

Spectral energy distributions and 37 GHz monitoring of BL Lacertae objects

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Outline

- ◆ Introduction
- ◆ Spectral energy distributions (SEDs) using multifrequency data
- ◆ Metsähovi BL Lac observing project
- ◆ 37 GHz BL Lac data publication
- ◆ Future

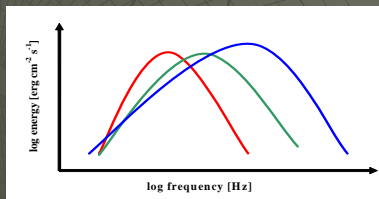


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Introduction

- ◆ BL Lacertae objects (BL Lacs) – a subgroup of blazars
- ◆ BL Lacs are divided into subclasses
 - Observational basis: RBLs (radio-selected) and XBLs (X-ray-selected)
 - Physical basis: LBLs (low-energy) and HBLs (high-energy)
 - IBLs (intermediate) in between



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SEDs of BL Lacs

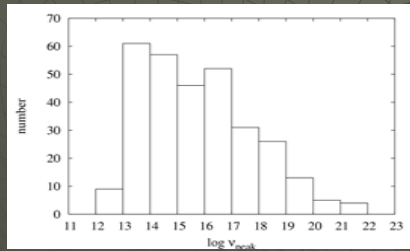
- ◆ SEDs of 304 objects determined using mf-data
 - Main data source CATS database (<http://cats.sao.ru>)
 - Parabolic fit to the synchrotron component (observer's frame)
 - → division to LBL / IBL / HBL
 - ◆ Nieppola, Tornikoski & Valtaoja 2006, A&A, 445, 441



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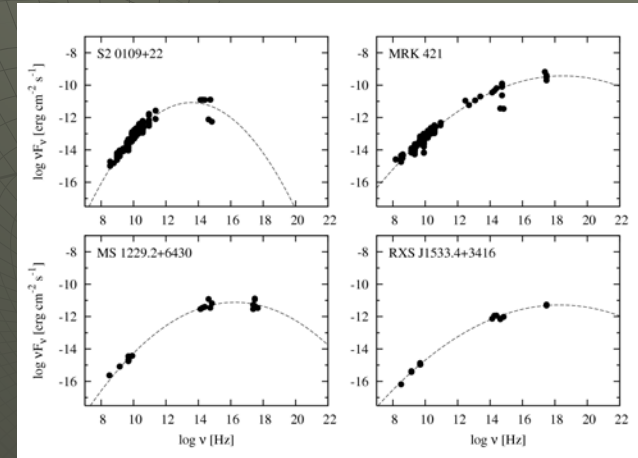
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SEDs of BL Lacs



- ◆ Dividing boundaries:
 - $\log \nu_{peak} < 14.5 \rightarrow$ LBL
 - $14.5 < \log \nu_{peak} < 16.5 \rightarrow$ IBL
 - $\log \nu_{peak} > 16.5 \rightarrow$ HBL
- ◆ Result: 98 LBLs, 96 IBLs, 110 HBLs

SEDs of BL Lacs



SEDs of BL Lacs

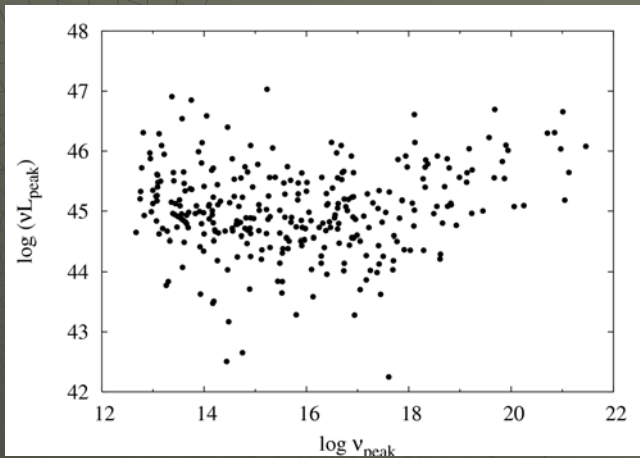
- ◆ Division of observational classes to physical ones:
 - \rightarrow X-ray surveys discover also LBLs

	LBL	IBL	HBL
RBL	84%	10%	6%
IBL	22%	36%	42%
XBL	21%	25%	54%

SEDs of BL Lacs

- ◆ Clear negative correlation between radio luminosity and $\log \nu_{peak}$ but:
- ◆ No correlation between $\log \nu_{peak}$ and luminosity at $\nu_{peak} \rightarrow$ inconsistent with the “blazar sequence” scenario (Fossati et al. 1998, MNRAS, 299, 433)

SEDs of BL Lacs



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Metsähovi BL Lac observing project @ 37 GHz

- ◆ Started in December 2001 (ongoing)
- ◆ Source sample of 398 BL Lac objects mostly from Veron-Cetty & Veron BL Lac catalogue (9th ed., 2000)



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Metsähovi BL Lac observing project @ 37 GHz

- ◆ Main objective: to get an idea of the high radio frequency behaviour of different types of BL Lacs (especially IBLs and XBLs)
- ◆ Some powerful objects monitored before as a part of the extragalactic sources monitoring project



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Metsähovi BL Lac observing project @ 37 GHz

- ◆ Main benefit: Planck extragalactic foregrounds
 - The foreground sources must be removed from the CMB maps
 - Metsähovi gives a preview of what Planck is expected to see



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37 GHz BL Lac data publication

- ◆ First data publication of the extended BL Lac source list (Nieppola et al. 2006, submitted)
- ◆ More than 3000 datapoints @ 37 GHz
- ◆ All 398 observed at least once, 34% detected at $S/N > 4$



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37 GHz BL Lac data publication

- ◆ Detection rates by class:
 - 77% of LBLs detected, 37% of IBLs and 15% of HBLs
- ◆ Most observed sources: BL Lac, OJ 287, Mrk 421, AO 0235+164, S5 0716+714
- ◆ Still, 96% of the sample have been observed < 10 times



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37 GHz BL Lac data publication

- ◆ Observing intervals vary
 - For objects with > 5 observations the mean interval is 124 days
- ◆ The mean fractional variability index of the sample $\Delta S = 0.31$
 - Almost half of the sample increased their flux level to twice their S_{\min}

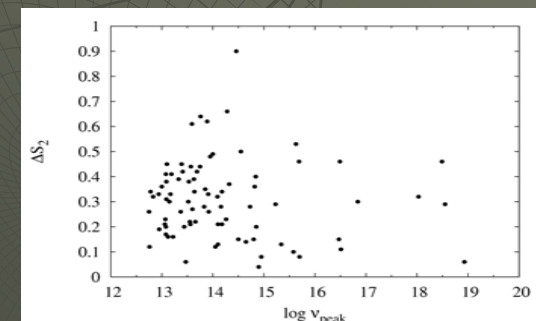


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37 GHz BL Lac data publication

- ◆ No dependence between v_{peak} and fractional variability can be established



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37 GHz BL Lac data publication

- ◆ Unprecedented data set for BLOs at high frequencies
 - The main result: HBLs & IBLs cannot be overlooked when estimating the foreground contamination
 - The ratio of detections vs. non-detections is ~ 20%
→ fair chance of a random detection



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Future

- ◆ Analysis of the long-term radio variability of BL Lacs (continuation of Hovatta et al., in preparation)
 - Limited sample, only Metsähovi monitoring sources
 - Time scales and flare analysis
- ◆ SEDs
 - Dependence of ν_{peak} and other properties
 - ◆ Doppler factors
 - ◆ viewing angles, etc.



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