





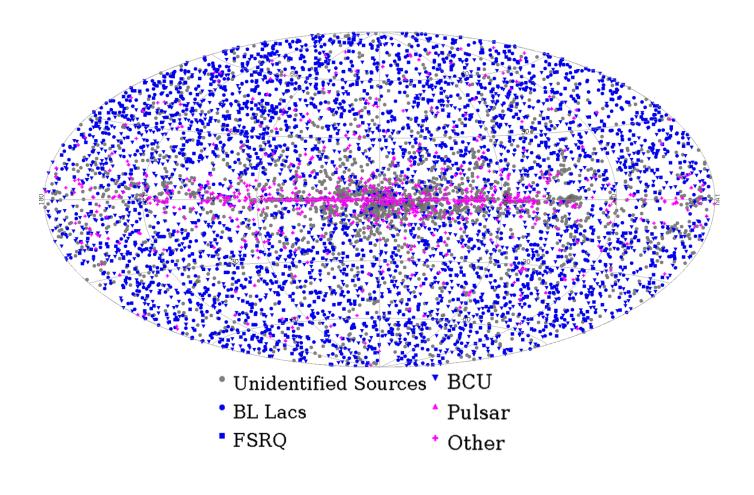
# Artificial Neural Network Classification of the Fermi-LAT Catalog Blazars of Unknown Type and Unidentified Sources

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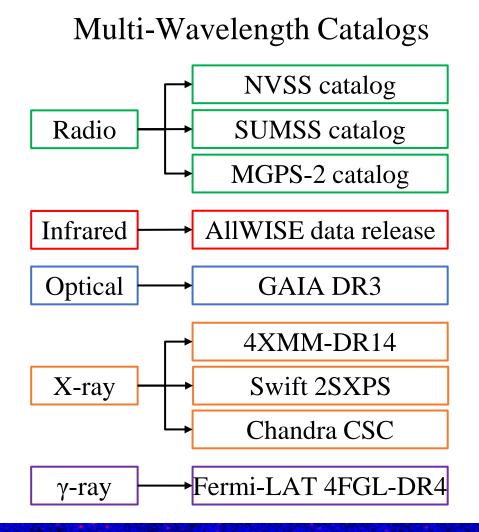
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### Fermi-LAT 4FGL-DR4 Catalog

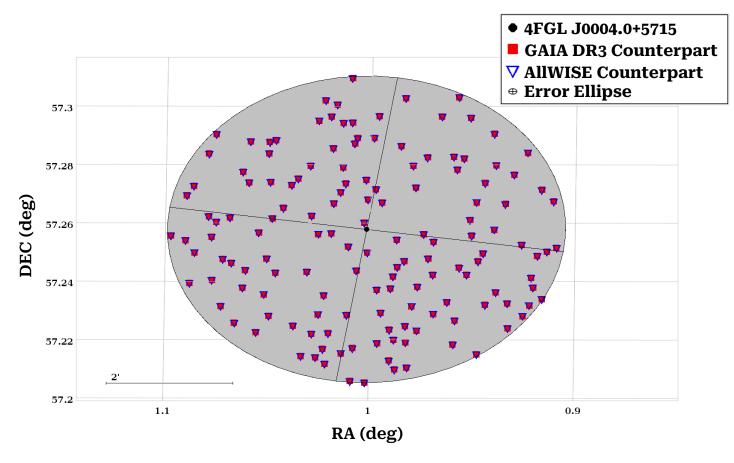
Class	Designator	Number
Blazar Candidate of Uncertain Type	BCU	1624
Binary	$_{ m BIN}$	10
BL Lacertae type blazar	$\operatorname{BLL}$	1490
Compact Steep Spectrum Quasar	$\operatorname{CSS}$	6
Flat Spectrum Radio Quasar	FSRQ	820
Normal Galaxy (or part)	$\operatorname{GAL}$	6
Globular Cluster	$\operatorname{GLC}$	34
High-Mass Binary	$_{ m HMB}$	11
Low-Mass Binary	$_{ m LMB}$	9
Millisecond Pulsar	MSP	179
Narrow-line Seyfert 1	NLSY1	8
Nova	NOV	8
Pulsar	PSR	141
Pulsar Wind Nebula	PWN	22
Radio Galaxy	RDG	54
Starburst Galaxy	$\operatorname{SBG}$	8
Seyfert Galaxy	SEY	3
Star-Forming Region	SFR	6
Supernova Remnant	SNR	45
Special Case	$\operatorname{SPP}$	124
Steep Spectrum Radio Quasar	SSRQ	2
Unknown	UNK	147
Unassociated		2430



#### Counterpart selection of Fermi-LAT sources



#### Unidentified Sources Counterpart selection



#### Neural Network Data Selection

#### Sorted and normalized Light Curve

#### 1.0 $10^{-10}$ 0.9 $10^{-11}$ Flux (Normalized) 2.0 0.0 2.0 2.0 S $cm^{-2}$ $10^{-12}$ S 10-13 BL Lac Radio Data (NVSS, SUMSS) FSRQ X Data (Swift, Chandra, XMM) BL Lac Infared Data (AIIWISE) FSRQ Gamma Data (Fermi-LAT) BL Lac Optical Data (GAIA) Not-Blazar Radio Data (NVSS, SUMSS) BL Lac X Data (Swift, Chandra, XMM Not-Blazar Infrared Data (AIIWISE) BL Lac Gamma Data (Fermi-LAT Not-Blazar Optical Data (GAIA) FSRQ Infrared Data (AllWISE) 0.4 Not-Blazar X Data (Swift, Chandra, XMM) FSRQ Radio Data (NVSS, SUMSS) $10^{-14}$ Not-Blazar Gamma Data (Fermi-LAT) FSRQ Optical Data (GAIA) 10-4 10-2 10<sup>2</sup> 12 13 Energy Bands (eV) Time Bins

Example of a  $\gamma$ -ray light curve with sorted flux values

Example of SED for FSRQ, BL Lacs and Not-Blazar

104

106

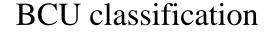
Bari

**Spectral Energy Distribution** 

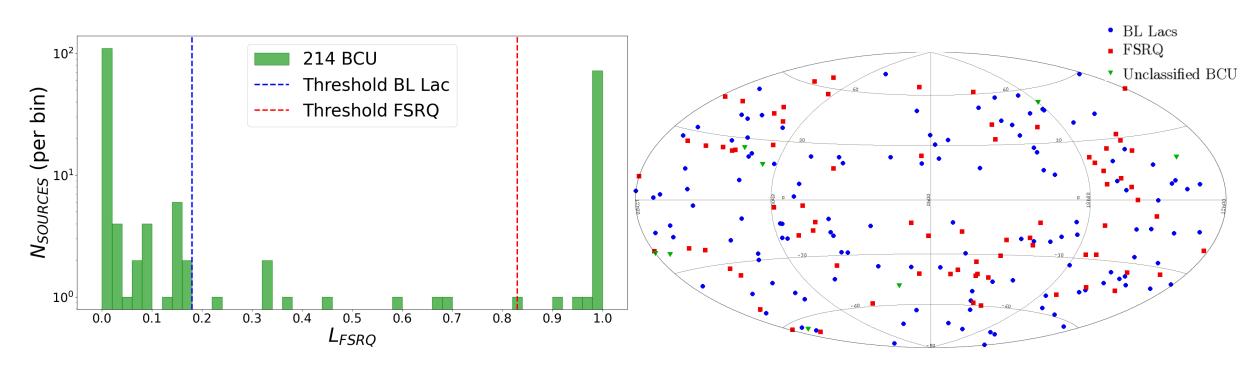
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108

#### Neural Network classification of BCUs



#### Classified BCU distribution

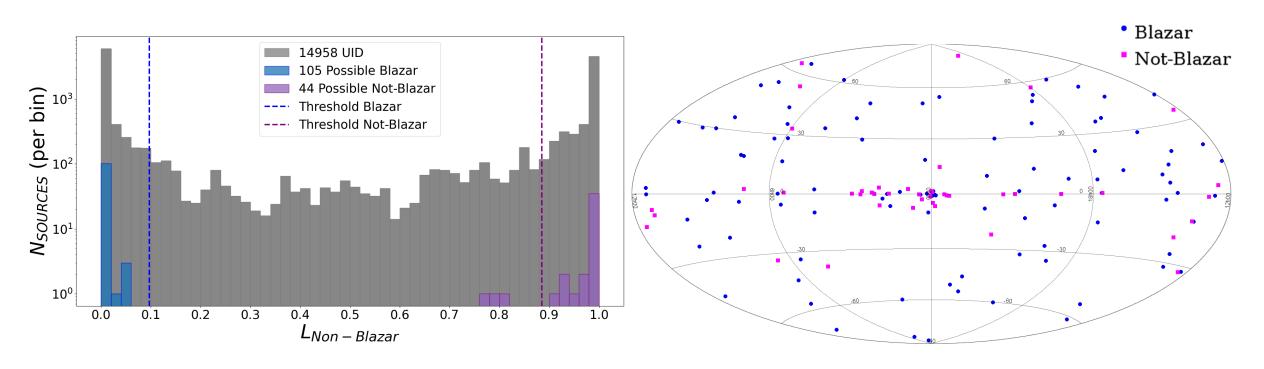


130 BCUs classified as BL Lacs76 BCUs classified as FSRQs8 remain unclassified

#### Neural Network classification of UIDs

#### UID counterparts classification

#### Classified UID counterparts distribution



14958 UIDs' counterparts for 152 UIDs

105 UIDs classified as Blazars
44 UIDs classified as Not-Blazars
3 remain unclassified

5

#### Conclusions and future improvements

## Work in progress...