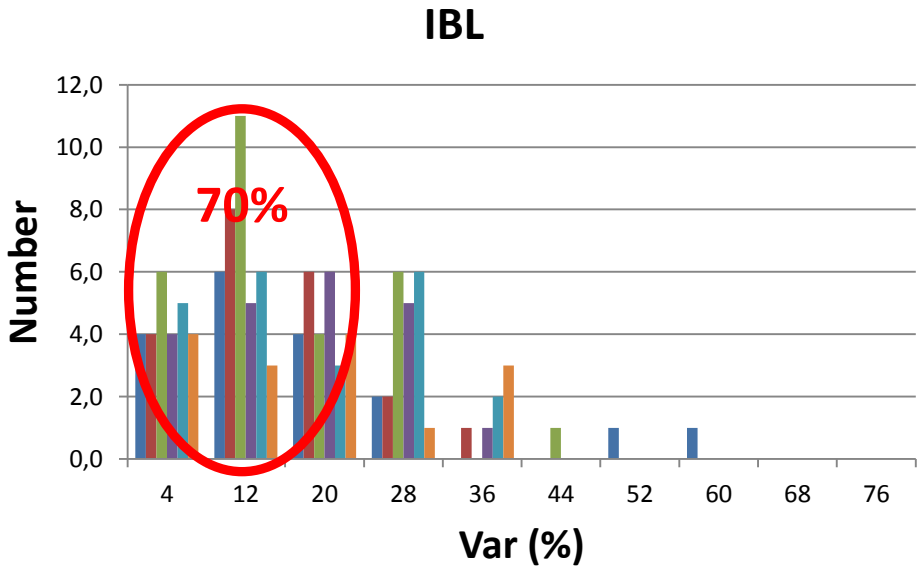



# Variability



# Conclusion

- ✓ 108 BL Lacs (including all three subclasses: HBL, IBL, LBL)
- ✓ Most of them with $z < 0.5$
- ✓ In average HBLs show steeper spectra than IBLs & LBLs
- ✓ Expectedly LBLs more luminous at radio

and

- ✓ Expectedly HBLs peaked at higher frequencies than IBLs and LBLs
- ✓ No significant difference in variability between HBLs, IBLs, LBLs at our frequencies

Tack !

Danke !

Gracias !

Dank U zeer !

Köszönöm !

# Thank you !

Dziękuję !

Go raibh maith agat !

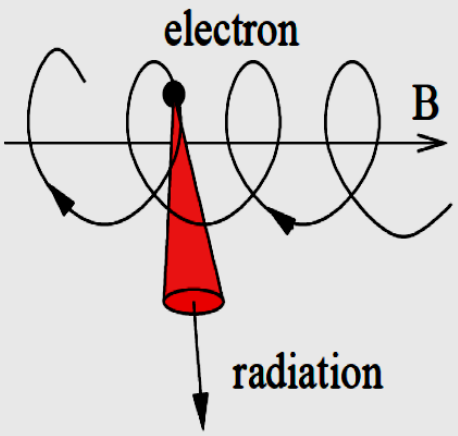
Спасибі !

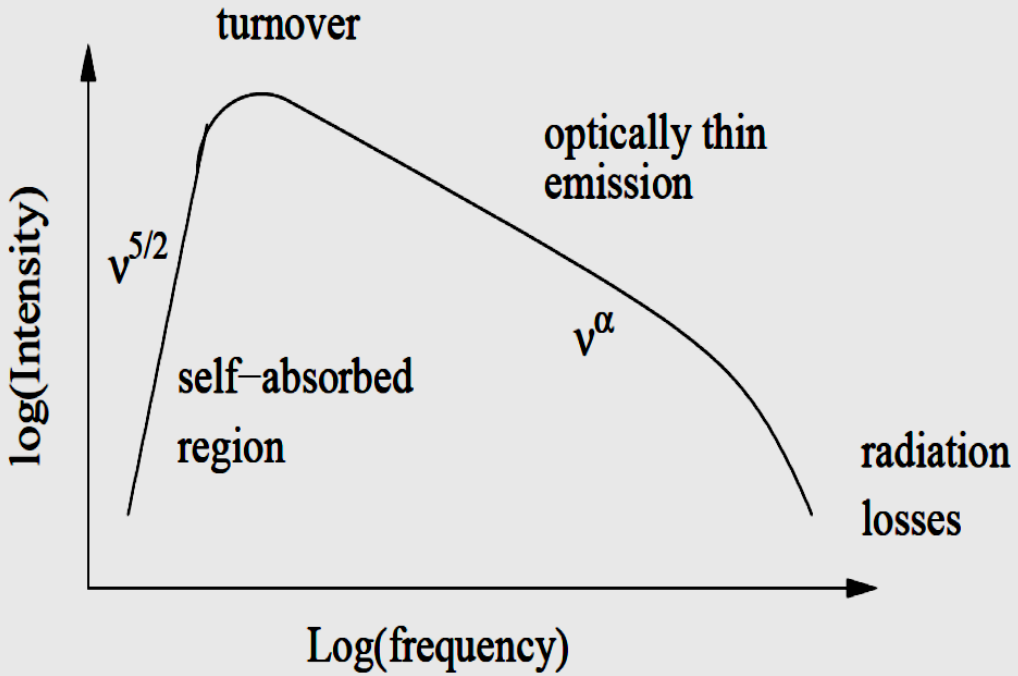
Спасибо !

Thank you!

# Основной комплект радиометров континуума установлен на вторичном зеркале № 1 РАТАН-600 и круглосуточно используется в наблюдательных программах. Параметры комплекса на начало 2005 г.:

| $\lambda$ cm | $\nu$ GHz | $\Delta\nu$ GHz | Чувств mK/$s^{1/2}$ | $T_{sys}$ K | Схема | Примечание |
|---|---|---|---|---|---|---|
| 1.0 | 30.0 | 4.0 | 6 | 220 | МОД | «МАРС-2» |
| 1.4 | 21.7 | 2.5 | 4.5 | 80 | МОД | КРИО (15К) |
| 2.7 | 11.2 | 1.4 | 3 | 70 | МОД | КРИО (15К) |
| 3.9 | 7.7 | 1.0 | 3 | 62 | МОД | КРИО (15К) |
| 6.3 | 4.8 | 0.8 | 2.2 | 38 | РДШ | КРИО (15К), 2канала |
| 13 | 2.4 | 0.4 | 12 | 95 | РДШ | Сист. помехозащиты |
| 31 | 0.96 | 0.12 | 15* | 105 | РДШ | Помехи от GSM |
| 49 | 0.6 | 0.13 | 25** | 125 | РДШ | Помехи от ТВ |


electron
B
radiation


turnover
optically thin
emission
$\nu^{5/2}$
$\nu^{\alpha}$
self–absorbed
region
radiation
losses
log(Intensity)
Log(frequency)

- We are doing something important here
- And we are just started
- It is turned out to be so great

# Variability

Average variability indicies (in %)

| | 1.1 GHz | 2.3 GHz | 4.8 GHz | 7.7 GHz | 11.2 GHz | 21.7 GHz |
|---|---|---|---|---|---|---|
| HBL | 26.7 | 15.8 | 14.7 | 17.6 | 16.7 | 24.2 |
| IBL | 19.3 | 15.9 | 15.8 | 17.4 | 16.8 | 17.5 |
| LBL | 12.7 | 15.9 | 20.2 | 25.5 | 27 | 26.1 |