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An online Changing-Look (Transition) Blazars Catalog: TCLB Catalog

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ABSTRACT

The Changing-Look Blazars (CLBs) are the sources that there are optical spectra at different epochs showing significant changes and present a clear transition between the standard FSRQ and BL Lac types. Here, we compiled "An online Changing-Look (Transition) Blazars Catalog" (TCLB Catalog, https://github.com/ksj7924/CLBCat) (Kang et al., in preparation, update and maintain) that presented in https://github.com/ for easy communication. The CLBs are extremely rare astronomical objects. As CLB sources continue to grow, the TCLB Catalog may provide the global astrophysics community with easy, timely and comprehensive information on this rapidly developing new field.

At present, the TCLB Catalog has not been fully publicly released, and a preliminary resultsis only submitted to arXiv (https://doi.org/10.48550/arXiv.2308.00000) and available online at http://orcid.org/0000-0002-9071-5469 for a web link: https://github.com/ksj7924/CLBCat for the convenience of everyone to view, modify and improve until the application is permanently fixed in a network space. Community groups or individuals are welcome to contribute or provide a suitable network for the joint development.

Keywords: Active galactic nuclei (16) – Blazars (164) — BL Lacertae objects (158) — Flat-spectrum radio quasars (2163) — Changing-Look Blazars — Transitional blazars

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1. INTRODUCTION

The Changing-Look (transition) blazars (CLBs) are extremely rare astronomical objects. Which show significant changes in optical spectra at different epochs and present a clear transition between the standard FSRQ and BL Lac type blazars. These peculiar rare transition phenomenon between FSRQs and BL Lacs (e.g., equivalent width, EW, of the optical spectral line, become larger or smaller) are common addressed by some possible scenarios in the previous literature (e.g., see Ruan et al. 2014; Peña-Herazo et al. 2021; Mishra et al. 2021; Foschini et al. 2021, 2022 for the related discussions and references therein).

For instance:

- The broad lines (e.g., EW) may be swamped by the strong (beamed) jet continuum variability (e.g., Vermeulen et al. 1995; Giommi et al. 2012; Ruan et al. 2014; Pasham & Wevers 2019), or jet bulk Lorentz factor variability (e.g., Bianchin et al. 2009);
- The broad lines are overwhelmed by the non-thermal continuum due to weak radiative cooling (e.g., Ghisellini et al. 2012).
- The broad lines may be not detected due to the high redshift effect (e.g., $z > 0.7$, D'Elia et al. 2015), for instance, the Hα line, one of the strongest emission line maybe falls outside the optical window so that it is not detected, which may cause the misclassification (e.g., D'Elia et al. 2015).
- In addition, several observational effects (e.g., signal-to-noise ratio, and spectral resolution, etc.) may also affected the optical classification (see Peña-Herazo et al. 2021 for the related discussions).

The rare changing look and transitional phenomena is very important in being shed light on the accretion disk-jet connection, the radiation mechanism of jets, the central engine of AGNs, ... etc. In-depth studying of the Changing-Look (transition) blazars (CLBs) would be is of great significance to deepen the understanding of the origin of CLB sources, the divergent properties of BL Lacs and FSRQs, such as redshift evolution, the accretion state transition of supermassive black holes; jet particle acceleration process; and black hole-galaxy co-evolution, etc, the physical properties of CLBs (**e.g.,** Copied from Ruan et al. 2014; Mishra 2021).

In the catalog, partial, including but not limited to, the reported Changing-Look Blazars (CLBs), the predicted CLBs; and the transitional blazars, or the possible transitional blazars between the standard FSRQs and BL Lac types (EW-based classification); even also including the red or blue (quasars) blazars; and broad line BL Lac types sources, and so on. So, using this catalog still requires careful discrimination.

Note:

- **In addition, in order to describe as accurately as possible, some sentences are directly copied from the original text.**
- **During the collection and sorting process, we try to check every detail, however, errors, omissions, errata, ... etc. are inevitable, please do not hesitate to enlighten us for any errors, typos, ... etc. Thanks, thanks very much again.**
- **Finally, we hope that our manuscript will be helpful and beneficial to you.**
- **Research on CLBs is ongoing, a detailed in-depth discussion of it is in progress.**

Some results are described below:

1.1. *Summary of the Tables*

In the Catalog, "An online Catalog for Changing-Look (Transition) Blazars" (TCLB Catalog, https://github.com/ksj7924/CLBCat, Kang et al., in preparation, update and maintain) is compiled.

In Section 2 of the catalog, based on the transition between the standard FSRQs and BL Lac types (EW-based classification), a total of 154 (5+32+52+9+26+6+11+6+7) records for the CLBs reported/confirmed by EW changes of spectral emission lines are collected. Where, 5 CLBs that is labeled as a different subclass in different Fermi FGL catalogs are compiled/collected and reported in Zhang et al. (2022), 32 CLBs reported in Foschini et al. (2022), 52 CLBs reported in Xiao et al. (2022), 9 of 11 changing-look AGNs are CLBs reported in Foschini et al. (2021), 26 CLBs reported in Peña-Herazo et al. (2021), and 6 transition sources (CLB type) reported in Ruan et al. (2014), 11 transition sources (CLB type) reported in Shaw et al. (2012), 6 transition sources (CLB type) reported in Ghisellini et al. (2011), and other 7 Changing-Look (Transition) Blazars (Vermeulen et al. 1995; Mishra et al. 2021; Álvarez Crespo et al. 2016; Pasham & Wevers 2019; Cutini et al. 2014; Padovani et al. 2019; Bianchin et al. 2009) are listed in Table 9 of Sections 2.9.

In the catalog, a total of 297+46 (33+47+2+157+58+46) forecast records were collected in Section 4 (see Table 11, 12 13, and 14,15). where, 33 LSP BL Lacs predicted as possible FSRQs in Fan & Wu (2019); 2 LSP BL Lacs predicted as possible FSRQs in Pei et al. (2022); 47 LSP BL Lacs predicted as possible FSRQs in Cheng et al. (2022); and 215 LSP BL Lacs predicted as potential FSRQs in **Kang et al. 2023 (accepted by MN)**, including 157 possible FSRQs and 58 unknown sources without a clear prediction (see, Table 14), also, 46 changing-look blazar candidates including 39 BL Lacs predicted as possible FSRQs and 7 FSRQs predicted as possible BL Lacs reported in Zhang et al. (2022) (see Table 15)

Furthermore, there are 5 **'blue quasars'** (e.g., Blue Fermi flat spectrum radio quasars) that are also shown in the catalog (see Section 3).

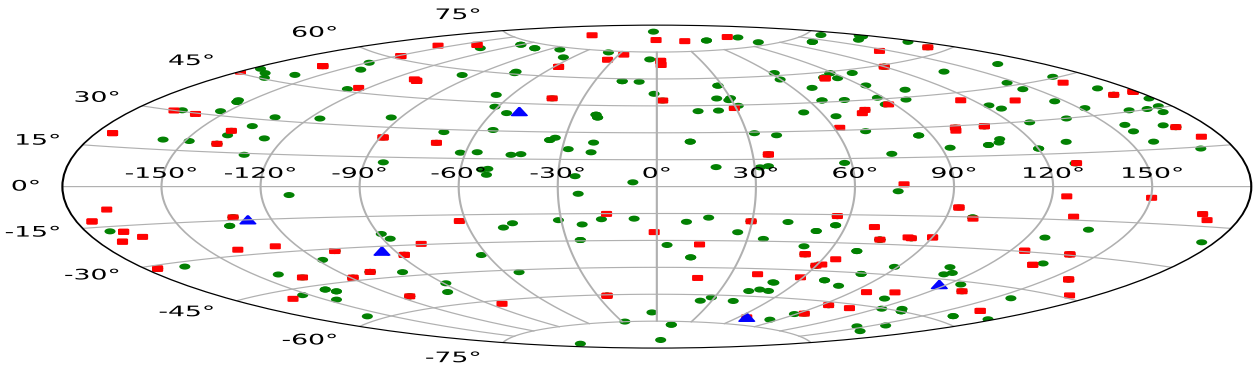

Figure 1. Aittof projection of the distribution in galactic coordinates of the Changing-Look and transition blazars reported (red) and predicted (blue) in literatures.

Table 0. The Results of Summary

Number (1)	R.A. (2)	$N_{\rm Results}$ (3)	Class (4)	Class (5)	Sections (6)	Tables (7)	References (8)
1	reported	5	LSP BL Lacs	LSP BL Lacs	Sections 2.1	Table 1	Zhang et al. (2022)
2	reported	32	LSP BL Lacs	LSP BL Lacs	Sections 2.2	Table 2	Foschini et al. (2022)
3	reported	52	LSP BL Lacs	LSP BL Lacs	Sections 2.3	Table 3	Xiao et al. (2022)
4	reported	9	LSP BL Lacs	LSP BL Lacs	Sections 2.4	Table 4	Foschini et al. (2021)
5	reported	26	LSP BL Lacs	LSP BL Lacs	Sections 2.5	Table 5	Peña-Herazo et al. (2021)
6	reported	6	LSP BL Lacs	LSP BL Lacs	Sections 2.6	Table 6	Ruan et al. (2014)
7	reported	11	LSP BL Lacs	LSP BL Lacs	Sections 2.7	Table 7	Shaw et al. (2012)
8	reported	6	LSP BL Lacs	LSP BL Lacs	Sections 2.8	Table 8	Ghisellini et al. (2011)
9	reported	7	LSP BL Lacs	LSP BL Lacs	Sections 2.9	Table 9	[a,b,c,d,e,f,g]
10	blue FSRQs	5	LSP BL Lacs	LSP BL Lacs	Sections 3.1	Table 10	Ghisellini et al. (2012, 2013)
11	Predictions	33	LSP BL Lacs	FSRQ	Sections 4.1	Table 11	Fan & Wu (2019)
12	Predictions	2	LSP BL Lacs	FSRQ	Sections 4.2	Table 12	Pei et al. (2022)
13	Predictions	47	LSP BL Lacs	FSRQ	Sections 4.3	Table 13	Cheng et al. (2022)
14	Predictions	157	LSP BL Lacs	FSRQ	Sections 4.4	Table 14	Kang et al. (2023)
14	Predictions	58	LSP BL Lacs	UNKs	Sections 4.4	Table 14	Kang et al. (2023)
15	Predictions	39	BL Lacs	FSRQ	Sections 4.5	Table 15	Zhang et al. (2022)
15	Predictions	7	FSRQ	BL Lacs	Sections 4.5	Table 15	Zhang et al. (2022)

NOTE—The number of Table are presented in Column 1. The Comments are presented in Column 2. The number of CLB type sources reported in literatures are presented in Column 3. Columns 4 and 5 are the optical Class. Column 6 lists the Sections and Column 7 lists the Tables, respectively. The references are presented in Columns 8, where, [a]Vermeulen et al. (1995); [b]Mishra et al. (2021); [c]Álvarez Crespo et al. (2016); [d]Pasham & Wevers (2019); [e]Cutini et al. (2014); [f]Padovani et al. (2019); [g]Bianchin et al. (2009).

2. THE CHANGING-LOOK AND TRANSITION BLAZARS

2.1. *The CLBs compiled in Zhang et al. (2022)*

In Zhang et al. (2022), they track the histories of blazar's classification in the Fermi catalogs (including 1FGL, 2FGL, 3FGL, and 4FGL/4FGL-DR2). If an blazar is labeled as a different subclass in different Fermi catalogs, then it is recorded as a changing-look blazar in their sample. In this way, they find five changing-look blazars **(Copied from Zhang et al. 2022)**.

Table 1. The CLBs compiled in Zhang et al. (2022)

4FGL name (1)	R.A. (2)	Decl. (3)	ASSOC name (4)	SED class (5)	4FGL Class (6)	Change class (7)
4FGL J0114.8+1326	18.7119	13.4342	GB6 J0114+1325	ISP	bll	1bzb/2bzq/3CB/4CB
4FGL J0203.7+3042	30.9327	30.7139	NVSS J020344+304238	LSP	bll	1agu/ 2bzq/3CB/4CB

Table 1 *continued on next page*

Table 1 *(continued)*

4FGL name	R.A.	Decl.	ASSOC name	SED class	4FGL Class	Change class
(1)	(2)	(3)	(4)	(5)	(6)	(7)
4FGL J0407.5+0741	61.8921	7.6998	TXS 0404+075	LSP	bll	1bzq/2bzq/3CB/ 4CB
4FGL J0433.1+3227	68.2897	32.4614	NVSS J043307+322840	HSP	bll	1bzq/2bzq/3BCU/4CB
4FGL J1058.4+0133	164.6240	1.5641	4C +01.28	LSP	bll	1bzq/2bzb/3CB/4CB

Note—The 4FGL name are presented in Column 1. Columns 2 and 3 are the J2000 coordinates. The counterpart names are listed in Column 4. Column 5 lists the optical class, column 4 is the spectral energy distribution (SED) class reported in 4FGL catalog, respectively. The classification in the Fermi catalogs compiled in Zhang et al. (2022) are presented in Columns 7.

2.2. *The CLBs compiled in Foschini et al. (2022)*

In Foschini et al. (2022), they compiled a gamma-ray jetted AGN sample based on the 4FGL-DR2 catalog. They reported 34 Changing-Look AGNs, 32 of them are labeled as blazars (24 FSRQs, 7 BL Lacs, and 1 BCU) in 4FGL catalog, based on a significant change in optical spectral lines (disappearance and reappearance) in different observation epochs reported in the previous literature (see Foschini et al. 2022 for more details and references therein). Among the 32 CLBs, there are 27 LSP CLBs (22 LSP FSRQ type and 5 LSP BL Lac type), one HSP FSRQ type CLB, one ISP BL Lac type CLB, and 3 no SED class CLBs (one FSRQ, one BL Lac, and one BCU) **(a portion of the words or sentences are copied from Foschini et al. 2022)**, which are listed in Table 2.

Table 2. The CLBs compiled in Foschini et al. (2022)

4FGL name	R.A.	Decl.	ASSOC name	SED class	4FGL Class
(1)	(2)	(3)	(4)	(5)	(6)
4FGL J0014.2+0854	3.5695	8.9114	MS 0011.7+0837	..	bll
4FGL J0134.5+2637	23.6272	26.6294	RX J0134.4+2638	HSP	fsrq
4FGL J0217.8+0144	34.4621	1.7346	PKS 0215+015	LSP	fsrq
4FGL J0407.5+0741	61.8921	7.6998	TXS 0404+075	LSP	bll
4FGL J0449.1+1121	72.2823	11.3569	PKS 0446+11	LSP	fsrq
4FGL J0509.4+1012	77.3510	10.2008	PKS 0506+101	LSP	fsrq
4FGL J0510.0+1800	77.5181	18.0135	PKS 0507+17	LSP	fsrq
4FGL J0719.3+3307	109.8400	33.1232	B2 0716+33	LSP	fsrq
4FGL J0833.9+4223	128.4759	42.3989	OJ 451	LSP	fsrq
4FGL J1037.4−2933	159.3564	-29.5568	PKS 1034−293	LSP	fsrq
4FGL J1043.2+2408	160.8053	24.1460	B2 1040+24A	LSP	fsrq
4FGL J1124.0+2336	171.0045	23.6159	OM 235	LSP	fsrq
4FGL J1224.9+2122	186.2277	21.3814	4C +21.35	LSP	fsrq
4FGL J1302.8+5748	195.7209	57.8146	TXS 1300+580	LSP	bll
4FGL J1322.2+0842	200.5510	8.7036	NVSS J132210+084231	LSP	fsrq
4FGL J1333.2+2725	203.3227	27.4221	MG2 J133305+2725	LSP	fsrq
4FGL J1422.3+3223	215.5772	32.3911	OQ 334	LSP	fsrq
4FGL J1623.6+5743	245.9186	57.7290	TXS 1623+578	..	fsrq
4FGL J1657.7+4808	254.4383	48.1368	4C +48.41	LSP	fsrq
4FGL J1751.5+0938	267.8776	9.6456	OT 081	LSP	bll

Table 2 *continued on next page*

Table 2 *(continued)*

4FGL name	R.A.	Decl.	ASSOC name	SED class	4FGL Class
(1)	(2)	(3)	(4)	(5)	(6)
4FGL J1800.6+7828	270.1730	78.4674	S5 1803+784	LSP	bll
4FGL J1823.5+6858	275.8884	68.9676	7C 1823+6856	ISP	bll
4FGL J1937.2−3958	294.3092	-39.9825	PKS 1933−400	LSP	fsrq
4FGL J2026.0−2845	306.5048	-28.7546	PMN J2025−2845	LSP	fsrq
4FGL J2134.2−0154	323.5699	-1.9042	PKS 2131−021	LSP	bll
4FGL J2158.1−1501	329.5275	-15.0237	PKS 2155−152	LSP	fsrq
4FGL J2207.6+0053	331.9137	0.8907	PMN J2207+0052	..	bcu
4FGL J2212.0+2356	333.0191	23.9334	PKS 2209+236	LSP	fsrq
4FGL J2225.7−0457	336.4321	-4.9537	3C 446	LSP	fsrq
4FGL J2236.3+2828	339.0962	28.4832	B2 2234+28A	LSP	fsrq
4FGL J2345.2−1555	356.3030	-15.9182	PMN J2345−1555	LSP	fsrq
4FGL J2349.4+0534	357.3558	5.5790	TXS 2346+052	LSP	fsrq
4FGL J0522.9−3628	80.7370	-36.4686	PKS 0521−36	LSP	agn
4FGL J0910.0+4257	137.5058	42.9623	3C 216	...	css

NOTE—The 4FGL name are presented in Column 1. Columns 2 and 3 are the J2000 coordinates. The counterpart names are listed in Column 4. Column 5 lists the SED class, column 6 is the optical class reported in 4FGL catalog, respectively.

2.3. *The CLBs reported in Xiao et al. (2022)*

In Xiao et al. (2022), based on blazar's EW, they reported that 52 Changing-look blazars, and declared 45 of them are newly confirmed that listed in Table 3 **(a portion of the words or sentences are copied from Xiao et al. 2022)**.

Table 3. The CLBs reported in Xiao et al. (2022)

4FGL name	R.A.	Decl.	ASSOC name	SED class	4FGL Class	From-To
(1)	(2)	(3)	(4)	(5)	(6)	(7)
4FGL J0102.8+5824	15.701	58.409	TXS 0059+581	LSP	fsrq	F → B
4FGL J0337.8−1157	54.474	-11.960	PKS 0335−122	LSP	fsrq	F → B
4FGL J0347.0+4844	56.753	48.738	IVS B0343+485	LSP	fsrq	F → B
4FGL J0521.3−1734	80.341	-17.574	TXS 0519−176	LSP	fsrq	F → B
4FGL J0539.6+1432	84.905	14.544	TXS 0536+145	LSP	fsrq	F → B
4FGL J0539.9−2839	84.995	-28.659	PKS 0537−286	LSP	fsrq	F → B
4FGL J0601.1−7035	90.296	-70.590	PKS 0601−70	LSP	fsrq	F → B
4FGL J1816.9−4942	274.244	-49.716	PMN J1816−4943	LSP	fsrq	F → B
4FGL J2015.5+3710	303.892	37.176	MG2 J201534+3710	LSP	fsrq	F → B
4FGL J2121.0+1901	320.260	19.032	OX 131	LSP	fsrq	F → B
4FGL J0006.3−0620	1.599	-6.349	PKS 0003−066	LSP	bll	B → F
4FGL J0127.9+4857	21.978	48.954	GB6 J0128+4901	...	bll	B → F
4FGL J0203.7+3042	30.933	30.714	NVSS J020344+304238	LSP	bll	B → F

Table 3 *continued on next page*

Table 3 *(continued)*

4FGL name (1)	R.A. (2)	Decl. (3)	ASSOC name (4)	SED class (5)	4FGL Class (6)	From-To (7)
4FGL J0209.9+7229	32.498	72.488	S5 0205+722	LSP	bll	B → F
4FGL J0238.6+1637	39.668	16.618	PKS 0235+164	LSP	bll	B → F
4FGL J0334.2−4008	53.557	-40.145	PKS 0332−403	LSP	bll	B → F
4FGL J0407.5+0741	61.892	7.700	TXS 0404+075	LSP	bll	B → F
4FGL J0428.6−3756	67.173	-37.940	PKS 0426−380	LSP	bll	B → F
4FGL J0433.6+2905	68.411	29.097	MG2 J043337+2905	LSP	bll	B → F
4FGL J0438.9−4521	69.745	-45.358	PKS 0437−454	LSP	bll	B → F
4FGL J0516.7−6207	79.180	-62.125	PKS 0516−621	LSP	bll	B → F
4FGL J0538.8−4405	84.709	-44.086	PKS 0537−441	LSP	bll	B → F
4FGL J0629.3−1959	97.348	-20.000	PKS 0627−199	LSP	bll	B → F
4FGL J0654.7+4246	103.686	42.779	B3 0651+428	LSP	bll	B → F
4FGL J0710.9+4733	107.732	47.553	S4 0707+47	LSP	bll	B → F
4FGL J0814.4+2941	123.610	29.686	RX J0814.4+2941	HSP	bll	B → F
4FGL J0823.3+2224	125.844	22.409	OJ 233	...	bll	B → F
4FGL J0831.8+0429	127.973	4.494	PKS 0829+046	LSP	bll	B → F
4FGL J0832.4+4912	128.108	49.213	OJ 448	LSP	bll	B → F
4FGL J1001.1+2911	150.294	29.188	GB6 J1001+2911	LSP	bll	B → F
4FGL J1031.1+7442	157.792	74.702	S5 1027+74	ISP	bll	B → F
4FGL J1058.0+4305	164.518	43.094	B3 1055+433	LSP	bll	B → F
4FGL J1058.4+0133	164.624	1.564	4C +01.28	LSP	bll	B → F
4FGL J1058.6−8003	164.660	-80.064	PKS 1057−79	LSP	bll	B → F
4FGL J1147.0−3812	176.760	-38.201	PKS 1144−379	LSP	bll	B → F
4FGL J1250.6+0217	192.651	2.288	PKS 1247+025	LSP	bll	B → F
4FGL J1331.2−1325	202.819	-13.428	PMN J1331−1326	LSP	bll	B → F
4FGL J1402.6+1600	210.658	16.002	4C +16.39	ISP	bll	B → F
4FGL J1412.1+7427	213.038	74.450	GB6 J1411+7424	ISP	bll	B → F
4FGL J1503.5+4759	225.895	47.996	TXS 1501+481	LSP	bll	B → F
4FGL J1647.5+4950	251.892	49.834	SBS 1646+499	LSP	bll	B → F
4FGL J1751.5+0938	267.878	9.646	OT 081	LSP	bll	B → F
4FGL J1800.6+7828	270.173	78.467	S5 1803+784	LSP	bll	B → F
4FGL J1806.8+6949	271.711	69.827	3C 371	LSP	bll	B → F
4FGL J1954.6−1122	298.669	-11.382	TXS 1951−115	LSP	bll	B → F
4FGL J2134.2−0154	323.570	-1.904	PKS 2131−021	LSP	bll	B → F
4FGL J2152.5+1737	328.137	17.617	S3 2150+17	LSP	bll	B → F
4FGL J2202.7+4216	330.695	42.282	BL Lac	LSP	bll	B → F
4FGL J2204.3+0438	331.083	4.640	4C +04.77	ISP	bll	B → F
4FGL J2216.9+2421	334.238	24.358	B2 2214+24B	LSP	bll	B → F
4FGL J2315.6−5018	348.914	-50.313	PKS 2312−505	LSP	bll	B → F
4FGL J2357.4−0152	359.367	-1.870	PKS 2354−021	LSP	bll	B → F

Table 3 *continued on next page*

Table 3 *(continued)*

4FGL name	R.A.	Decl.	ASSOC name	SED class	4FGL Class	From-To
(1)	(2)	(3)	(4)	(5)	(6)	(7)

NOTE—The 4FGL name are presented in Column 1. Columns 2 and 3 are the J2000 coordinates. The counterpart names are listed in Column 4. Column 5 is the spectral energy distribution (SED) class and column 6 lists the optical class reported in 4FGL catalog, respectively. The change of optical class before and after the transition in Xiao et al. (2022) are presented in Columns 7, where F is FSRQ and B is BL Lac.

2.4. *The CLBs compiled in Foschini et al. (2021)*

Foschini et al. (2021) compiled a gamma-ray jetted AGN sample based on the 4FGL-DR2 catalog. They reported 11 changing-look AGNs, based on a featureless spectrum reported in the previous literature (see Foschini et al. 2021 for more details and references therein). Where, 9 of them are blazars labeled as FSRQ in 4FGL-DR2 catalog, one of them is non-blazar active galaxy labeled as "agn" in 4FGL-DR2 catalog, and one of them is compact steep spectrum radio source labeled as "css" in 4FGL catalog **(a portion of the words or sentences are copied from Foschini et al. 2021)**.

The 11 sources are listed in Table 4.

Table 4. The CLBs compiled in Foschini et al. (2021)

4FGL name	R.A.	Decl.	ASSOC name	SED class	4FGL Class	From class	To class
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
4FGL J0134.5+2637	23.6272	26.6294	RX J0134.4+2638	HSP	fsrq	featureless	fsrq
4FGL J0217.8+0144	34.4621	1.7346	PKS 0215+015	LSP	fsrq	featureless	fsrq
4FGL J0449.1+1121	72.2823	11.3569	PKS 0446+11	LSP	fsrq	featureless	fsrq
4FGL J0509.4+1012	77.3510	10.2008	PKS 0506+101	LSP	fsrq	featureless	fsrq
4FGL J0510.0+1800	77.5181	18.0135	PKS 0507+17	LSP	fsrq	featureless	fsrq
4FGL J0522.9−3628	80.7370	-1636.4686	PKS 0521−36	LSP	agn	featureless	agn
4FGL J0719.3+3307	109.8400	33.1232	B2 0716+33	LSP	fsrq	featureless	fsrq
4FGL J0833.9+4223	128.4759	42.3989	OJ 451	LSP	fsrq	featureless	fsrq
4FGL J0910.0+4257	137.5058	42.9623	3C 216	...	css	featureless	css
4FGL J1037.4−2933	159.3564	-29.5568	PKS 1034−293	LSP	fsrq	featureless	fsrq
4FGL J1124.0+2336	171.0045	23.6159	OM 235	LSP	fsrq	featureless	fsrq

NOTE—The 4FGL name are presented in Column 1. Columns 2 and 3 are the J2000 coordinates. The counterpart names are listed in Column 4. Column 5 and 6 lists the spectral energy distribution (SED) class and the optical class reported in 4FGL-DR2 catalog, respectively. The optical class before and after the transition in Foschini et al. (2021) are presented in Columns 7 and 8, respectively.

2.5. *The CLBs reported in Peña-Herazo et al. (2021)*

In Peña-Herazo et al. (2021), they reported 26 Changing-Look (transitional) blazars (CLBs) that changed their classification. Six of them are confirmed that are the blazar-like nature of BL Lac candidates. All remaining sources followed with previous classifications (**a portion of the words or sentences are copied from Peña-Herazo et al. 2021**).

Which are listed in Table 5.

Table 5. The CLBs reported in Peña-Herazo et al. (2021)

4FGL name	R.A.	Decl.	SED class	4FGL Class	ASSOC name	From class	To class
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
4FGL J1410.3+1438	212.5908	14.6434	...	bll	4FGL J1410.3+1438	bll	bzq
4FGL J1503.5+4759	225.8955	47.9959	LSP	bll	4FGL J1503.5+4759	bll	bzq
...	...	...	...	...	SDSS J134240.02+094752.4	bzq	bzb
...	...	...	...	...	5BZG J0006+1051	bzg	bzb
4FGL J0022.0+0006	5.5154	0.1134	HSP	bll	5BZG J0022+0006	bzg	bzb
4FGL J0303.3+0555	45.8465	5.9249	HSP	bll	5BZG J0303+0554	bzg	bzb
...	...	...	...	...	5BZG J0751+1730	bzg	bzq
...	...	...	...	...	5BZG J0756+3834	bzg	bzq
4FGL J0916.7+5238	139.1906	52.6454	HSP	bll	5BZG J0916+5238	bzg	bzb
4FGL J1001.1+2911	150.2938	29.1880	LSP	bll	5BZB J1001+2911	bzb	bzq
4FGL J1043.2+2408	160.8053	24.1460	LSP	fsrq	5BZQ J1043+2408	bzq	bzb
...	...	...	...	...	5BZQ J1054+3855	bzq	bzb
4FGL J1056.0+0253	164.0027	2.8935	...	bll	5BZG J1056+0252	bzg	bzb
...	...	...	...	...	5BZG J1103+0022	bzg	bzb
4FGL J1106.0+2813	166.5020	28.2254	LSP	fsrq	5BZQ J1106+2812	bzq	bzb
...	...	...	...	...	5BZQ J1243+4043	bzq	bzb
4FGL J1321.1+2216	200.2958	22.2808	LSP	fsrq	5BZQ J1321+2216	bzq	bzb
4FGL J1326.1+1232	201.5493	12.5348	HSP	bll	5BZG J1326+1229	bzg	bzb
...	...	...	...	...	5BZQ J1343+2844	bzq	bzb
4FGL J1402.6+1600	210.6584	16.0016	ISP	bll	5BZB J1402+1559	bzb	bzq
4FGL J1449.5+2746	222.3956	27.7686	ISP	rdg	5BZG J1449+2746	bzg	bzb
...	...	...	...	...	5BZG J1504−0248	bzg	bzq
4FGL J1512.2+0202	228.0702	2.0403	LSP	fsrq	5BZG J1512+0203	bzg	bzq
4FGL J1730.8+3715	262.7026	37.2641	ISP	bll	5BZG J1730+3714	bzg	bzb
...	...	...	...	...	5BZG J1733+4519	bzg	bzb
...	...	...	...	...	5BZG J2346+4024	bzg	bzq

Note—The 4FGL name are presented in Column 1. Columns 2 and 3 are the J2000 coordinates. Column 4 is the spectral energy distribution (SED) class and Column 5 lists the optical class reported in 4FGL catalog, respectively. The counterpart names are listed in Column 6. The optical class before and after the transition in Peña-Herazo et al. (2021) are presented in Columns 7 and 8, respectively. Where, BL lacs labeled as BZB and FSRQs labeled as BZQ (or BZG) in the Roma-BZCAT.

2.6. *The transition blazars reported in Ruan et al. (2014)*

Based on the EW of their (blazars) optical broad emission lines, blazars are common classically divided into the BL Lacs and FSRQs subclasses. The EW-based classification criteria are not physically motivated, and some blazars have previously "transitioned" from one subclass to the other. In Ruan et al. (2014), they present the first systematic search for these transition blazars in a sample of 602 unique pairs of repeat spectra of 354 blazars in the Sloan Digital Sky Survey, finding six clear transition blazars (**a portion of the words or sentences are copied from Ruan et al. 2014**).

Which are listed in Table 6.

Table 6. The transition blazars reported in Ruan et al. (2014)

4FGL name	R.A.	Decl.	SED class	4FGL Class	ASSOC name	From class	To class
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
4FGL J0833.9+4223	128.4759	42.3989	LSP	fsrq	SDSS J083353.88+422401.8	P−BLL	FSRQ−like
4FGL J1016.0+0512	154.0093	5.2089	LSP	fsrq	SDSS J101603.13+051302.3	P−BLL	FSRQ−like
4FGL J1308.5+3547	197.1286	35.7918	LSP	fsrq	SDSS J130823.70+354637.0	P−BLL	FSRQ−like
4FGL J2206.8−0032	331.7087	-0.5461	LSP	bll	SDSS J220643.28−003102.5	P−BLL	FSRQ−like
4FGL J1250.6+0217	192.6513	2.2876	LSP	bll	SDSS J125032.57+021632.1	P−BLL	FSRQ−like
...	...	...	...	...	SDSS J143758.67+300207.1	P−BLL	FSRQ−like

NOTE—The 4FGL name are presented in Column 1. Columns 2 and 3 are the J2000 coordinates. Column 4 lists the spectral energy distribution (SED) class and column 5 lists the optical class reported in 4FGL catalog, respectively. The counterpart names are listed in Column 6. The optical class before and after the transition in Ruan et al. (2014) are presented in Columns 7 and 8.

2.7. *The transition blazars reported in Shaw et al. (2012)*

In Shaw et al. 2012, they found that some blazars were classified as BL Lacs in initial epoch observations. However, in some spectral observation periods, where the continuum is low, and they all show broad lines as FSRQ-type sources. In addition, some BL Lacs with very high S/N observations that the broad lines were detected at high significance at EW levels < 5Å. These were thus "BL Lac objects" can be analyzed along with the FSRQ. They suggested that these sources present a clear transitional between the standard FSRQs and BL Lac types (**a portion of the words or sentences are copied from Shaw et al. 2012**).

Which are listed in Table 7

Table 7. The 11 transition blazars reported in Shaw et al. (2012)

4FGL name	R.A.	Decl.	SED class	4FGL Class	ASSOC name	From class	To class
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
4FGL J0058.4+3315	14.6101	33.2505	LSP	fsrq	1FGL J0058.0+3314	BL Lac	nominal_FSRQ
4FGL J0923.5+4125	140.8949	41.4283	LSP	fsrq	1FGL J0923.2+4121	BL Lac	nominal_FSRQ
4FGL J1001.1+2911	150.2938	29.1880	LSP	bll	1FGL J1000.9+2915	BL Lac	nominal_FSRQ
4FGL J1607.0+1550	241.7745	15.8447	LSP	bll	1FGL J1607.1+1552	BL Lac	nominal_FSRQ
4FGL J2032.0+1219	308.0040	12.3279	LSP	bll	1FGL J2031.5+1219	BL Lac	nominal_FSRQ
4FGL J2244.2+4057	341.0614	40.9597	LSP	fsrq	1FGL J2243.4+4104	BL Lac	nominal_FSRQ
4FGL J0430.3−2507	67.5751	-25.1283	ISP	bll	1FGL J0430.4−2509	BL Lac	broad_lines_BLL

Table 7 *continued on next page*

Table 7 *(continued)*

4FGL name	R.A.	Decl.	SED class	4FGL Class	ASSOC name	From class	To class
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
4FGL J0516.7−6207	79.1798	-62.1248	LSP	bll	1FGL J0516.7−6207	BL Lac	broad_lines_BLL
4FGL J1058.4+0133	164.6240	1.5641	LSP	bll	1FGL J1058.4+0134	BL Lac	broad_lines_BLL
4FGL J2236.3+2828	339.0962	28.4832	LSP	fsrq	1FGL J2236.2+2828	BL Lac	broad_lines_BLL
4FGL J2315.6−5018	348.9140	-50.3127	LSP	bll	1FGL J2315.9−5014	BL Lac	broad_lines_BLL

Note—The 4FGL name are presented in Column 1. Columns 2 and 3 are the J2000 coordinates. Column 4 is the spectral energy distribution (SED) class and Column 5 lists the optical class reported in 4FGL catalog, respectively. The 1FGL counterpart names are listed in Column 6. The optical class before and after the transition in Shaw et al. (2012) are presented in Columns 7 and 8, respectively.

2.8. *The transition blazars reported in Ghisellini et al. (2011)*

In Ghisellini et al. (2011), they suggested that some sources classified as BL Lacs with an SED appearing as intermediate between BL Lacs and FSRQs also have relatively weak broad emission lines and small EW, and can be considered as transition sources (**a portion of the words or sentences are copied from Ghisellini et al. 2011**). . Which are listed in Table 8.

Table 8. The transition blazars reported in Ghisellini et al. (2011)

4FGL name	R.A.	Decl.	ASSOC name	SED class	4FGL Class	From class	To class
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
4FGL J0058.4+3315	14.6101	33.2505	MG3 J005830+3311	LSP	fsrq	BL Lacs	FS
4FGL J0210.7−5101	32.6946	-51.0218	PKS 0208−512	LSP	fsrq	BL Lacs	FS
4FGL J0538.8−4405	84.7089	-44.0862	PKS 0537−441	LSP	bll	BL Lacs	FS
4FGL J0811.4+0146	122.8610	1.7756	OJ 014.	LSP	bll	BL Lacs	FS
4FGL J0238.6+1637	39.6680	16.6179	PKS 0235+164	LSP	bll	BL Lacs	FS
4FGL J0428.6−3756	67.1730	-37.9403	PKS 0426−380	LSP	bll	BL Lacs	FS

Note—The 4FGL name are presented in Column 1. Columns 2 and 3 are the J2000 coordinates. The counterpart names are listed in Column 4. Column 5 is the spectral energy distribution (SED) class and column 6 lists the optical class reported in 4FGL catalog, respectively. The optical class before and after the transition in Ghisellini et al. (2011) are presented in Columns 7 and 8.

2.9. *The other CLBs or transition blazars in other literatures*

Some other individual CLBs reported in some literatures (Vermeulen et al. 1995; Mishra et al. 2021; Álvarez Crespo et al. 2016; Pasham & Wevers 2019; Cutini et al. 2014; Padovani et al. 2019; Bianchin et al. 2009, to be added and updated.) that listed in Table 9.

Table 9. The other CLBs or transition blazars in other literatures

4FGL name	R.A.	Decl.	SED class	4FGL Class	ASSOC name	From class	To class	ref.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
4FGL J2202.7+4216	330.6946	42.2821	LSP	bll	BL Lac (prototype)	BL Lac	FSRQ	[a]

Table 9 *continued on next page*

Table 9 *(continued)*

4FGL name	R.A.	Decl.	SED class	4FGL Class	ASSOC name	From class	To class	ref.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
4FGL J1422.3+3223	215.5772	32.3911	LSP	fsrq	B2 1420+32	FSRQ	BL Lac	[b]
...	...	...	...	...	5BZB J0724+2621	BL Lac	FSRQ.	[c]
...	...	...	...	...	J211354.71+112125.3.	FSRQ	no BELs.	[d]
...	...	...	...	...	(AT2019evq)	FSRQ	no BELs.	[d]
4FGL J1153.4+4931	178.3505	49.5169	LSP	fsrq	4C+29.22 (S4 1150+49)	FSRQ	BL Lacs	[e]
4FGL J0509.4+0542	77.3593	5.7014	ISP	bll	TXS 0506+056	bll	FSRQ	[f]
4FGL J2151.8−3027	327.9655	-30.4600	LSP	fsrq	PKS 2149−306			[g]

NOTE—The 4FGL name are presented in Column 1. Columns 2 and 3 are the J2000 coordinates. Column 4 is the spectral energy distribution (SED) class and column 5 lists the optical class reported in 4FGL catalog, respectively. The counterpart names are listed in Column 6. The optical class before and after the transition in literatures are presented in Columns 7 and 8, respectively. The references are reported in Columns 9, where,
[a] Vermeulen et al. (1995); based on optical line.
[b] Mishra et al. (2021); based on optical line.
[c] Álvarez Crespo et al. (2016); based on optical line.
[d] Pasham & Wevers (2019); based on optical line.
[e] Cutini et al. (2014); based on SED.
[f] Padovani et al. (2019); based on Eddington ratio.
[g] Bianchin et al. (2009). based on SED.

3. THE BLUE QUASARS

3.1. *The Blue Fermi FSRQs in Ghisellini et al. (2012, 2013)*

Many blazars detected by the Fermi satellite, observed spectroscopically in the optical, are line-less, and have been classified as BL Lac objects. Optical-ultraviolet (UV) photometry of nearly 100 of them allowed us to determine the redshift for a handful of objects and redshift upper limits in the great majority. A few of these are candidates to be **'blue quasars'**, namely flat spectrum radio quasars whose broad emission lines are hidden by an overwhelming synchrotron emission peaking in the UV. This implies that the emitting electrons have high energies. In turn, this requires relatively weak radiative cooling, a condition that can be met if the main radiative dissipation of the jet power occurs outside the broad-line region. We confirm this hypothesis by studying and modelling the spectral energy distributions of the four 'blue quasars' recently discovered. Furthermore, we discuss the distribution of Fermi blazars in the gamma-ray spectral index-gamma-ray luminosity plane, and argue that 'blue quasars' objects are a minority within the blazar populations **(a portion of the words or sentences are copied from Ghisellini et al. 2012)**.

Which are listed in Table 10.

In addition, the flat spectrum radio quasar PMN J2345-1555 (see, Table 10) is a bright gamma-ray source, that recently underwent a flaring episode in the infrared (IR), ultraviolet (UV) and gamma-ray bands. The flux changed quasi-simultaneously at different frequencies, suggesting that it was produced by a single population of emitting particles, hence by a single and well-localized region of the jet. While the overall spectral energy distribution (SED) before the flare was typical of powerful blazars (namely two broad humps peaking in the far-IR and below 100 MeV bands, respectively), during the flare the peaks moved to the optical-UV and to energies larger than 1 GeV, to resemble low power BL Lac objects, even if the observed bolometric luminosity increased by more than one order of magnitude. We interpret this behaviour as due to a change of the location of the emission region in the jet, from within the broad-line region, to just outside. The corresponding decrease of the radiation energy density as seen in the comoving frame of the jet allowed the relativistic electrons to be accelerated to higher energies, and thus produce **a 'bluer' SED (a portion of the words or sentences are copied from Ghisellini et al. 2013)** .

Table 10. The Blue Fermi FSRQs in Ghisellini et al. (2012, 2013)

4FGL name	R.A.	Decl.	SED class	4FGL Class	ASSOC name	From class	To class
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
4FGL J2345.2−1555	356.3030	-15.9182	LSP	fsrq	PMN J2345−1555.	FSRQ(red)	BL Lac(blue)
4FGL J0035.2+1514	8.8123	15.2405	ISP	bll	RX J0035.2+1515	bll	FSRQ(blue)
4FGL J0537.7−5717	84.4251	-57.2909	HSP	bll	SUMMS J053748−571828	bll	FSRQ(blue)
4FGL J0630.9−2406	97.7414	-24.1110	HSP	bll	CRATES J0630−2406	bll	FSRQ(blue)
4FGL J1312.4−2156	198.1108	-21.9380	HSP	bll	CRATES 1312−2156	bll	FSRQ(blue)

Note—The 4FGL name are presented in Column 1. Columns 2 and 3 are the J2000 coordinates. Column 4 is the spectral energy distribution (SED) class and Column 5 lists the optical class reported in 4FGL catalog, respectively. The counterpart names are listed in Column 6. The optical class before and after becoming blue in Ghisellini et al. (2012, 2013) are presented in Columns 7 and 8.

4. THE PREDICTIONS

4.1. *The predictions in Fan & Wu (2019)*

The jet power of LBLs shows a very broad distribution, which is somewhat bimodal. The bimodal distribution of LBLs suggests that they may contain two populations, one is actually FSRQs as suggested by Giommi et al. (2012). The other is transitional type BL Lac objects, which show weak emission lines and intermediate jet power. They generally divide LBLs into two groups with the limit $10^{44.6}$ erg s^{-1}. Of the 57 LBLs, 33 with the jet power larger than $10^{44.6}$ erg s^{-1} show similar jet power distribution with FSRQs. (**a portion of the words or sentences are copied from** Fan & Wu 2019). The 33 sources are listed in Table 11.

Table 11. The predictions in Fan & Wu (2019)

4FGL name	R.A.	Decl.	ASSOC name	Bzcat5 name	$Class_{sed}$	$Class_F$	$Class_p$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
3FGL J0049.7+0237	00 49 43.23	+02 37 03.77	PKS 0047+023	5BZBJ0049+0237	bll	LSP	FSRQ
3FGL J0141.4−0929	01 41 25.83	−09 28 43.67	PKS 0139−09	5BZBJ0141−0928	bll	LSP	FSRQ
3FGL J0238.6+1636	02 38 38.93	+16 36 59.27	AO 0235+164	5BZBJ0238+1636	bll	LSP	FSRQ
3FGL J0334.3−4008	03 34 13.65	−40 08 25.39	PKS 0332−403	5BZBJ0334−4008	bll	LSP	FSRQ
3FGL J0407.5+0740	04 07 29.08	+07 42 07.47	TXS 0404+075	5BZBJ0407+0742	bll	LSP	FSRQ
3FGL J0428.6−3756	04 28 40.42	−37 56 19.58	PKS 0426−380	5BZBJ0428−3756	bll	LSP	FSRQ
3FGL J0433.6+2905	04 33 37.82	+29 05 55.47	MG2 J043337+2905	5BZBJ0433+2905	bll	LSP	FSRQ
3FGL J0434.0−2010	04 34 07.91	−20 15 17.13	TXS 0431−203	5BZBJ0434−2015	bll	LSP	FSRQ
3FGL J0438.8−4519	04 39 00.85	−45 22 22.56	PKS 0437−454	5BZBJ0439−4522	bll	LSP	FSRQ
3FGL J0538.8−4405	05 38 50.36	−44 05 08.93	PKS 0537−441	5BZBJ0538−4405	bll	LSP	FSRQ
3FGL J0629.4−1959	06 29 23.76	−19 59 19.72	PKS 0627−199	5BZBJ0629−1959	bll	LSP	FSRQ
3FGL J0738.1+1741	07 38 07.39	+17 42 18.99	PKS 0735+17	5BZBJ0738+1742	bll	LSP	FSRQ
3FGL J0811.3+0146	08 11 26.7	+01 46 52.22	OJ 014	5BZBJ0811+0146	bll	LSP	FSRQ
3FGL J0818.2+4223	08 18 15.99	+42 22 45.41	S4 0814+42	5BZBJ0818+4222	bll	LSP	FSRQ

Table 11 *continued on next page*

Table 11 *(continued)*

4FGL name	R.A.	Decl.	ASSOC name	Bzcat5 name	$Class_{sed}$	$Class_F$	$Class_p$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
3FGL J0826.0+0307	08 25 50.33	+03 09 24.51	PKS 0823+033	5BZBJ0825+0309	bll	LSP	FSRQ
3FGL J1058.5+0133	10 58 29.6	+01 33 58.82	4C +01.28	5BZUJ1058+0133	bll	LSP	FSRQ
3FGL J1218.0−0029	12 17 58.72	−00 29 46.29	PKS 1215−002	5BZBJ1217−0029	bll	LSP	FSRQ
3FGL J1250.5+0217	12 50 32.58	+02 16 32.17	PKS 1247+025	5BZBJ1250+0216	bll	LSP	FSRQ
3FGL J1303.0+2435	13 03 03.21	+24 33 55.72	MG2 J130304+2434	5BZBJ1303+2433	bll	LSP	FSRQ
3FGL J1522.6−2730	15 22 37.67	−27 30 10.78	PKS 1519−273	5BZBJ1522−2730	bll	LSP	FSRQ
3FGL J1540.8+1449	15 40 49.49	+14 47 45.88	4C +14.60	5BZBJ1540+1447	bll	LSP	FSRQ
3FGL J1748.6+7005	17 48 32.84	+70 05 50.76	S4 1749+70	5BZBJ1748+7005	bll	LSP	FSRQ
3FGL J1800.5+7827	18 00 45.68	+78 28 04.01	S5 1803+784	5BZBJ1800+7828	bll	LSP	FSRQ
3FGL J1824.2+5649	18 24 07.06	+56 51 01.49	4C +56.27	5BZBJ1824+5651	bll	LSP	FSRQ
3FGL J2031.8+1223	20 31 54.99	+12 19 41.34	PKS 2029+121	5BZUJ2031+1219	bll	LSP	FSRQ
3FGL J2134.1−0152	21 34 10.3	−01 53 17.23	PKS 2131−021	5BZBJ2134−0153	bll	LSP	FSRQ
3FGL J2152.4+1735	21 52 24.81	+17 34 37.79	S3 2150+17	5BZBJ2152+1734	bll	LSP	FSRQ
3FGL J2206.9−0031	22 06 43.28	−00 31 02.49	PMN J2206−0031	5BZBJ2206−0031	bll	LSP	FSRQ
3FGL J2217.0+2421	22 17 00.82	+24 21 45.95	B2 2214+24B	5BZBJ2217+2421	bll	LSP	FSRQ
3FGL J2236.3+2829	22 36 22.47	+28 28 57.41	B2 2234+28A	5BZQJ2236+2828	bll	LSP	FSRQ
3FGL J2243.4−2541	22 43 26.4	−25 44 30.68	PKS 2240−260	5BZBJ2243−2544	bll	LSP	FSRQ
3FGL J2244.1+4057	22 44 12.73	+40 57 13.62	TXS 2241+406	5BZQJ2244+4057	bll	LSP	FSRQ
3FGL J2315.7−5018	23 15 44.33	−50 18 39.7	PKS 2312−505	5BZBJ2315−5018	bll	LSP	FSRQ

NOTE—The 3FGL name are presented in Column 1. Columns 2 and 3 are the J2000 coordinates. The counterpart names and Bzcat5 Counterpart names are listed in Column 4 and 5. Column 6 lists the optical class, column 7 is the spectral energy distribution (SED) class reported in 4FGL catalog. The predictions in Fan & Wu (2019) are presented in Columns 8.

4.2. *The predictions in Pei et al. (2022).*

Based on the values of L_{Disk}/L_{Edd} = 0.055 and 0.024 for the two LSP BL Lacs : 4FGL J0238.6+1637 (PKS 0235+164) and 4FGL J0538.8-4405 (PKS 0537-441) labeled as LSP BL Lacs in 4FGL catalog, which are located in the "appareling zone" that perhaps Changing-Look blazars and the transition of BL Lacs-FSRQs would occur, Pei et al. (2022) suggested that there are two sources to be potential changing-look blazars (**a portion of the words or sentences are copied from Pei et al. 2022**).

Which are listed in Table 12.

Table 12. The predictions in Pei et al. (2022)

4FGL name	R.A.	Decl.	ASSOC name	SED class	4FGL Class	From class	To class
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
4FGL J0238.6+1637	39.6680	16.6179	PKS 0235 +164	LSP	bll	BL Lacs	FRSQs
4FGL J0538.8−4405	84.7089	-44.0862	PKS 0537−441	LSP	bll	BL Lacs	FRSQs

NOTE—The 4FGL name are presented in Column 1. Columns 2 and 3 are the J2000 coordinates. The counterpart names are listed in Column 4. Column 6 lists the optical class, column 5 is the spectral energy distribution (SED) class reported in 4FGL catalog, respectively. The optical class before and after the predictions (transition) in Pei et al. (2022) are presented in Columns 7 and 8.

4.3. *The predictions in Cheng et al. (2022)*

In Cheng et al. (2022), they found that the distribution of the peak frequency of the synchrotron radiation, gamma-ray photon spectral index, and the X-band (8.4 GHz) flux density showed a similar bimodal **for LSP subclass**; one distribution hump similar to the BL Lacs and another similar to the FSRQs. These observations indicate that some LSP-BL Lacs may belong to BL Lacs and others are essentially FSRQs. They suggest that 47 LSP-BL Lacs that intrinsically FSRQ are misclassified as BL Lacs, and checked the Compton dominance (CD), 37 of 39 sources with CD > 1, which provides some further evidence that some FSRQs may be mistaken for LSP BL Lacs. where, some LSP BL Lacs are essentially FSRQs. (a portion of the words or sentences are copied from Cheng et al. 2022).

The 47 sources are listed in Table 13.

Table 13. The predictions in Cheng et al. (2022)

4FGL name	R.A.	Decl.	ASSOC name	RFC name	SED class	4FGL Class	From class	To class
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
4FGL J1302.8+5748	195.7209	57.8146	TXS 1300+580	J1302+5748	LSP	bll	bll	FSRQ
4FGL J2346.7+8008	356.6867	80.1366	WN B2344.2+7951	J2346+8007	LSP	bll	bll	FSRQ
4FGL J2357.4−0152	359.3674	-1.8703	PKS 2354−021	J2357−0152	LSP	bll	bll	FSRQ
4FGL J2200.3+1029	330.0887	10.4956	TXS 2157+102	J2200+1030	LSP	bll	bll	FSRQ
4FGL J2241.2+4120	340.3087	41.3396	B3 2238+410	J2241+4120	LSP	bll	bll	FSRQ
4FGL J1224.9+4334	186.2371	43.5691	B3 1222+438	J1224+4335	LSP	bll	bll	FSRQ
4FGL J0359.4−2616	59.8713	-26.2734	PKS 0357−264	J0359−2615	LSP	bll	bll	FSRQ
4FGL J0403.5−2437	60.8989	-24.6168	TXS 0401−248	J0403−2444	LSP	bll	bll	FSRQ
4FGL J0208.5−0046	32.135	-0.7768	PKS 0205−010	J0208−0047	LSP	bll	bll	FSRQ
4FGL J0610.1−1848	92.5455	-18.8076	PMN J0610−1847	J0610−1847	LSP	bll	bll	FSRQ
4FGL J1439.7+4958	219.9411	49.9775	GB6 J1439+4958	J1439+4958	LSP	bll	bll	FSRQ
4FGL J1445.9−1626	221.4978	-16.4498	PKS B1443−162	J1445−1629	LSP	bll	bll	FSRQ
4FGL J1148.6+1841	177.1542	18.6861	TXS 1146+189	J1148+1840	LSP	bll	bll	FSRQ
4FGL J1954.6−1122	298.6693	-11.3815	TXS 1951−115	J1954−1123	LSP	bll	bll	FSRQ
4FGL J1201.7+1429	180.4471	14.4852	OM 198	J1201+1431	LSP	bll	bll	FSRQ
4FGL J2315.6−5018	348.914	-50.3127	PKS 2312−505	J2315−5018	LSP	bll	bll	FSRQ
4FGL J0209.9+7229	32.4979	72.4877	S5 0205+722	J0209+7229	LSP	bll	bll	FSRQ
4FGL J0832.4+4912	128.1078	49.2127	OJ 448	J0832+4913	LSP	bll	bll	FSRQ
4FGL J1427.6−3305	216.913	-33.094	PKS 1424−328	J1427−3305	LSP	bll	bll	FSRQ
4FGL J1329.0−5607	202.2672	-56.1186	PMN J1329−5608	J1329−5608	LSP	bll	bll	FSRQ
4FGL J1500.7+4752	225.1837	47.8716	TXS 1459+480	J1500+4751	LSP	bll	bll	FSRQ
4FGL J1410.1+0202	212.5287	2.0354	PKS 1407+022	J1410+0203	LSP	bll	bll	FSRQ
4FGL J2257.5+0748	344.3874	7.8014	OY 91	J2257+0743	LSP	bll	bll	FSRQ
4FGL J1315.1−5333	198.7978	-53.5649	PMN J1315−5334	J1315−5334	LSP	bll	bll	FSRQ
4FGL J0113.7+0225	18.4279	2.4196	UGC 773	J0113+0222	LSP	bll	bll	FSRQ
4FGL J0710.9+4733	107.7323	47.553	S4 0707+47	J0710+4732	LSP	bll	bll	FSRQ
4FGL J2152.5+1737	328.137	17.6173	S3 2150+17	J2152+1734	LSP	bll	bll	FSRQ
4FGL J0407.5+0741	61.8921	7.6998	TXS 0404+075	J0407+0742	LSP	bll	bll	FSRQ
4FGL J2056.7−3209	314.178	-32.1612	PKS 2053−323	J2056−3208	LSP	bll	bll	FSRQ
4FGL J2050.0+0408	312.5181	4.1401	PKS 2047+039	J2050+0407	LSP	bll	bll	FSRQ

Table 13 *continued on next page*

Table 13 *(continued)*

4FGL name (1)	R.A. (2)	Decl. (3)	ASSOC name (4)	RFC name (5)	SED class (6)	4FGL Class (7)	From class (8)	To class (9)
4FGL J2049.9+1002	312.4782	10.0407	PKS 2047+098	J2049+1003	LSP	bll	bll	FSRQ
4FGL J1516.9+1934	229.2442	19.5805	PKS 1514+197	J1516+1932	LSP	bll	bll	FSRQ
4FGL J1717.5−3342	259.3985	-33.7003	TXS 1714−336	J1717−3342	LSP	bll	bll	FSRQ
4FGL J1941.3−6210	295.3468	-62.1753	PKS 1936−623	J1941−6211	LSP	bll	bll	FSRQ
4FGL J2216.9+2421	334.238	24.3575	B2 2214+24B	J2217+2421	LSP	bll	bll	FSRQ
4FGL J0438.9−4521	69.7447	-45.3584	PKS 0437−454	J0439−4522	LSP	bll	bll	FSRQ
4FGL J2010.0+7229	302.5159	72.4874	4C +72.28.	J2009+7229	LSP	bll	bll	FSRQ
4FGL J1330.4+3157	202.6002	31.963	MG2 J132953+3153	J1329+3154	LSP	bll	bll	FSRQ
4FGL J0747.3−3310	116.8328	-33.1778	PKS 0745−330	J0747−3310	LSP	bll	bll	FSRQ
4FGL J1326.8−5256	201.7201	-52.9376	PMN J1326−5256	J1326−5256	LSP	bll	bll	FSRQ
4FGL J2032.0+1219	308.004	12.3279	PKS 2029+121	J2031+1219	LSP	bll	bll	FSRQ
4FGL J1604.5−4441	241.1277	-44.6903	PMN J1604−4441	J1604−4441	LSP	bll	bll	FSRQ
4FGL J1824.1+5651	276.0393	56.8585	4C +56.27	J1824+5651	LSP	bll	bll	FSRQ
4FGL J1641.9−0621	250.4892	-6.3529	TXS 1639−062	J1642−0621	LSP	bll	bll	FSRQ
4FGL J1650.3−5045	252.5894	-50.7515	PMN J1650−5044	J1650−5044	LSP	bll	bll	FSRQ
4FGL J2134.2−0154	323.5699	-1.9042	PKS 2131−021	J2134−0153	LSP	bll	bll	FSRQ
4FGL J2025.3+3341	306.3412	33.6891	B2 2023+33	J2025+3343	LSP	bll	bll	FSRQ

NOTE—The 4FGL name are presented in Column 1. Columns 2 and 3 are the J2000 coordinates. The counterpart names and VLBI Counterpart names are listed in Column 4 and 5. Column 6 lists the optical class, column 7 is the spectral energy distribution (SED) class reported in 4FGL catalog. The based optical class (From class) in Cheng et al. (2022) listed in Columns 8. The predictions in Cheng et al. (2022) are presented in Columns 9.

4.4. *The predictions in Kang et al. 2023*

Based on the 4LAC, 4FGL and RCF catalog, we constructed a sample containing 1680 Fermi sources with known EW-based (optical) classifications (FSRQs and BL Lacs) and SED-based classifications (LSP, ISP, and HSP). Using the random forests supervised machine learning algorithm, 113 actually BL Lac type sources and 157 false BL Lacs (FBLs) that possible intrinsically FSRQs misclassified as BL Lacs are predicted, and 58 remain without a clear prediction; for 328 LSP BL Lacs reported in the high Galactic latitudes ($|b| > 10°$) 4LAC-DR2 catalog (**a portion of the words or sentences are copied from Kang et al. 2023, accepted**). These 157 FBLs are possible Changing-Look Blazar Candidates that are argued and 58 sources without a clear prediction (UNK) are listed in Table 14

Table 14. The predictions in Kang et al. 2023

4FGL name (1)	R.A. (2)	Decl. (3)	ASSOC name (4)	SED class (5)	4FGL Class (6)	From class (7)	To class (8)
4FGL J0003.9−1149	0.9986	-11.8251	PMN J0004−1148	LSP	bll	bll	FSRQ
4FGL J0006.3−0620	1.5992	-6.3493	PKS 0003−066	LSP	bll	bll	FSRQ
4FGL J0013.1−3955	3.2802	-39.9272	PKS 0010−401	LSP	bll	bll	FSRQ
4FGL J0014.1+1910	3.5368	19.1713	MG3 J001356+1910	LSP	bll	bll	FSRQ
4FGL J0019.6+2022	4.9070	20.3755	PKS 0017+200	LSP	bll	bll	FSRQ

Table 14 *continued on next page*

Table 14 *(continued)*

4FGL name	R.A.	Decl.	ASSOC name	SED class	4FGL Class	From class	To class
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
4FGL J0049.7+0237	12.4377	2.6273	PKS 0047+023	LSP	bll	bll	FSRQ
4FGL J0056.8+1626	14.2020	16.4360	TXS 0054+161	LSP	bll	bll	FSRQ
4FGL J0105.1+3929	16.2913	39.4963	GB6 J0105+3928	LSP	bll	bll	FSRQ
4FGL J0107.4+0334	16.8508	3.5691	PMN J0107+0333	LSP	bll	bll	FSRQ
4FGL J0113.7+0225	18.4279	2.4196	UGC 773	LSP	bll	bll	FSRQ
4FGL J0125.3−2548	21.3474	-25.8074	PKS 0122−260	LSP	bll	bll	FSRQ
4FGL J0141.4−0928	25.3626	-9.4825	PKS 0139−09	LSP	bll	bll	FSRQ
4FGL J0144.6+2705	26.1502	27.0899	TXS 0141+268	LSP	bll	bll	FSRQ
4FGL J0202.7+4204	30.6862	42.0714	B3 0159+418	LSP	bll	bll	FSRQ
4FGL J0203.6+7233	30.9114	72.5530	S5 0159+723	LSP	bll	bll	FSRQ
4FGL J0203.7+3042	30.9327	30.7139	NVSS J020344+304238	LSP	bll	bll	FSRQ
4FGL J0208.5−0046	32.1350	-0.7768	PKS 0205−010	LSP	bll	bll	FSRQ
4FGL J0209.9+7229	32.4979	72.4877	S5 0205+722	LSP	bll	bll	FSRQ
4FGL J0217.2+0837	34.3163	8.6234	ZS 0214+083	LSP	bll	bll	FSRQ
4FGL J0238.6+1637	39.6680	16.6179	PKS 0235+164	LSP	bll	bll	FSRQ
4FGL J0301.0−1652	45.2714	-16.8688	PMN J0301−1652	LSP	bll	bll	FSRQ
4FGL J0334.2−4008	53.5566	-40.1450	PKS 0332−403	LSP	bll	bll	FSRQ
4FGL J0340.5−2118	55.1477	-21.3158	PKS 0338−214	LSP	bll	bll	FSRQ
4FGL J0348.6−1609	57.1532	-16.1654	PKS 0346−163	LSP	bll	bll	FSRQ
4FGL J0354.7+8009	58.6919	80.1647	S5 0346+80	LSP	bll	bll	FSRQ
4FGL J0359.4−2616	59.8713	-26.2734	PKS 0357−264	LSP	bll	bll	FSRQ
4FGL J0403.5−2437	60.8989	-24.6168	TXS 0401−248	LSP	bll	bll	FSRQ
4FGL J0407.5+0741	61.8921	7.6998	TXS 0404+075	LSP	bll	bll	FSRQ
4FGL J0424.7+0036	66.1945	0.6028	PKS 0422+00	LSP	bll	bll	FSRQ
4FGL J0424.9−5331	66.2498	-53.5257	PMN J0425−5331	LSP	bll	bll	FSRQ
4FGL J0438.9−4521	69.7447	-45.3584	PKS 0437−454	LSP	bll	bll	FSRQ
4FGL J0502.5+1340	75.6341	13.6685	PKS 0459+135	LSP	bll	bll	FSRQ
4FGL J0513.9−3746	78.4961	-37.7774	NVSS J051404−374607	LSP	bll	bll	FSRQ
4FGL J0516.7−6207	79.1798	-62.1248	PKS 0516−621	LSP	bll	bll	FSRQ
4FGL J0538.8−4405	84.7089	-44.0862	PKS 0537−441	LSP	bll	bll	FSRQ
4FGL J0610.1−1848	92.5455	-18.8076	PMN J0610−1847	LSP	bll	bll	FSRQ
4FGL J0625.3+4439	96.3288	44.6648	GB6 J0625+4440	LSP	bll	bll	FSRQ
4FGL J0628.8−6250	97.2174	-62.8405	PKS 0628−627	LSP	bll	bll	FSRQ
4FGL J0629.3−1959	97.3478	-19.9999	PKS 0627−199	LSP	bll	bll	FSRQ
4FGL J0647.7−6058	101.9314	-60.9781	PMN J0647−6058	LSP	bll	bll	FSRQ
4FGL J0706.9+6109	106.7319	61.1595	TXS 0702+612	LSP	bll	bll	FSRQ
4FGL J0710.9+4733	107.7323	47.5530	S4 0707+47	LSP	bll	bll	FSRQ
4FGL J0712.7+5033	108.1876	50.5506	GB6 J0712+5033	LSP	bll	bll	FSRQ
4FGL J0743.1+1713	115.7753	17.2198	TXS 0740+173	LSP	bll	bll	FSRQ
4FGL J0753.0+5353	118.2530	53.8891	4C +54.15	LSP	bll	bll	FSRQ

Table 14 *continued on next page*

Table 14 *(continued)*

4FGL name	R.A.	Decl.	ASSOC name	SED class	4FGL Class	From class	To class
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
4FGL J0754.7+4823	118.6929	48.3932	GB1 0751+485	LSP	bll	bll	FSRQ
4FGL J0757.1+0956	119.2856	9.9491	PKS 0754+100	LSP	bll	bll	FSRQ
4FGL J0800.9+4401	120.2457	44.0181	B3 0757+441	LSP	bll	bll	FSRQ
4FGL J0814.6+6430	123.6654	64.5050	GB6 J0814+6431	LSP	bll	bll	FSRQ
4FGL J0819.0+2746	124.7636	27.7772	5C 07.119	LSP	bll	bll	FSRQ
4FGL J0825.8+0309	126.4567	3.1656	PKS 0823+033	LSP	bll	bll	FSRQ
4FGL J0831.8+0429	127.9732	4.4941	PKS 0829+046	LSP	bll	bll	FSRQ
4FGL J0832.4+4912	128.1078	49.2127	OJ 448	LSP	bll	bll	FSRQ
4FGL J0839.4+1803	129.8695	18.0606	TXS 0836+182	LSP	bll	bll	FSRQ
4FGL J0847.9−0702	131.9945	-7.0434	TXS 0845−068	LSP	bll	bll	FSRQ
4FGL J0848.9+0205	132.2375	2.0870	PMN J0849+0206	LSP	bll	bll	FSRQ
4FGL J0854.8+2006	133.7071	20.1159	OJ 287	LSP	bll	bll	FSRQ
4FGL J0901.2+6742	135.3164	67.7129	TXS 0856+679	LSP	bll	bll	FSRQ
4FGL J0925.7+3126	141.4454	31.4470	B2 0922+31B	LSP	bll	bll	FSRQ
4FGL J0929.3+5014	142.3265	50.2352	GB6 J0929+5013	LSP	bll	bll	FSRQ
4FGL J0930.3+8612	142.5994	86.2021	S5 0916+864	LSP	bll	bll	FSRQ
4FGL J0930.7+3502	142.6813	35.0334	B2 0927+35	LSP	bll	bll	FSRQ
4FGL J0942.3−0800	145.5856	-8.0076	PMN J0942−0800	LSP	bll	bll	FSRQ
4FGL J0958.7+6534	149.6897	65.5678	S4 0954+65	LSP	bll	bll	FSRQ
4FGL J1001.1+2911	150.2938	29.1880	GB6 J1001+2911	LSP	bll	bll	FSRQ
4FGL J1008.0+0620	152.0136	6.3475	MG1 J100800+0621	LSP	bll	bll	FSRQ
4FGL J1019.7+6321	154.9263	63.3527	GB6 J1019+6319	LSP	bll	bll	FSRQ
4FGL J1024.8+2332	156.2101	23.5462	MG2 J102456+2332	LSP	bll	bll	FSRQ
4FGL J1058.0+4305	164.5181	43.0938	B3 1055+433	LSP	bll	bll	FSRQ
4FGL J1058.4+0133	164.6240	1.5641	4C +01.28	LSP	bll	bll	FSRQ
4FGL J1058.6−8003	164.6600	-80.0640	PKS 1057−79	LSP	bll	bll	FSRQ
4FGL J1105.8+3944	166.4589	39.7426	GB6 J1105+3946	LSP	bll	bll	FSRQ
4FGL J1128.8+3757	172.2042	37.9657	NVSS J112903+375655	LSP	bll	bll	FSRQ
4FGL J1138.2+4115	174.5711	41.2562	NVSS J113812+411353	LSP	bll	bll	FSRQ
4FGL J1147.0−3812	176.7600	-38.2006	PKS 1144−379	LSP	bll	bll	FSRQ
4FGL J1148.6+1841	177.1542	18.6861	TXS 1146+189	LSP	bll	bll	FSRQ
4FGL J1154.1−3243	178.5423	-32.7189	PKS 1151−324	LSP	bll	bll	FSRQ
4FGL J1201.7+1429	180.4471	14.4852	OM 198	LSP	bll	bll	FSRQ
4FGL J1218.0−0028	184.5136	-0.4832	PKS 1215−002	LSP	bll	bll	FSRQ
4FGL J1218.5−0119	184.6388	-1.3270	PKS 1216−010	LSP	bll	bll	FSRQ
4FGL J1223.8+8039	185.9707	80.6598	S5 1221+80	LSP	bll	bll	FSRQ
4FGL J1224.9+4334	186.2371	43.5691	B3 1222+438	LSP	bll	bll	FSRQ
4FGL J1227.1−4437	186.7859	-44.6274	PKS 1224−443	LSP	bll	bll	FSRQ
4FGL J1239.4+0728	189.8620	7.4709	PKS 1236+077	LSP	bll	bll	FSRQ
4FGL J1250.6+0217	192.6513	2.2876	PKS 1247+025	LSP	bll	bll	FSRQ

Table 14 *continued on next page*

Table 14 *(continued)*

4FGL name	R.A.	Decl.	ASSOC name	SED class	4FGL Class	From class	To class
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
4FGL J1254.9−4426	193.7280	-44.4441	PKS 1252−441	LSP	bll	bll	FSRQ
4FGL J1259.7−3223	194.9449	-32.3898	LEDA 4075145	LSP	bll	bll	FSRQ
4FGL J1302.8+5748	195.7209	57.8146	TXS 1300+580	LSP	bll	bll	FSRQ
4FGL J1303.0+2434	195.7571	24.5821	MG2 J130304+2434	LSP	bll	bll	FSRQ
4FGL J1305.6+7853	196.4126	78.8923	S5 1304+79	LSP	bll	bll	FSRQ
4FGL J1309.7+1153	197.4377	11.8969	4C +12.46	LSP	bll	bll	FSRQ
4FGL J1330.4+3157	202.6002	31.9630	MG2 J132953+3153	LSP	bll	bll	FSRQ
4FGL J1353.0−4413	208.2566	-44.2260	PKS 1349−439	LSP	bll	bll	FSRQ
4FGL J1353.3+1434	208.3355	14.5755	OP 186	LSP	bll	bll	FSRQ
4FGL J1407.6−4301	211.9194	-43.0234	SUMSS J140739−430231	LSP	bll	bll	FSRQ
4FGL J1410.1+0202	212.5287	2.0354	PKS 1407+022	LSP	bll	bll	FSRQ
4FGL J1419.8+5423	214.9550	54.3937	OQ 530	LSP	bll	bll	FSRQ
4FGL J1427.6−3305	216.9130	-33.0940	PKS 1424−328	LSP	bll	bll	FSRQ
4FGL J1439.7+4958	219.9411	49.9775	GB6 J1439+4958	LSP	bll	bll	FSRQ
4FGL J1440.0−1530	220.0072	-15.5154	PKS 1437−153	LSP	bll	bll	FSRQ
4FGL J1445.9−1626	221.4978	-16.4498	PKS B1443−162	LSP	bll	bll	FSRQ
4FGL J1458.6+3722	224.6733	37.3726	B3 1456+375	LSP	bll	bll	FSRQ
4FGL J1500.7+4752	225.1837	47.8716	TXS 1459+480	LSP	bll	bll	FSRQ
4FGL J1505.0−3433	226.2581	-34.5546	PMN J1505−3432	LSP	bll	bll	FSRQ
4FGL J1516.9+1934	229.2442	19.5805	PKS 1514+197	LSP	bll	bll	FSRQ
4FGL J1522.6−2730	230.6642	-27.5059	PKS 1519−273	LSP	bll	bll	FSRQ
4FGL J1536.8−3155	234.2127	-31.9224	PKS 1533−317	LSP	bll	bll	FSRQ
4FGL J1540.7+1449	235.1903	14.8220	4C +14.60	LSP	bll	bll	FSRQ
4FGL J1546.5+1816	236.6338	18.2826	MG1 J154628+1817	LSP	bll	bll	FSRQ
4FGL J1549.6+1710	237.4120	17.1784	MG1 J154930+1708	LSP	bll	bll	FSRQ
4FGL J1553.3+0600	238.3284	6.0127	NVSS J155331+060143	LSP	bll	bll	FSRQ
4FGL J1603.8+1104	240.9601	11.0701	MG1 J160340+1106	LSP	bll	bll	FSRQ
4FGL J1604.7+1734	241.1857	17.5717	NVSS J160436+173324	LSP	bll	bll	FSRQ
4FGL J1607.0+1550	241.7745	15.8447	4C +15.54	LSP	bll	bll	FSRQ
4FGL J1624.6+5651	246.1715	56.8504	SBS 1623+569	LSP	bll	bll	FSRQ
4FGL J1641.9−0621	250.4892	-6.3529	TXS 1639−062	LSP	bll	bll	FSRQ
4FGL J1642.3−8108	250.5855	-81.1375	PKS 1633−810	LSP	bll	bll	FSRQ
4FGL J1701.3+3956	255.3340	39.9406	B3 1659+399	LSP	bll	bll	FSRQ
4FGL J1751.5+0938	267.8776	9.6456	OT 081	LSP	bll	bll	FSRQ
4FGL J1800.6+7828	270.1730	78.4674	S5 1803+784	LSP	bll	bll	FSRQ
4FGL J1806.8+6949	271.7108	69.8270	3C 371	LSP	bll	bll	FSRQ
4FGL J1824.1+5651	276.0393	56.8585	4C +56.27	LSP	bll	bll	FSRQ
4FGL J1830.0−5225	277.5117	-52.4188	SUMSS J183004−522618	LSP	bll	bll	FSRQ
4FGL J1834.7−5858	278.6874	-58.9818	PKS 1830−589	LSP	bll	bll	FSRQ
4FGL J1849.4+2745	282.3543	27.7542	MG2 J184929+2748	LSP	bll	bll	FSRQ

Table 14 *continued on next page*

Table 14 *(continued)*

4FGL name	R.A.	Decl.	ASSOC name	SED class	4FGL Class	From class	To class
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
4FGL J1925.8−2220	291.4665	-22.3410	TXS 1922−224	LSP	bll	bll	FSRQ
4FGL J1927.5+6117	291.8822	61.2940	S4 1926+61	LSP	bll	bll	FSRQ
4FGL J1941.3−6210	295.3468	-62.1753	PKS 1936−623	LSP	bll	bll	FSRQ
4FGL J1954.6−1122	298.6693	-11.3815	TXS 1951−115	LSP	bll	bll	FSRQ
4FGL J2005.5+7752	301.3930	77.8829	S5 2007+77	LSP	bll	bll	FSRQ
4FGL J2010.0+7229	302.5159	72.4874	4C +72.28	LSP	bll	bll	FSRQ
4FGL J2012.2−1646	303.0719	-16.7729	PMN J2012−1646	LSP	bll	bll	FSRQ
4FGL J2015.2−0137	303.8074	-1.6254	PKS 2012−017	LSP	bll	bll	FSRQ
4FGL J2022.5+7612	305.6459	76.2007	S5 2023+760	LSP	bll	bll	FSRQ
4FGL J2032.0+1219	308.0040	12.3279	PKS 2029+121	LSP	bll	bll	FSRQ
4FGL J2049.9+1002	312.4782	10.0407	PKS 2047+098	LSP	bll	bll	FSRQ
4FGL J2050.0+0408	312.5181	4.1401	PKS 2047+039	LSP	bll	bll	FSRQ
4FGL J2056.7−3209	314.1780	-32.1612	PKS 2053−323	LSP	bll	bll	FSRQ
4FGL J2134.2−0154	323.5699	-1.9042	PKS 2131−021	LSP	bll	bll	FSRQ
4FGL J2152.5+1737	328.1370	17.6173	S3 2150+17	LSP	bll	bll	FSRQ
4FGL J2200.3+1029	330.0887	10.4956	TXS 2157+102	LSP	bll	bll	FSRQ
4FGL J2202.7+4216	330.6946	42.2821	BL Lac	LSP	bll	bll	FSRQ
4FGL J2206.8−0032	331.7087	-0.5461	PMN J2206−0031	LSP	bll	bll	FSRQ
4FGL J2216.9+2421	334.2380	24.3575	B2 2214+24B	LSP	bll	bll	FSRQ
4FGL J2224.0−1127	336.0241	-11.4658	PKS 2221−116	LSP	bll	bll	FSRQ
4FGL J2236.2−1706	339.0648	-17.1066	PKS 2233−173	LSP	bll	bll	FSRQ
4FGL J2236.5−1433	339.1444	-14.5557	PKS 2233−148	LSP	bll	bll	FSRQ
4FGL J2243.4−2544	340.8654	-25.7363	PKS 2240−260	LSP	bll	bll	FSRQ
4FGL J2247.4−0001	341.8670	-0.0263	PKS 2244−002	LSP	bll	bll	FSRQ
4FGL J2250.7−2806	342.6903	-28.1114	PMN J2250−2806	LSP	bll	bll	FSRQ
4FGL J2256.6−2011	344.1728	-20.1986	PKS 2254−204	LSP	bll	bll	FSRQ
4FGL J2257.5+0748	344.3874	7.8014	OY 91	LSP	bll	bll	FSRQ
4FGL J2315.6−5018	348.9140	-50.3127	PKS 2312−505	LSP	bll	bll	FSRQ
4FGL J2330.6−3726	352.6603	-37.4346	PKS 2327−376	LSP	bll	bll	FSRQ
4FGL J2346.7+8008	356.6867	80.1366	WN B2344.2+7951	LSP	bll	bll	FSRQ
4FGL J2353.7−3037	358.4321	-30.6219	PKS 2351−309	LSP	bll	bll	FSRQ
4FGL J2357.4−0152	359.3674	-1.8703	PKS 2354−021	LSP	bll	bll	FSRQ
4FGL J0001.2−0747	0.3151	-7.7971	PMN J0001−0746	LSP	bll	bll	UNK
4FGL J0003.2+2207	0.8058	22.1302	2MASX J00032450+2204559	LSP	bll	bll	UNK
4FGL J0022.5+0608	5.6376	6.1343	PKS 0019+058	LSP	bll	bll	UNK
4FGL J0029.0−7044	7.2509	-70.7414	PKS 0026−710	LSP	bll	bll	UNK
4FGL J0032.4−2849	8.1076	-28.8224	PMN J0032−2849	LSP	bll	bll	UNK
4FGL J0124.8−0625	21.2178	-6.4328	PMN J0124−0624	LSP	bll	bll	UNK
4FGL J0142.7−0543	25.6754	-5.7332	PKS 0140−059	LSP	bll	bll	UNK
4FGL J0224.0−7941	36.0056	-79.6934	PMN J0223−7940	LSP	bll	bll	UNK

Table 14 *continued on next page*

Table 14 *(continued)*

4FGL name	R.A.	Decl.	ASSOC name	SED class	4FGL Class	From class	To class
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
4FGL J0241.0−0505	40.2509	-5.0943	PKS 0238−052	LSP	bll	bll	UNK
4FGL J0314.3−5103	48.5929	-51.0550	PMN J0314−5104	LSP	bll	bll	UNK
4FGL J0422.3+1951	65.5868	19.8618	MS 0419.3+1943	LSP	bll	bll	UNK
4FGL J0428.6−3756	67.1730	-37.9403	PKS 0426−380	LSP	bll	bll	UNK
4FGL J0617.2+5701	94.3162	57.0249	87GB 061258.1+570222	LSP	bll	bll	UNK
4FGL J0811.4+0146	122.8610	1.7756	OJ 014	LSP	bll	bll	UNK
4FGL J0817.8−0934	124.4734	-9.5777	TXS 0815−094	LSP	bll	bll	UNK
4FGL J0818.2+4222	124.5572	42.3819	S4 0814+42	LSP	bll	bll	UNK
4FGL J0850.0+4855	132.5083	48.9217	GB6 J0850+4855	LSP	bll	bll	UNK
4FGL J0909.6+0159	137.4222	1.9917	PKS 0907+022	LSP	bll	bll	UNK
4FGL J0934.3+3926	143.5861	39.4365	GB6 J0934+3926	LSP	bll	bll	UNK
4FGL J0941.9+2724	145.4936	27.4136	GB6 J0941+2721	LSP	bll	bll	UNK
4FGL J1018.1+1905	154.5480	19.0963	NVSS J101808+190614	LSP	bll	bll	UNK
4FGL J1129.1+3703	172.2959	37.0644	CRATES J112916+370317	LSP	bll	bll	UNK
4FGL J1143.1+6122	175.7881	61.3801	GB6 J1143+6122	LSP	bll	bll	UNK
4FGL J1153.7+3822	178.4464	38.3684	B3 1151+386	LSP	bll	bll	UNK
4FGL J1223.3+1213	185.8415	12.2312	MG1 J122332+1208	LSP	bll	bll	UNK
4FGL J1226.8−1329	186.7188	-13.4940	PMN J1226−1328	LSP	bll	bll	UNK
4FGL J1238.3−1959	189.5936	-19.9945	PMN J1238−1959	LSP	bll	bll	UNK
4FGL J1259.1−2311	194.7798	-23.1925	PKS B1256−229	LSP	bll	bll	UNK
4FGL J1304.0+3704	196.0075	37.0710	WISE J130407.31+370908.1	LSP	bll	bll	UNK
4FGL J1311.8+3954	197.9598	39.9010	FIRST J131146.0+395317	LSP	bll	bll	UNK
4FGL J1331.2−1325	202.8192	-13.4282	PMN J1331−1326	LSP	bll	bll	UNK
4FGL J1424.2+0433	216.0508	4.5628	TXS 1421+048	LSP	bll	bll	UNK
4FGL J1431.1−3120	217.7962	-31.3468	PKS 1428−311	LSP	bll	bll	UNK
4FGL J1451.4+6355	222.8554	63.9172	RX J1451.4+6354	LSP	bll	bll	UNK
4FGL J1455.0+0247	223.7616	2.7958	87GB 145233.9+030210	LSP	bll	bll	UNK
4FGL J1456.0+5051	224.0181	50.8500	RGB J1456+508	LSP	bll	bll	UNK
4FGL J1516.8+3651	229.2217	36.8505	MG2 J151646+3650	LSP	bll	bll	UNK
4FGL J1539.9+4220	234.9771	42.3381	87GB 153741.6+422719	LSP	bll	bll	UNK
4FGL J1549.3+6310	237.3324	63.1780	WN B1549+6319	LSP	bll	bll	UNK
4FGL J1558.8+5625	239.7179	56.4268	TXS 1557+565	LSP	bll	bll	UNK
4FGL J1616.7+4107	244.1821	41.1234	B3 1615+412	LSP	bll	bll	UNK
4FGL J1643.0−7714	250.7719	-77.2488	PKS 1636−77	LSP	bll	bll	UNK
4FGL J1643.0+3223	250.7585	32.3982	NVSS J164301+322104	LSP	bll	bll	UNK
4FGL J1647.5+4950	251.8923	49.8336	SBS 1646+499	LSP	bll	bll	UNK
4FGL J1704.2+1234	256.0599	12.5752	NVSS J170409+123421	LSP	bll	bll	UNK
4FGL J1719.2+1745	259.8062	17.7533	PKS 1717+177	LSP	bll	bll	UNK
4FGL J1745.4−0753	266.3636	-7.8894	TXS 1742−078	LSP	bll	bll	UNK
4FGL J1749.0+4321	267.2554	43.3616	B3 1747+433	LSP	bll	bll	UNK

Table 14 *continued on next page*

Table 14 *(continued)*

4FGL name	R.A.	Decl.	ASSOC name	SED class	4FGL Class	From class	To class
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
4FGL J1813.6+0614	273.4084	6.2408	TXS 1811+062	LSP	bll	bll	UNK
4FGL J1849.4−4313	282.3623	-43.2214	PMN J1849−4314	LSP	bll	bll	UNK
4FGL J1858.3+4321	284.5967	43.3590	NVSS J185813+432452	LSP	bll	bll	UNK
4FGL J2017.5−3753	304.3957	-37.8970	PKS 2014−380	LSP	bll	bll	UNK
4FGL J2039.0−1046	309.7581	-10.7731	TXS 2036−109	LSP	bll	bll	UNK
4FGL J2115.9−0113	318.9959	-1.2306	NVSS J211603−010828	LSP	bll	bll	UNK
4FGL J2225.5−1114	336.3957	-11.2422	PKS 2223−114	LSP	bll	bll	UNK
4FGL J2241.2+4120	340.3087	41.3396	B3 2238+410	LSP	bll	bll	UNK
4FGL J2307.6+1451	346.9222	14.8644	MG1 J230734+1449	LSP	bll	bll	UNK
4FGL J2311.0+0205	347.7661	2.0995	NVSS J231101+020504	LSP	bll	bll	UNK

NOTE—The 4FGL name are presented in Column 1. Columns 2 and 3 are the J2000 coordinates. The counterpart names are listed in Column 4. Column 5 and 6 lists the spectral energy distribution (SED) class and the optical class reported in 4FGL catalog, respectively. The based optical class (From class) in **Kang et al. 2023** listed in Columns 7. The predictions in Kang et al. 2023 are presented in Columns 8, where, UNK indicate the sources without a clear prediction.

4.5. *The predictions in Zhang et al. (2022)*

In Zhang et al. (2022), they obtained a boundary dividing line for separating the BL Lacs and the FSRQs based on the ratio of the broad line region (BLR) luminosity to the Eddington luminosity. on the basis of the a boundary of log $(L_{BLR}/L_{Edd}) = 3.14$, they predicted 46 candidates for changing-look blazars due to BL Lacs divided as FSRQs or FSRQs divided as BL Lacs **(a portion of the words or sentences are copied from Zhang et al. 2022)** that are listed in Table 15.

Table 15. The predictions in Zhang et al. (2022)

4FGL name	R.A.	Decl.	ASSOC name	SED class	4FGL Class	Change class
(1)	(2)	(3)	(4)	(5)	(6)	(7)
4FGL J0114.8+1326	18.712	13.434	GB6 J0114+1325	ISP	bll	CB−CF−C
4FGL J0203.7+3042	30.933	30.714	NVSS J020344+304238	LSP	bll	CB−CF−C
4FGL J0325.5−5635	51.379	-56.591	1RXS J032521.8−563543	HSP	bll	CB−CF
4FGL J0334.2−4008	53.557	-40.145	PKS 0332−403	LSP	bll	CB−CF
4FGL J0407.5+0741	61.892	7.700	TXS 0404+075	LSP	bll	CB−CF−C
4FGL J0428.6−3756	67.173	-37.940	PKS 0426−380	LSP	bll	CB−CF
4FGL J0430.3−2507	67.575	-25.128	PMN J0430−2507	ISP	bll	CB−CF
4FGL J0433.1+3227	68.290	32.461	NVSS J043307+322840	HSP	bll	CB−CF−C
4FGL J0434.1−2014	68.529	-20.244	TXS 0431−203	ISP	bll	CB−CF/C
4FGL J0438.9−4521	69.745	-45.358	PKS 0437−454	LSP	bll	CB−CF
4FGL J0516.7−6207	79.180	-62.125	PKS 0516−621	LSP	bll	CB−CF
4FGL J0538.8−4405	84.709	-44.086	PKS 0537−441	LSP	bll	CB−CF
4FGL J0629.3−1959	97.348	-20.000	PKS 0627−199	LSP	bll	CB−CF
4FGL J0644.6+6039	101.162	60.656	NVSS J064435+603849	ISP	bll	CB−CF
4FGL J0747.2+4529	116.822	45.499	NVSS J074654+453231	ISP	bcu	CB−CF

Table 15 *continued on next page*

Table 15 *(continued)*

4FGL name (1)	R.A. (2)	Decl. (3)	ASSOC name (4)	SED class (5)	4FGL Class (6)	Change class (7)
4FGL J0749.7+7450	117.431	74.846	RX J0749.4+7451	ISP	bll	CB−CF
4FGL J0811.4+0146	122.861	1.776	OJ 014	LSP	bll	CB−CF
4FGL J0833.9+4223	128.476	42.399	OJ 451	LSP	fsrq	CF−CB
4FGL J0854.8+2006	133.707	20.116	OJ 287	LSP	bll	CB−CF
4FGL J0856.8+2056	134.200	20.946	TXS 0853+211	ISP	bll	CB−CF
4FGL J1001.1+2911	150.294	29.188	GB6 J1001+2911	LSP	bll	CB−CF
4FGL J1015.0+4926	153.768	49.434	1H 1013+498	HSP	bll	CB−CF/C
4FGL J1022.4−4231	155.622	-42.524	PMN J1022−4232	LSP	bll	CB−CF
4FGL J1037.4−2933	159.356	-29.557	PKS 1034−293	LSP	fsrq	CF−CB
4FGL J1048.0−1912	162.004	-19.212	PKS 1045−18	LSP	fsrq	CF−CB
4FGL J1058.4+0133	164.624	1.564	4C +01.28	LSP	bll	CB−CF−C
4FGL J1125.9+2005	171.491	20.091	4C +20.25	LSP	fsrq	CF−CB
4FGL J1132.7+0034	173.196	0.574	PKS B1130+008	ISP	bll	CB−CF
4FGL J1224.9+4334	186.237	43.569	B3 1222+438	LSP	bll	CB−CF
4FGL J1440.0−1530	220.007	-15.515	PKS 1437−153	LSP	bll	CB−CF
4FGL J1509.7+5556	227.441	55.942	SBS 1508+561	ISP	bll	CB−CF
4FGL J1512.2+0202	228.070	2.040	PKS 1509+022	LSP	fsrq	CF−CB
4FGL J1615.6+4712	243.922	47.203	B3 1614+473	ISP	fsrq	CF−CB
4FGL J1616.7+4107	244.182	41.123	B3 1615+412	LSP	bll	CB−CF
4FGL J1751.5+0938	267.878	9.646	OT 081	LSP	bll	CB−CF
4FGL J1754.5−6425	268.639	-64.418	PMN J1754−6423		bll	CB−CF
4FGL J1800.6+7828	270.173	78.467	S5 1803+784	LSP	bll	CB−CF
4FGL J1811.3+0340	272.826	3.679	NVSS J181118+034113	HSP	bll	CB−CF
4FGL J1924.8−2914	291.214	-29.247	PKS B1921−293	LSP	fsrq	CF−CB
4FGL J2032.0+1219	308.004	12.328	PKS 2029+121	LSP	bll	CB−CF
4FGL J2152.5+1737	328.137	17.617	S3 2150+17	LSP	bll	CB−CF
4FGL J2206.8−0032	331.709	-0.546	PMN J2206−0031	LSP	bll	CB−CF
4FGL J2243.7−1231	340.927	-12.526	RBS 1888		bll	CB−CF
4FGL J2247.4−0001	341.867	-0.026	PKS 2244−002	LSP	bll	CB−CF
4FGL J2315.6−5018	348.914	-50.313	PKS 2312−505	LSP	bll	CB−CF
4FGL J2353.7−3037	358.432	-30.622	PKS 2351−309	LSP	bll	CB−CF

Note—The 4FGL name are presented in Column 1. Columns 2 and 3 are the J2000 coordinates. The counterpart names are listed in Column 4. Column 6 lists the optical class, column 5 is the spectral energy distribution (SED) class reported in 4FGL catalog, respectively. The class before and after the predictions (transition) in Zhang et al. (2022) are presented in Columns 7.

5. THE PRELIMINARY RESULTS

5.1. *The Preliminary Results of the CLBs*

5.2. *The Preliminary Results of the predictions*

5.3. *The Preliminary Results of the CLBs + predictions*

Based on the 4FGL catalogs (4LAC-DR2, Lott et al. 2020 and the 4FGL-DR2 Ballet et al. 2020), and Paliya's Blazars Sample (Paliya et al. 2021), we complied a sample of 2052 sources (includes 1308 BL Lacs and 744 FSRQs) with the gamma-ray photon spectral index ($\Gamma_{\rm ph}$), the spectral slope (α at E_0, photon index at Pivot Energy when fitting with LogParabola), the hardness ratios $\rm HR_{34}$ (3: 300MeV − 1GeV; and 4: 1 − 3GeV), the hardness ratios $\rm HR_{45}$ (4: 1 − 3GeV; 5: 3 − 10GeV), the Pivot Energy (E_{pivot}, MeV, Energy at which error on differential flux is minimal), the Redshift (z), the black hole mass (M_{BH}), the accretion disk luminosity (L_{disk}) in the Eddington units ($\eta = L_{disk}/L_{Edd}$), and Compton dominance (CD; the ratio of the inverse Compton to synchrotron peak luminosities). Which are listed in Table 16. **The Preliminary Results (Kang et al., in preparation).**

Table 16. The number of sources

	CLBs			predictions			CLBs+predictions		
Parameter	$N_{\rm CLBs}$	$N_{\rm BLLacs}$	$N_{\rm FSRQs}$	$N_{\rm CLBs}$	$N_{\rm BLLacs}$	$N_{\rm FSRQs}$	$N_{\rm CLBs}$	$N_{\rm BLLacs}$	$N_{\rm FSRQs}$
$\Gamma_{\rm ph}$	106	1248	699	233	1085	744	296	1058	699
α	106	1248	699	233	1085	744	296	1058	699
$\rm HR_{34}$	106	1248	699	233	1085	744	296	1058	699
$\rm HR_{45}$	106	1248	699	233	1085	744	296	1058	699
E_{pivot}	106	1248	699	233	1085	744	296	1058	699
z	106	729	696	124	662	741	194	637	696
CD	96	298	521	53	298	564	114	280	521
η	96	298	521	53	298	564	114	280	521
M_{BH}	96	298	521	53	298	564	114	280	521

NOTE—The Column 1 lists the selected parameters. The number of CLBs, BL Lacs and FSRQs used in Figure 2-14 for the Changing-Look (Transition) Blazars reported in the literatures, the predicted candidates of CLB, all the CLB type sources (CLBs + predictions) are listed Column 2,3,4; Column 5,6,7; and Column 8,9,10, respectively.

Cross-matching the CLBsCat (https://github.com/ksj7924/CLBCat/), there are 106 common sources for the 154 records of CLBs with the 2052 sources, 223 common sources for the 297 records of predictions CLBs with the 2052 sources, and 296 common sources for the 456 records of all CLB type sources (CLBs + predictions) with the 2052 sources.

In Figure 2-14, the density distributions of the $\Gamma_{\rm ph}$, α, $\rm HR_{34}$, $\rm HR_{45}$, z, L_{disk}/L_{Edd}, CD, $M_{\rm BH}$, and Pivot Energy are shown respectively. Where the black dotted lines, red dashed lines, and green solid lines indicate the BL Lacs, FSRQs and **CLBs** respectively. The Changing-Look (Transition) Blazars, the predicted candidates of CLB and all the CLBs (CLBs + predictions) are shown in the upper panels, middle panels and lower panels respectively.

Comparing the density distributions of CLBs with the BL Lacs and the FSRQs in Figure 2-14, we note that the median and mean for the $\Gamma_{\rm ph}$, α, z, logCD, and logη of CLBs are greater than that of the BL Lacs, and are less than that of FSRQs respectively (see Table 17). Meanwhile, the median and mean for the $\rm HR_{34}$, $\rm HR_{45}$, and logE_{pivot} of CLBs are less than that of the BL Lacs, and are greater than that of FSRQs respectively (see Table 17). The median and mean of these parameters for the CLBs are are located between that of FSRQs and that of BL Lacs. The preliminary results indicate that the CLBs are in an intermediate transition state between the FSRQs and the BL Lacs **(Kang et al., in preparation)**. Which would influence the study of different properties between BL Lacs and FSRQs, especially regarding the role of CLB sources in the evolution of blazar sequences, or their redshift evolution, etc.

However, the median and mean of the black hole mass (logM_{BH}) are overlapping and cannot be distinguished (see Figure 14). Whether it is similar to or related to the transition of the accretion mode of the central engine, or other related physical changes, requires further in-depth study. It will be of great significance to understand the evolution of blazars and other blazar jets physics. **The Preliminary Results of the CLBs (Kang et al., in preparation).**

Table 17. The median and mean of the parameters for CLBs, BL Lacs, FSRQs

	BL Lacs		CLBs		FSRQ		
Parameters	mean	median	mean	median	mean	median	trends
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Gamma_{\rm ph}$	2.026	2.015	2.272	2.269	2.485	2.469	↑
α	1.929	1.938	2.207	2.218	2.410	2.398	↑
$\rm HR_{34}$	0.065	0.032	-0.113	-0.119	-0.252	-0.249	↓
$\rm HR_{45}$	0.031	0.035	-0.187	-0.183	-0.345	-0.341	↓
$\log E_{pivot}$	3.404	3.399	3.064	2.999	2.903	2.879	↓
z	0.409	0.311	0.882	0.784	1.205	1.122	↑
logCD	-0.478	-0.481	0.197	0.165	0.546	0.530	↑
$\log\eta$	-3.688	-3.063	-1.652	-1.583	-0.910.	-0.863	↑
$\log M_{BH}$	8.783	8.780	8.423	8.495	8.556	8.570	↘↗

Note: Column 1 presents the parameters. Column 2 and 3 list the mean and median of BL Lacs; Column 4 and 5 list the mean and median of CLBs; Column 6 and 7 list the mean and median of FSRQs, respectively. The arrows are used to demonstrate trends of mean and median from BL Lacs, to CLBs, to FSRQs shown in Column 8.

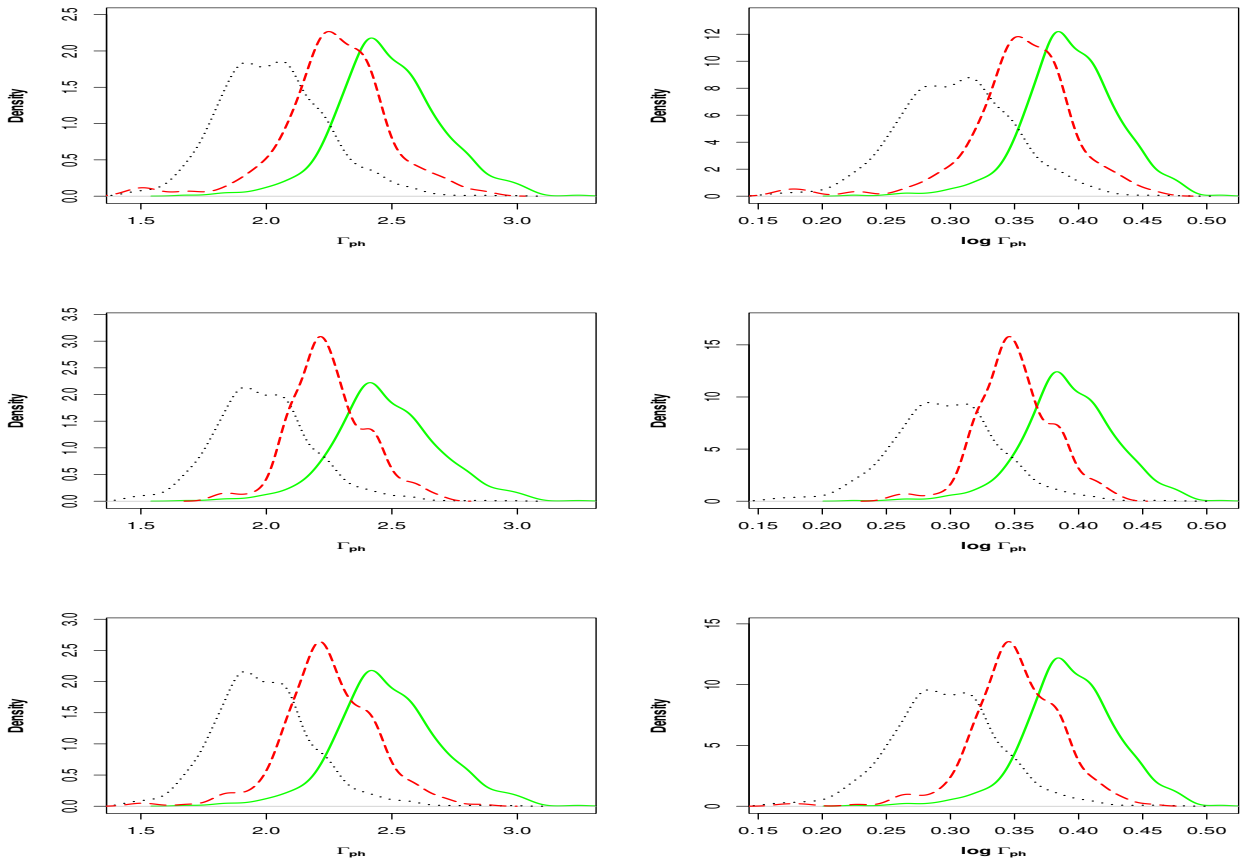

Figure 2. The density distributions of the gamma-ray photon spectral index ($\Gamma_{\rm ph}$), where the black dotted lines, red dashed lines, and green solid lines indicate the BL Lacs, FSRQs and **CLBs** respectively. The Changing-Look Blazars and Transition Blazars, the predicted candidates of CLB and all the CLBs (CLBs + predictions) are shown in the upper panels, middle panels and lower panels respectively.

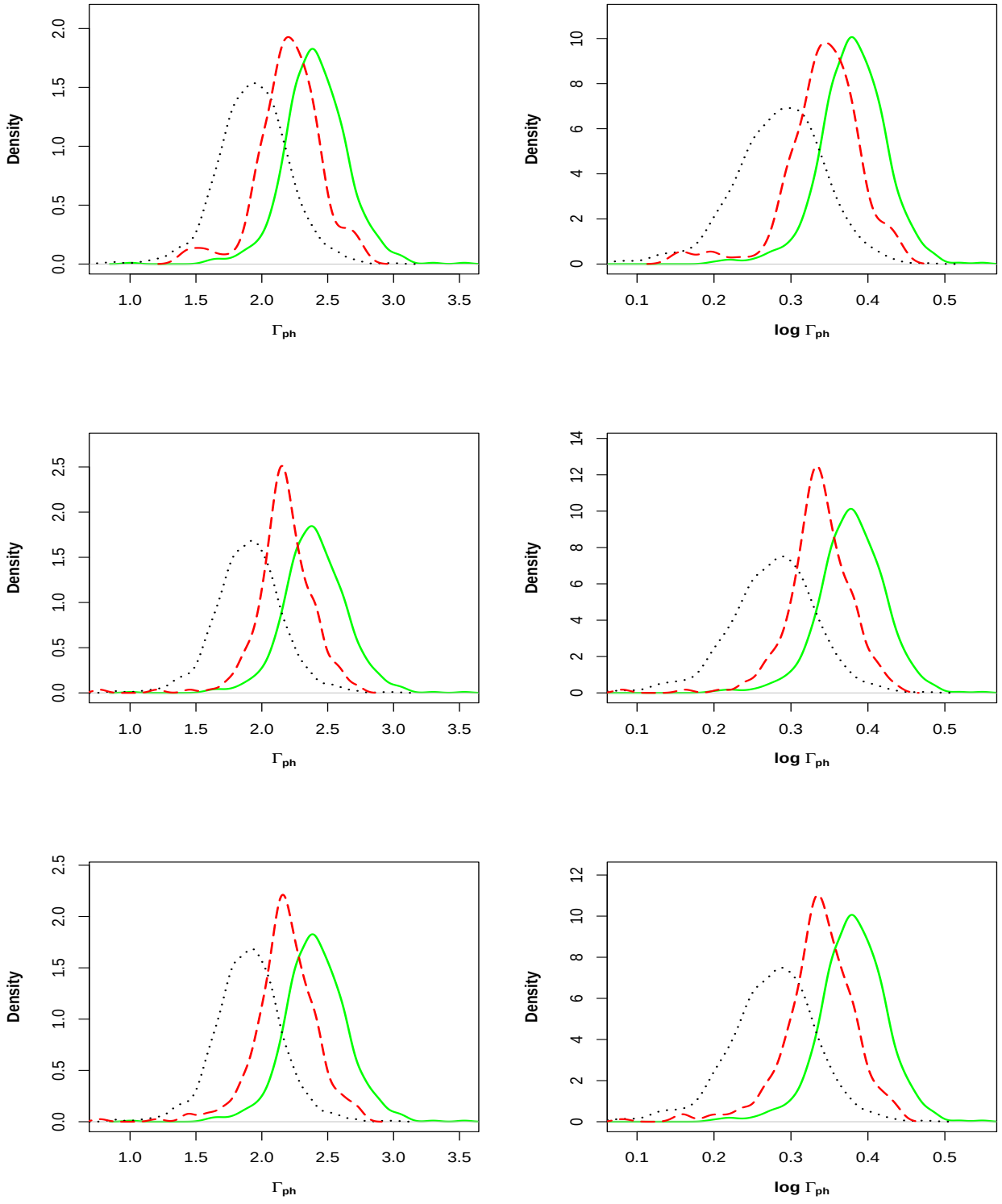

Figure 3. The density distributions of the spectral slope (α at E_0, photon index at Pivot Energy when fitting with LogParabola), where the black dotted lines, red dashed lines, and green solid lines indicate the BL Lacs, FSRQs and **CLBs** respectively. The Changing-Look Blazars and Transition Blazars, the predicted candidates of CLB and all the CLBs (CLBs + predictions) are shown in the upper panels, middle panels and lower panels respectively.

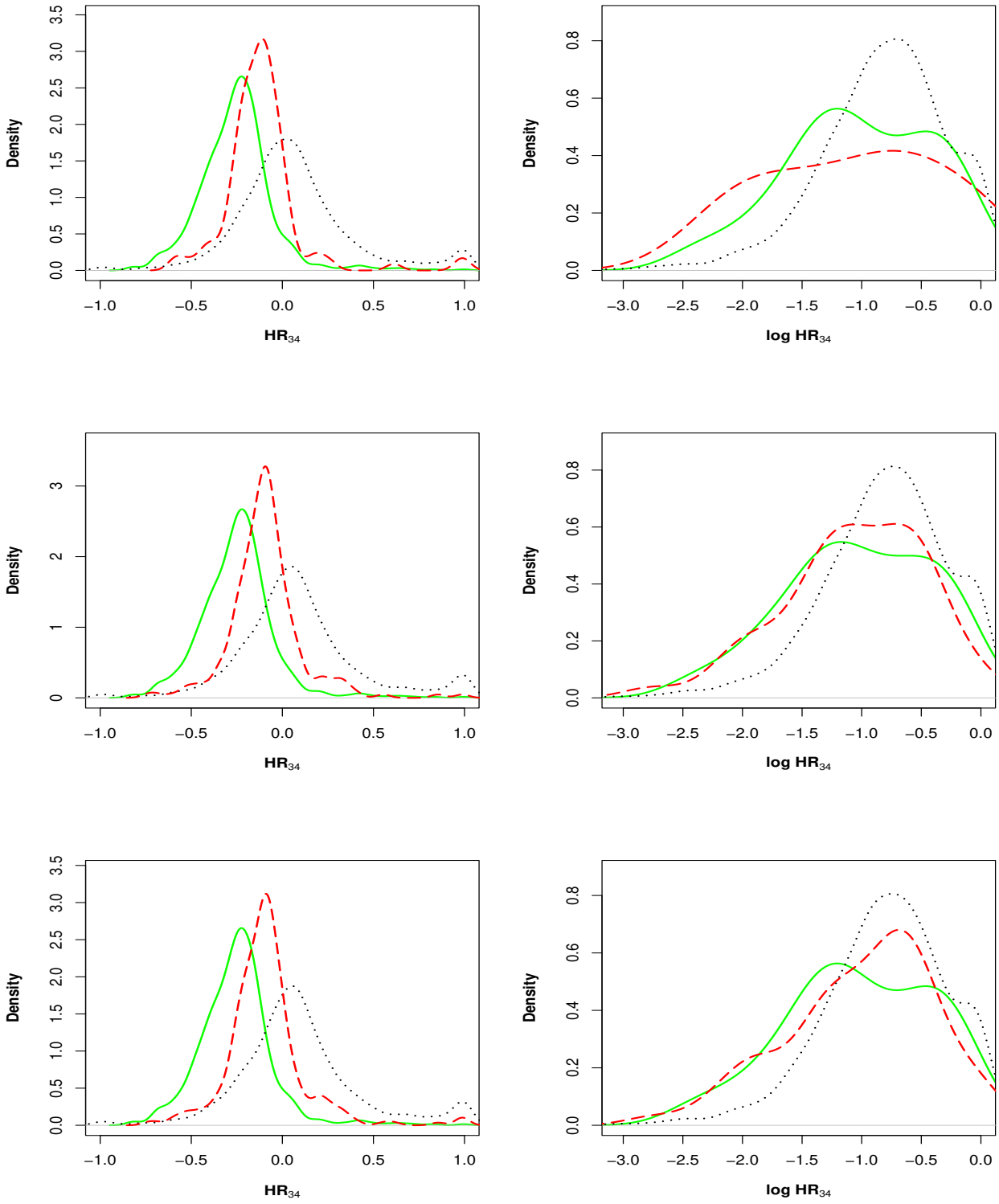

Figure 4. The density distributions of the hardness ratios HR_{34} (3: 300MeV − 1GeV; and 4: 1 − 3GeV), where the black dotted lines, red dashed lines, and green solid lines indicate the BL Lacs, FSRQs and **CLBs** respectively. The Changing-Look Blazars and Transition Blazars, the predicted candidates of CLB and all the CLBs (CLBs + predictions) are shown in the upper panels, middle panels and lower panels respectively.

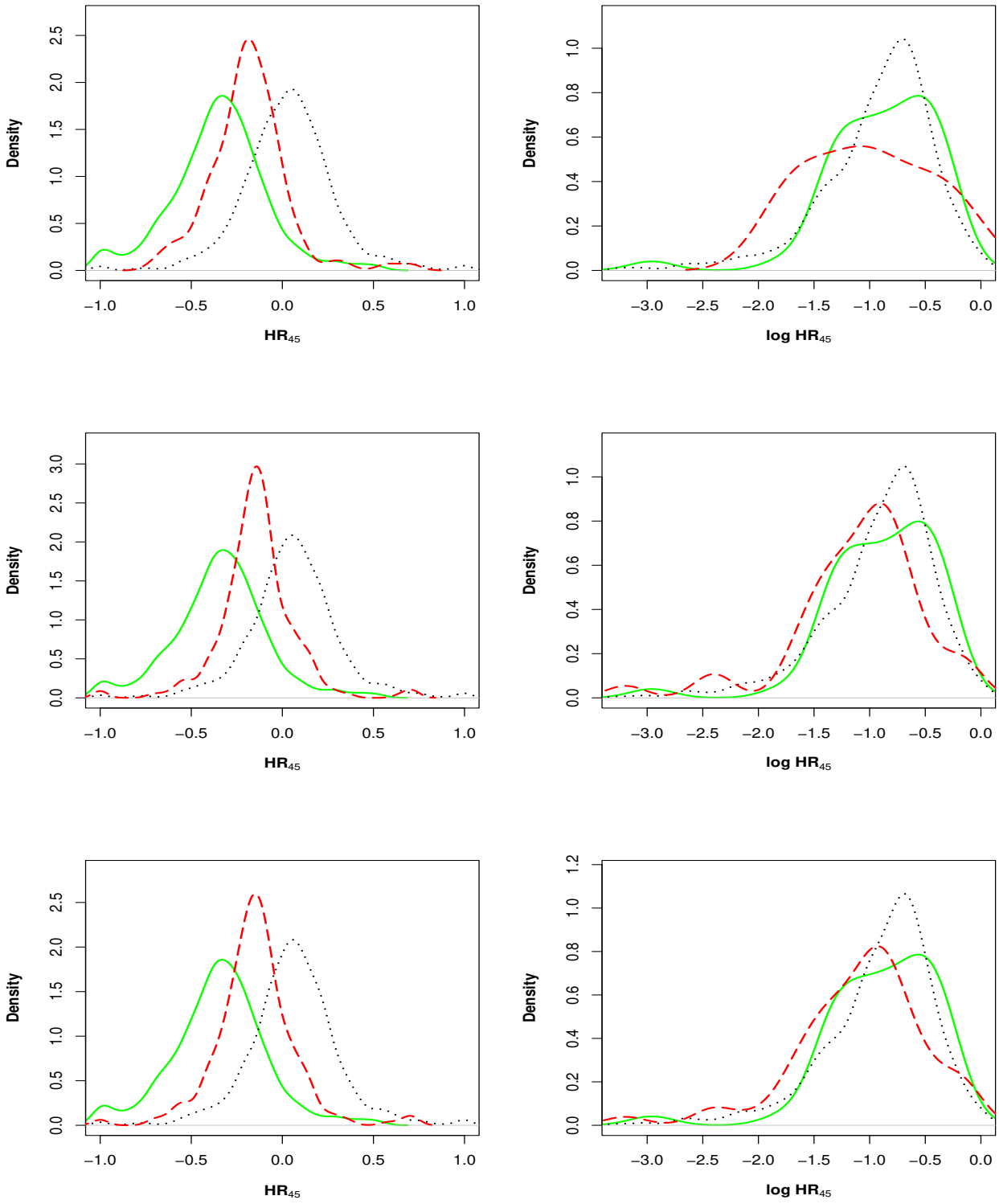

Figure 5. The density distributions of the hardness ratios HR_{45} (4: 1 − 3GeV; 5: 3 − 10GeV), where the black dotted lines, red dashed lines, and green solid lines indicate the BL Lacs, FSRQs and **CLBs** respectively. The Changing-Look Blazars and Transition Blazars, the predicted candidates of CLB and all the CLBs (CLBs + predictions) are shown in the upper panels, middle panels and lower panels respectively.

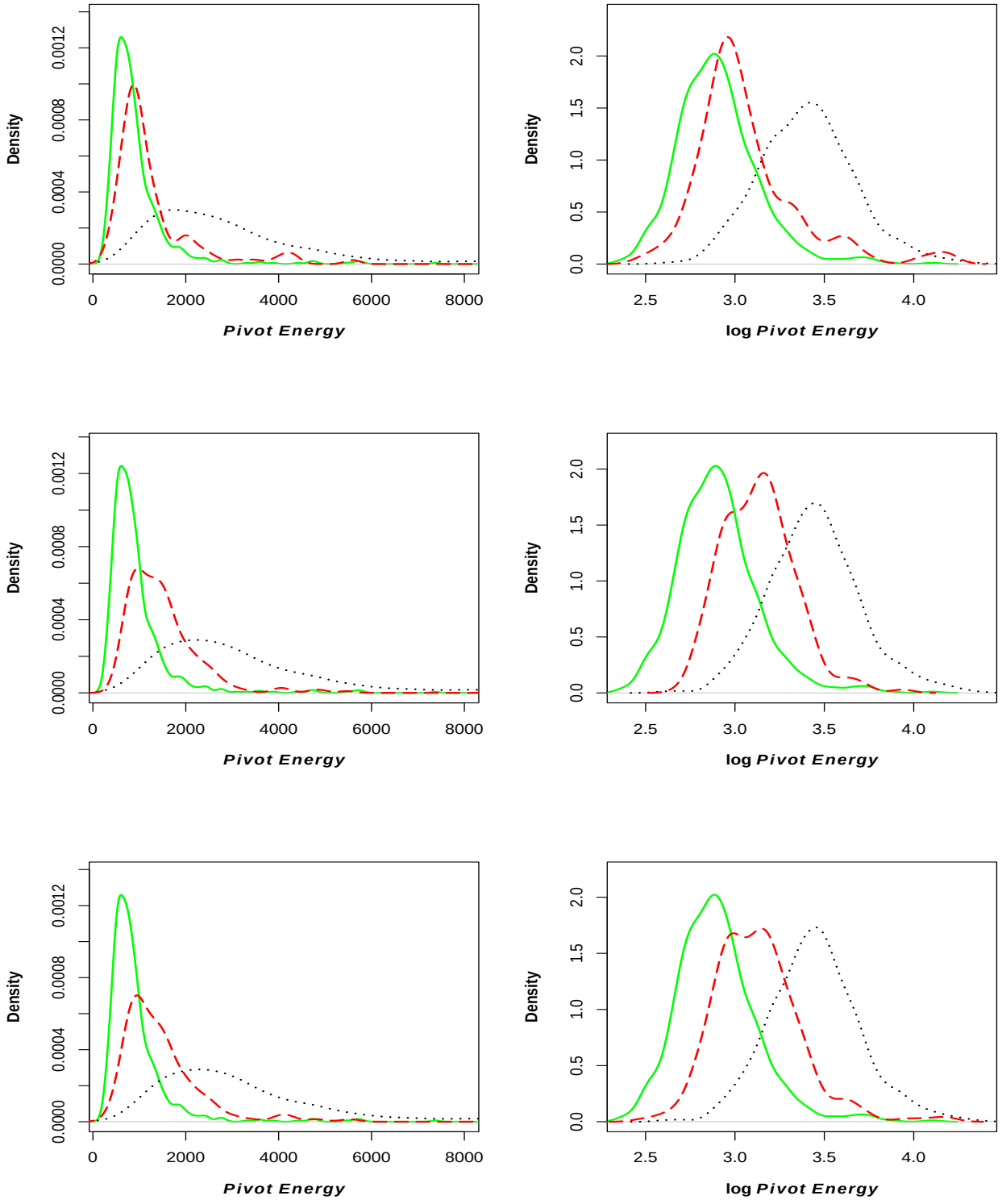

Figure 6. The density distributions of the Pivot Energy (MeV, Energy at which error on differential flux is minimal), where the black dotted lines, red dashed lines, and green solid lines indicate the BL Lacs, FSRQs and **CLBs** respectively. The Changing-Look Blazars and Transition Blazars, the predicted candidates of CLB and all the CLBs (CLBs + predictions) are shown in the upper panels, middle panels and lower panels respectively.

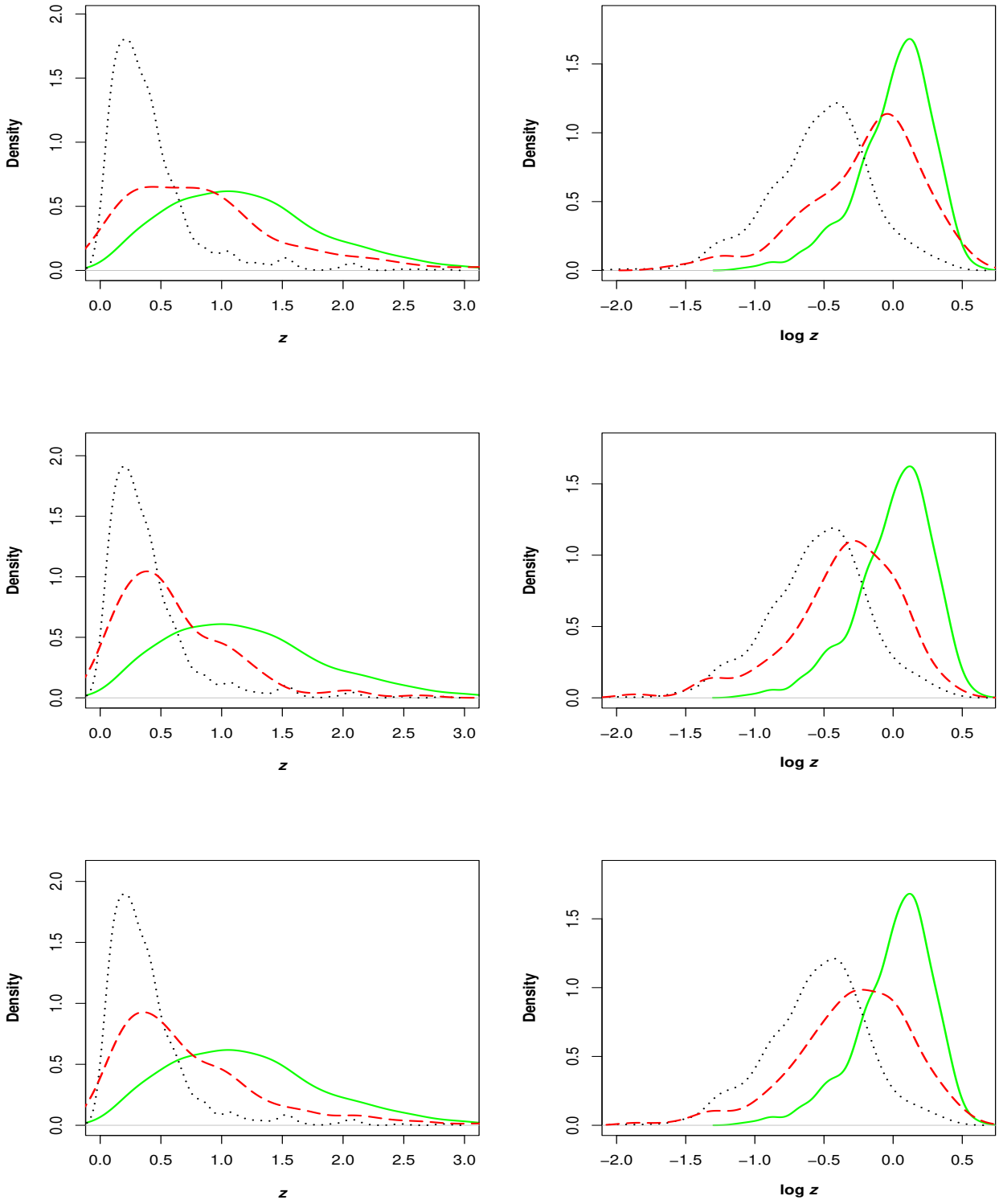

Figure 7. The density distributions of the Redshift (z), where the black dotted lines, red dashed lines, and green solid lines indicate the BL Lacs, FSRQs and **CLBs** respectively. The Changing-Look Blazars and Transition Blazars, the predicted candidates of CLB and all the CLBs (CLBs + predictions) are shown in the upper panels, middle panels and lower panels respectively.

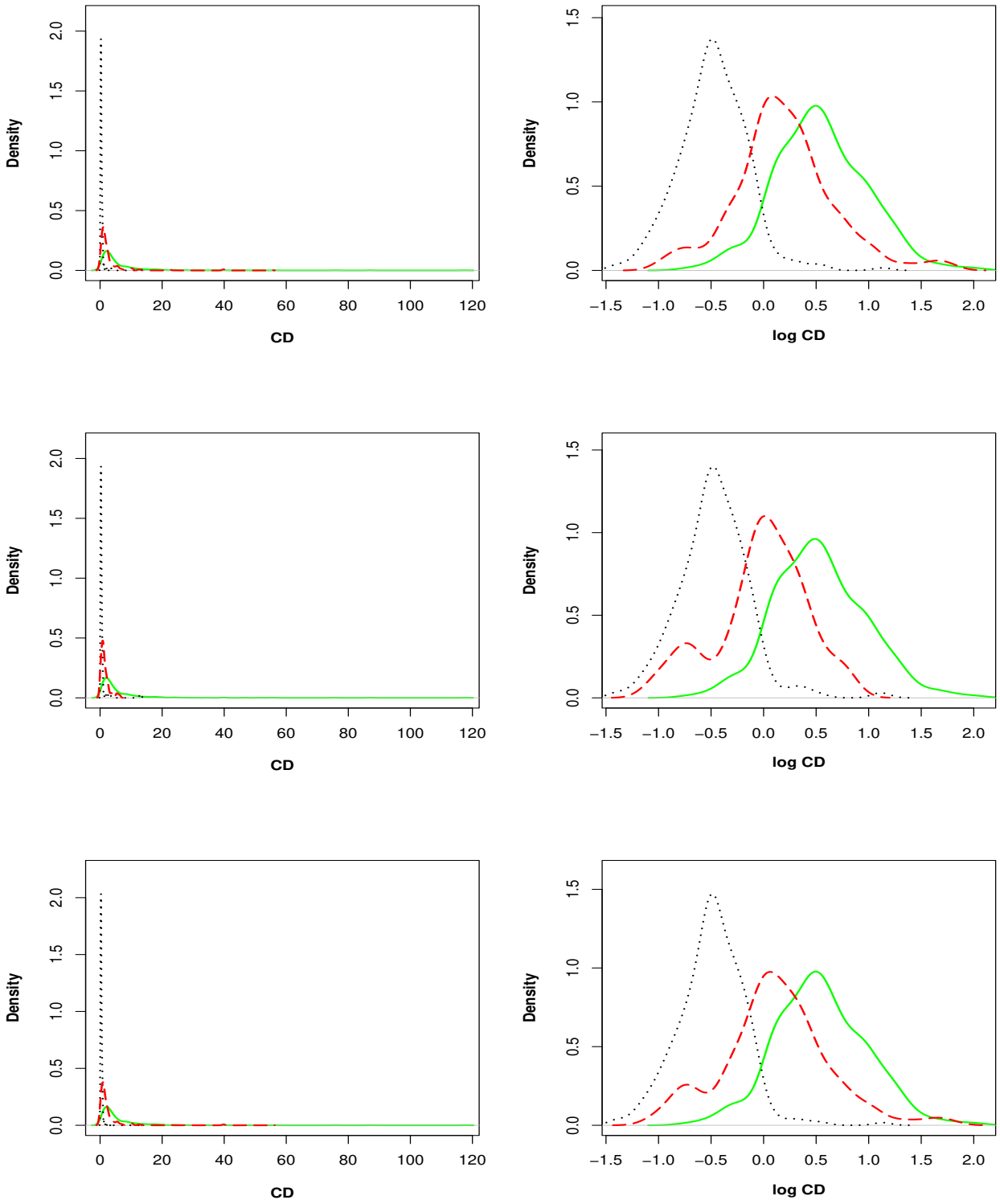

Figure 8. The density distributions of the Compton dominance (CD; the ratio of the inverse Compton to synchrotron peak luminosities), where the black dotted lines, red dashed lines, and green solid lines indicate the BL Lacs, FSRQs and **CLBs** respectively. The Changing-Look Blazars and Transition Blazars, the predicted candidates of CLB and all the CLBs (CLBs + predictions) are shown in the upper panels, middle panels and lower panels respectively.

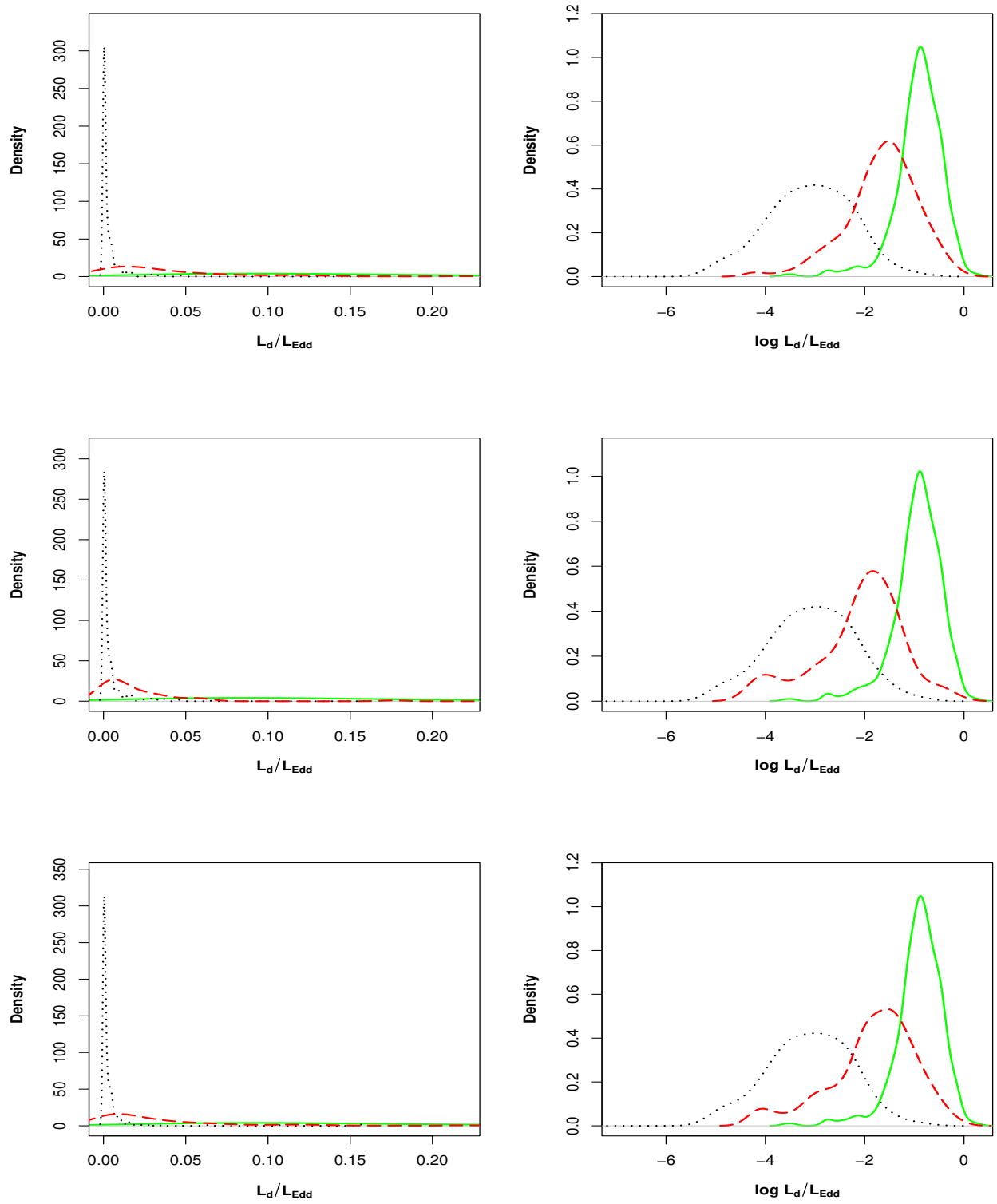

Figure 9. The density distributions of the accretion disk luminosity (L_{disk}) in the Eddington units ($L_{disk}L_{Edd}$), where the black dotted lines, red dashed lines, and green solid lines indicate the BL Lacs, FSRQs and **CLBs** respectively. The Changing-Look Blazars and Transition Blazars, the predicted candidates of CLB and all the CLBs (CLBs + predictions) are shown in the upper panels, middle panels and lower panels respectively.

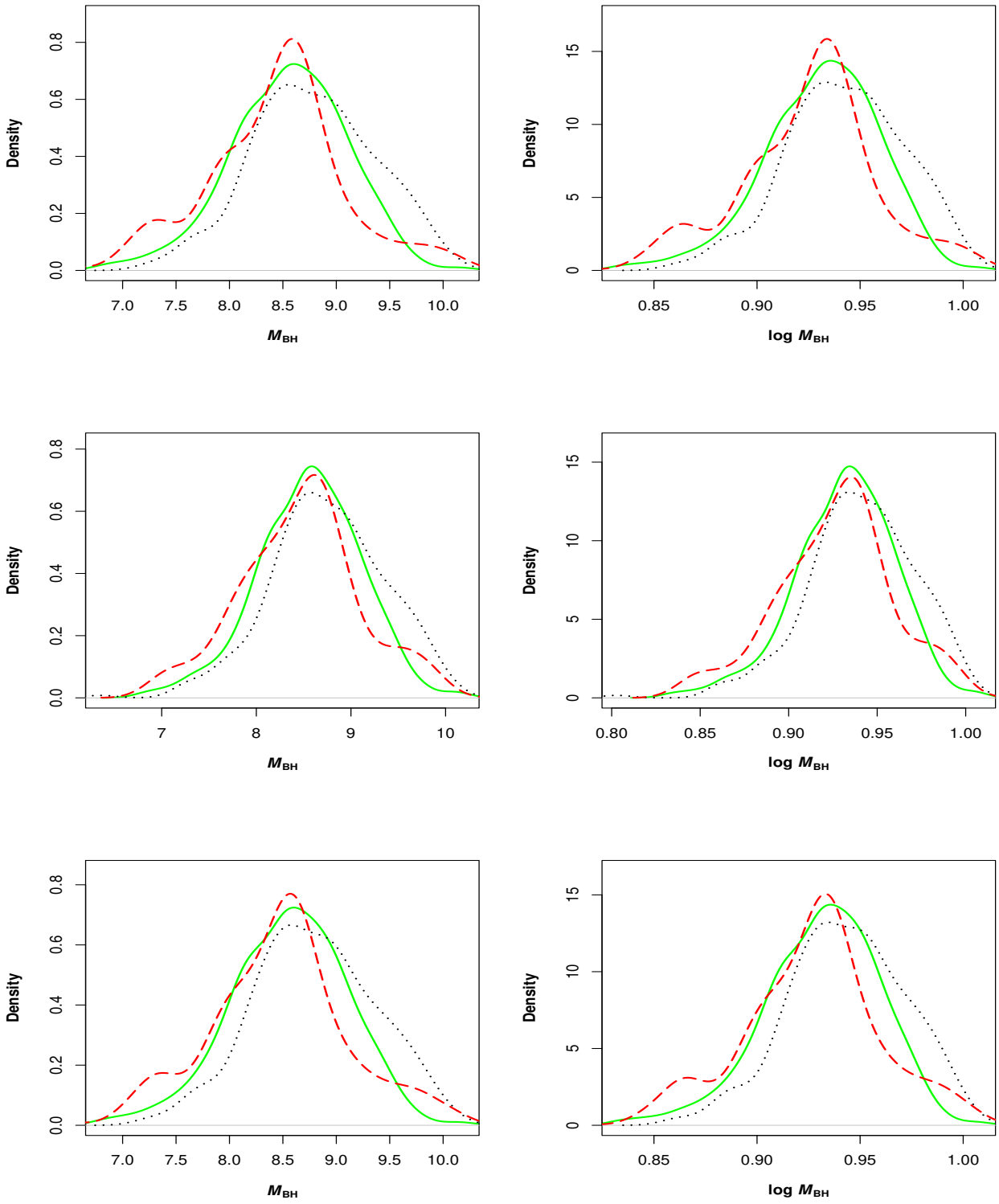

Figure 10. The density distributions of the black hole mass ($M_{\rm BH}$), where the black dotted lines, red dashed lines, and green solid lines indicate the BL Lacs, FSRQs and **CLBs** respectively. The Changing-Look Blazars and Transition Blazars, the predicted candidates of CLB and all the CLBs (CLBs + predictions) are shown in the upper panels, middle panels and lower panels respectively.

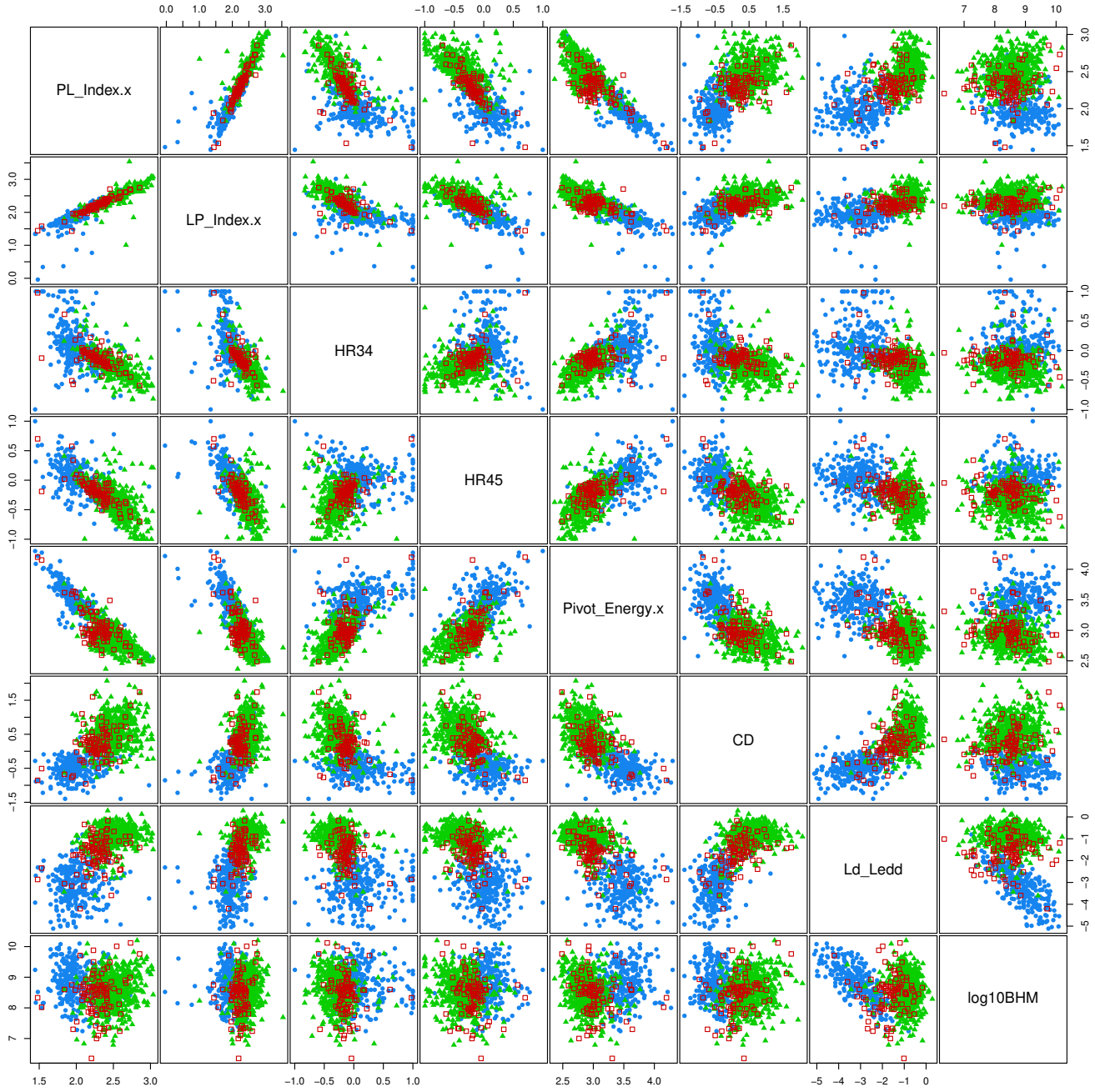

Figure 11. Scatterplots of the $\Gamma_{\rm ph}$, α, $\rm HR_{34}$, $\rm HR_{45}$, $\log E_{pivot}$ z, L_{disk}/L_{Edd}, CD, and $M_{\rm BH}$ for the CLBs, BL Lacs and FSRQs. where red empty squares represent the CLBs : Changing-Look (Transition) Blazars, and blue solid points represent BL Lacs, and green empty triangles represent FSRQs. where the green empty triangles, and blue solid circles, and red empty squares indicate FSRQs, BL Lacs and Changing-Look (Transition) Blazars respectively.

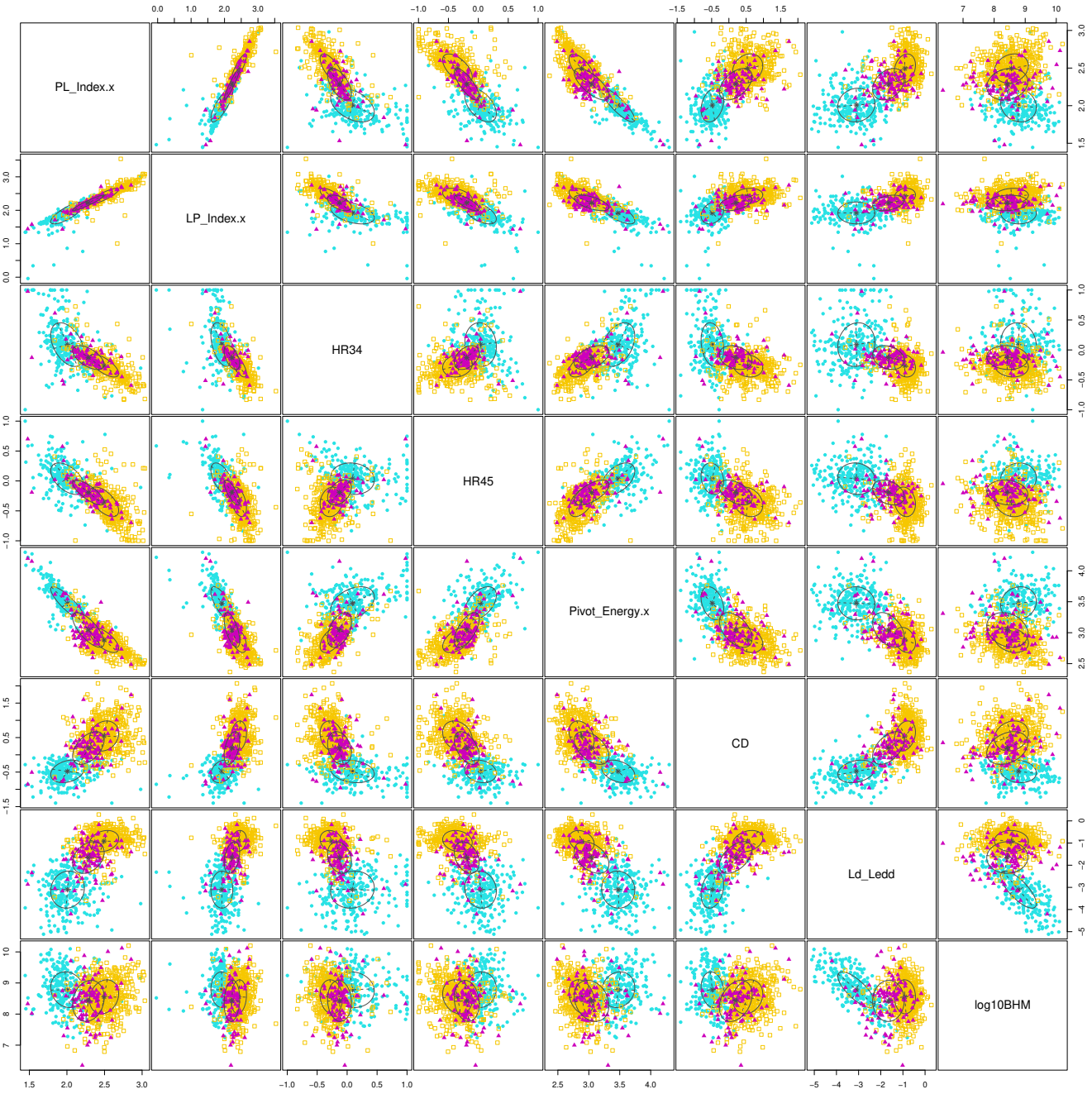

Figure 12. Scatterplots of the $\Gamma_{\rm ph}$, α, HR_{34}, HR_{45}, $\log E_{pivot}$ z, L_{disk}/L_{Edd}, CD, and $M_{\rm BH}$ for the CLBs, BL Lacs and FSRQs. where red empty squares represent the CLBs : Changing-Look (Transition) Blazars, and blue solid points represent BL Lacs, and green empty triangles represent FSRQs. where the green empty triangles, and blue solid circles, and red empty squares indicate FSRQs, BL Lacs and Changing-Look (Transition) Blazars respectively.

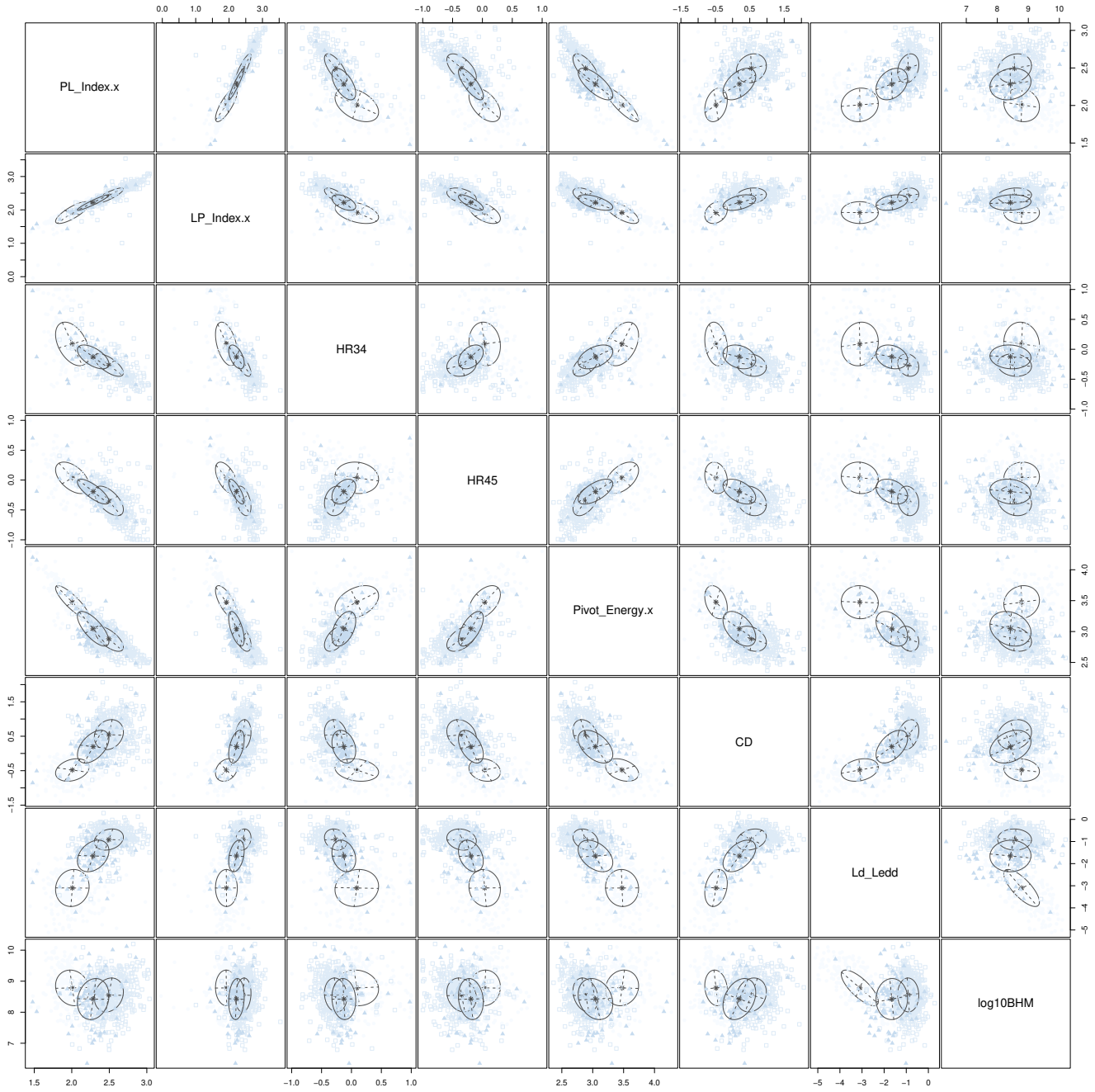

Figure 13. Scatterplots of the $\Gamma_{\rm ph}$, α, $\rm HR_{34}$, $\rm HR_{45}$, $\log E_{pivot}$ z, L_{disk}/L_{Edd}, CD, and $M_{\rm BH}$ for the CLBs, BL Lacs and FSRQs. where red empty squares represent the CLBs : Changing-Look (Transition) Blazars, and blue solid points represent BL Lacs, and green empty triangles represent FSRQs. where the green empty triangles, and blue solid circles, and red empty squares indicate FSRQs, BL Lacs and Changing-Look (Transition) Blazars respectively.

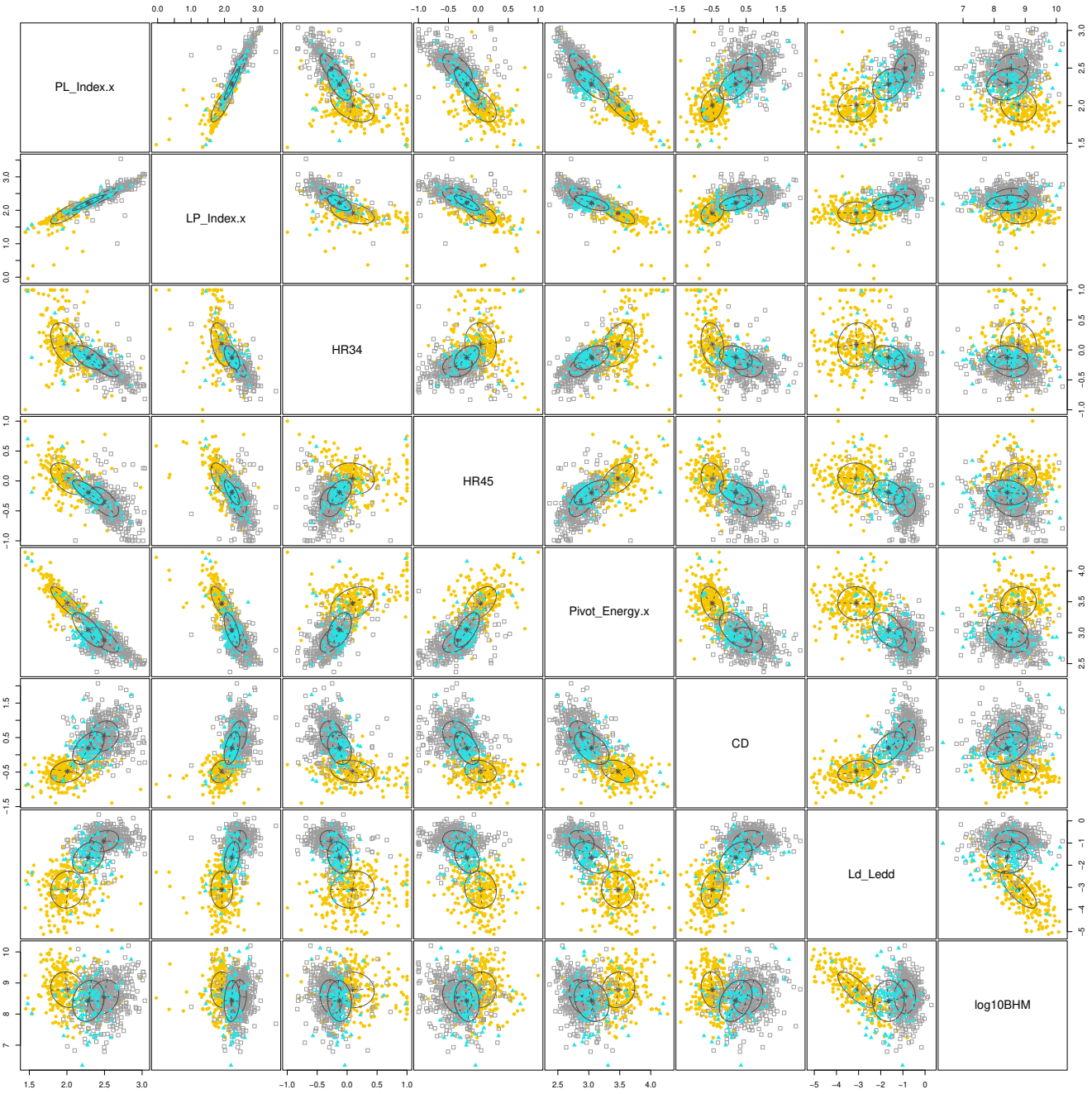

Figure 14. Scatterplots of the $\Gamma_{\rm ph}$, α, HR_{34}, HR_{45}, $\log E_{pivot}$ z, L_{disk}/L_{Edd}, CD, and $M_{\rm BH}$ for the CLBs, BL Lacs and FSRQs. where red empty squares represent the CLBs : Changing-Look (Transition) Blazars, and blue solid points represent BL Lacs, and green empty triangles represent FSRQs. where the green empty triangles, and blue solid circles, and red empty squares indicate FSRQs, BL Lacs and Changing-Look (Transition) Blazars respectively.

6. SUMMARY

In the letter, based on the 4FGL catalogs (4LAC-DR3, Ajello et al. 2022 and the 4FGL-DR2 Abdollahi et al. 2022) and Paliya et al. (2021)'s Blazars Sample, we try to explore the Role of Changing-Look Blazars in Fermi Blazars Sample. Using the *densityMclust*() function for density estimation, the density distributions of some univariate ($\Gamma_{\rm ph}$, $\alpha_{\rm ph}$, $\rm HR_{45}$, CD, $L_{\rm disk}$, and λ=$L_{\rm disk}/L_{\rm Edd}$, $\log M_{\rm BH}$, Redshift and $\log E_{\rm pivot}$) are are calculated. We find that there are 6 parameters: $\Gamma_{\rm ph}$, $\alpha_{\rm ph}$, $\rm HR_{45}$, CD, $L_{\rm disk}$, and λ=$L_{\rm disk}/L_{\rm Edd}$, the univariate density distributions of CLBs are obviously located between that of BL Lacs and that of FSRQs. The scatterplots of these 6 parameters display a similar distribution that the CLBs are mainly scattered at the middle boundary between FSRQs and BL Lacs. Using the Dimension reduction function *mclustDR*() to the 6 parameters, the multidimensional data of the three groups are dimension reduction to two dimensions. In case of three groups in two dimensions, the CLB sources are also located at the cross districts between FSRQs and BL Lacs. Which indicate that the CLBs are in an intermediate transition state between FSRQs and BL Lacs and that are a class of excessive Blazar sources in transition from FSRQs to BL Lacs **(The Preliminary Results of the CLBs, Kang et al., in preparation)**.

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APPENDIX

A. APPENDIX: ALL THE CLB SOURCES LISTED IN A TABLE

Table 18. The catalog of changing-look blazars

4FGL name (1)	R.A. (2)	Decl. (3)	ASSOC name (4)	SED (5)	4FGL (6)	Reference (7)
4FGL J0114.8+1326	18.7119	13.4342	GB6 J0114+1325	ISP	bll	Zhang et al. 2022
4FGL J0203.7+3042	30.9327	30.7139	NVSS J020344+304238	LSP	bll	Zhang et al. 2022
4FGL J0407.5+0741	61.8921	7.6998	TXS 0404+075	LSP	bll	Zhang et al. 2022
4FGL J0433.1+3227	68.2897	32.4614	NVSS J043307+322840.	HSP	bll	Zhang et al. 2022
4FGL J1058.4+0133	164.6240	1.5641	4C +01.28	LSP	bll	Zhang et al. 2022
4FGL J0014.2+0854	3.5695	8.9114	MS 0011.7+0837	..	bll	Foschini et al. (2022)
4FGL J0134.5+2637	23.6272	26.6294	RX J0134.4+2638	HSP	fsrq	Foschini et al. (2022)
4FGL J0217.8+0144	34.4621	1.7346	PKS 0215+015	LSP	fsrq	Foschini et al. (2022)
4FGL J0407.5+0741	61.8921	7.6998	TXS 0404+075	LSP	bll	Foschini et al. (2022)
4FGL J0449.1+1121	72.2823	11.3569	PKS 0446+11	LSP	fsrq	Foschini et al. (2022)
4FGL J0509.4+1012	77.3510	10.2008	PKS 0506+101	LSP	fsrq	Foschini et al. (2022)
4FGL J0510.0+1800	77.5181	18.0135	PKS 0507+17	LSP	fsrq	Foschini et al. (2022)
4FGL J0719.3+3307	109.8400	33.1232	B2 0716+33	LSP	fsrq	Foschini et al. (2022)
4FGL J0833.9+4223	128.4759	42.3989	OJ 451	LSP	fsrq	Foschini et al. (2022)
4FGL J1037.4−2933	159.3564	-29.5568	PKS 1034−293	LSP	fsrq	Foschini et al. (2022)
4FGL J1043.2+2408	160.8053	24.1460	B2 1040+24A	LSP	fsrq	Foschini et al. (2022)
4FGL J1124.0+2336	171.0045	23.6159	OM 235	LSP	fsrq	Foschini et al. (2022)

Table 18 *continued on next page*

Table 18 *(continued)*

4FGL name (1)	R.A. (2)	Decl. (3)	ASSOC name (4)	SED (5)	4FGL (6)	Reference (7)
4FGL J1224.9+2122	186.2277	21.3814	4C +21.35	LSP	fsrq	Foschini et al. (2022)
4FGL J1302.8+5748	195.7209	57.8146	TXS 1300+580	LSP	bll	Foschini et al. (2022)
4FGL J1322.2+0842	200.5510	8.7036	NVSS J132210+084231	LSP	fsrq	Foschini et al. (2022)
4FGL J1333.2+2725	203.3227	27.4221	MG2 J133305+2725	LSP	fsrq	Foschini et al. (2022)
4FGL J1422.3+3223	215.5772	32.3911	OQ 334	LSP	fsrq	Foschini et al. (2022)
4FGL J1623.6+5743	245.9186	57.7290	TXS 1623+578	..	fsrq	Foschini et al. (2022)
4FGL J1657.7+4808	254.4383	48.1368	4C +48.41	LSP	fsrq	Foschini et al. (2022)
4FGL J1751.5+0938	267.8776	9.6456	OT 081	LSP	bll	Foschini et al. (2022)
4FGL J1800.6+7828	270.1730	78.4674	S5 1803+784	LSP	bll	Foschini et al. (2022)
4FGL J1823.5+6858	275.8884	68.9676	7C 1823+6856	ISP	bll	Foschini et al. (2022)
4FGL J1937.2−3958	294.3092	-39.9825	PKS 1933−400	LSP	fsrq	Foschini et al. (2022)
4FGL J2026.0−2845	306.5048	-28.7546	PMN J2025−2845	LSP	fsrq	Foschini et al. (2022)
4FGL J2134.2−0154	323.5699	-1.9042	PKS 2131−021	LSP	bll	Foschini et al. (2022)
4FGL J2158.1−1501	329.5275	-15.0237	PKS 2155−152	LSP	fsrq	Foschini et al. (2022)
4FGL J2207.6+0053	331.9137	0.8907	PMN J2207+0052	..	bcu	Foschini et al. (2022)
4FGL J2212.0+2356	333.0191	23.9334	PKS 2209+236	LSP	fsrq	Foschini et al. (2022)
4FGL J2225.7−0457	336.4321	-4.9537	3C 446	LSP	fsrq	Foschini et al. (2022)
4FGL J2236.3+2828	339.0962	28.4832	B2 2234+28A	LSP	fsrq	Foschini et al. (2022)
4FGL J2345.2−1555	356.3030	-15.9182	PMN J2345−1555	LSP	fsrq	Foschini et al. (2022)
4FGL J2349.4+0534	357.3558	5.5790	TXS 2346+052	LSP	fsrq	Foschini et al. (2022)
4FGL J0522.9−3628	80.7370	-36.4686	PKS 0521−36	LSP	agn	Foschini et al. (2022)
4FGL J0910.0+4257	137.5058	42.9623	3C 216.	..	css	Foschini et al. (2022)
4FGL J0102.8+5824	15.701	58.409	TXS 0059+581	LSP	fsrq	Xiao et al. (2022)
4FGL J0337.8−1157	54.474	-11.960	PKS 0335−122	LSP	fsrq	Xiao et al. (2022)
4FGL J0347.0+4844	56.753	48.738	IVS B0343+485	LSP	fsrq	Xiao et al. (2022)
4FGL J0521.3−1734	80.341	-17.574	TXS 0519−176	LSP	fsrq	Xiao et al. (2022)
4FGL J0539.6+1432	84.905	14.544	TXS 0536+145	LSP	fsrq	Xiao et al. (2022)
4FGL J0539.9−2839	84.995	-28.659	PKS 0537−286	LSP	fsrq	Xiao et al. (2022)
4FGL J0601.1−7035	90.296	-70.590	PKS 0601−70	LSP	fsrq	Xiao et al. (2022)
4FGL J1816.9−4942	274.244	-49.716	PMN J1816−4943	LSP	fsrq	Xiao et al. (2022)
4FGL J2015.5+3710	303.892	37.176	MG2 J201534+3710	LSP	fsrq	Xiao et al. (2022)
4FGL J2121.0+1901	320.260	19.032	OX 131	LSP	fsrq	Xiao et al. (2022)
4FGL J0006.3−0620	1.599	-6.349	PKS 0003−066	LSP	bll	Xiao et al. (2022)
4FGL J0127.9+4857	21.978	48.954	GB6 J0128+4901	...	bll	Xiao et al. (2022)
4FGL J0203.7+3042	30.933	30.714	NVSS J020344+304238	LSP	bll	Xiao et al. (2022)
4FGL J0209.9+7229	32.498	72.488	S5 0205+722	LSP	bll	Xiao et al. (2022)
4FGL J0238.6+1637	39.668	16.618	PKS 0235+164	LSP	bll	Xiao et al. (2022)
4FGL J0334.2−4008	53.557	-40.145	PKS 0332−403	LSP	bll	Xiao et al. (2022)
4FGL J0407.5+0741	61.892	7.700	TXS 0404+075	LSP	bll	Xiao et al. (2022)
4FGL J0428.6−3756	67.173	-37.940	PKS 0426−380	LSP	bll	Xiao et al. (2022)

Table 18 *continued on next page*

Table 18 *(continued)*

4FGL name	R.A.	Decl.	ASSOC name	SED	4FGL	Reference
(1)	(2)	(3)	(4)	(5)	(6)	(7)
4FGL J0433.6+2905	68.411	29.097	MG2 J043337+2905	LSP	bll	Xiao et al. (2022)
4FGL J0438.9−4521	69.745	-45.358	PKS 0437−454	LSP	bll	Xiao et al. (2022)
4FGL J0516.7−6207	79.180	-62.125	PKS 0516−621	LSP	bll	Xiao et al. (2022)
4FGL J0538.8−4405	84.709	-44.086	PKS 0537−441	LSP	bll	Xiao et al. (2022)
4FGL J0629.3−1959	97.348	-20.000	PKS 0627−199	LSP	bll	Xiao et al. (2022)
4FGL J0654.7+4246	103.686	42.779	B3 0651+428	LSP	bll	Xiao et al. (2022)
4FGL J0710.9+4733	107.732	47.553	S4 0707+47	LSP	bll	Xiao et al. (2022)
4FGL J0814.4+2941	123.610	29.686	RX J0814.4+2941	HSP	bll	Xiao et al. (2022)
4FGL J0823.3+2224	125.844	22.409	OJ 233	...	bll	Xiao et al. (2022)
4FGL J0831.8+0429	127.973	4.494	PKS 0829+046	LSP	bll	Xiao et al. (2022)
4FGL J0832.4+4912	128.108	49.213	OJ 448	LSP	bll	Xiao et al. (2022)
4FGL J1001.1+2911	150.294	29.188	GB6 J1001+2911	LSP	bll	Xiao et al. (2022)
4FGL J1031.1+7442	157.792	74.702	S5 1027+74	ISP	bll	Xiao et al. (2022)
4FGL J1058.0+4305	164.518	43.094	B3 1055+433	LSP	bll	Xiao et al. (2022)
4FGL J1058.4+0133	164.624	1.564	4C +01.28	LSP	bll	Xiao et al. (2022)
4FGL J1058.6−8003	164.660	-80.064	PKS 1057−79	LSP	bll	Xiao et al. (2022)
4FGL J1147.0−3812	176.760	-38.201	PKS 1144−379	LSP	bll	Xiao et al. (2022)
4FGL J1250.6+0217	192.651	2.288	PKS 1247+025	LSP	bll	Xiao et al. (2022)
4FGL J1331.2−1325	202.819	-13.428	PMN J1331−1326	LSP	bll	Xiao et al. (2022)
4FGL J1402.6+1600	210.658	16.002	4C +16.39	ISP	bll	Xiao et al. (2022)
4FGL J1412.1+7427	213.038	74.450	GB6 J1411+7424	ISP	bll	Xiao et al. (2022)
4FGL J1503.5+4759	225.895	47.996	TXS 1501+481	LSP	bll	Xiao et al. (2022)
4FGL J1647.5+4950	251.892	49.834	SBS 1646+499	LSP	bll	Xiao et al. (2022)
4FGL J1751.5+0938	267.878	9.646	OT 081	LSP	bll	Xiao et al. (2022)
4FGL J1800.6+7828	270.173	78.467	S5 1803+784	LSP	bll	Xiao et al. (2022)
4FGL J1806.8+6949	271.711	69.827	3C 371	LSP	bll	Xiao et al. (2022)
4FGL J1954.6−1122	298.669	-11.382	TXS 1951−115	LSP	bll	Xiao et al. (2022)
4FGL J2134.2−0154	323.570	-1.904	PKS 2131−021	LSP	bll	Xiao et al. (2022)
4FGL J2152.5+1737	328.137	17.617	S3 2150+17	LSP	bll	Xiao et al. (2022)
4FGL J2202.7+4216	330.695	42.282	BL Lac	LSP	bll	Xiao et al. (2022)
4FGL J2204.3+0438	331.083	4.640	4C +04.77	ISP	bll	Xiao et al. (2022)
4FGL J2216.9+2421	334.238	24.358	B2 2214+24B	LSP	bll	Xiao et al. (2022)
4FGL J2315.6−5018	348.914	-50.313	PKS 2312−505	LSP	bll	Xiao et al. (2022)
4FGL J2357.4−0152	359.367	-1.870	PKS 2354−021	LSP	bll	Xiao et al. (2022)
4FGL J0134.5+2637	23.6272	26.6294	RX J0134.4+2638	HSP	fsrq	Foschini et al. (2021)
4FGL J0217.8+0144	34.4621	1.7346	PKS 0215+015	LSP	fsrq	Foschini et al. (2021)
4FGL J0449.1+1121	72.2823	11.3569	PKS 0446+11	LSP	fsrq	Foschini et al. (2021)
4FGL J0509.4+1012	77.3510	10.2008	PKS 0506+101	LSP	fsrq	Foschini et al. (2021)
4FGL J0510.0+1800	77.5181	18.0135	PKS 0507+17	LSP	fsrq	Foschini et al. (2021)
4FGL J0522.9−3628	80.7370	-1636.4686	PKS 0521−36	LSP	agn	Foschini et al. (2021)

Table 18 *continued on next page*

Table 18 *(continued)*

4FGL name (1)	R.A. (2)	Decl. (3)	ASSOC name (4)	SED (5)	4FGL (6)	Reference (7)
4FGL J0719.3+3307	109.8400	33.1232	B2 0716+33	LSP	fsrq	Foschini et al. (2021)
4FGL J0833.9+4223	128.4759	42.3989	OJ 451	LSP	fsrq	Foschini et al. (2021)
4FGL J0910.0+4257	137.5058	42.9623	3C 216	...	css	Foschini et al. (2021)
4FGL J1037.4−2933	159.3564	-29.5568	PKS 1034−293	LSP	fsrq	Foschini et al. (2021)
4FGL J1124.0+2336	171.0045	23.6159	OM 235	LSP	fsrq	Foschini et al. (2021)
4FGL J1410.3+1438	212.5908	14.6434	4FGL J1410.3+1438	...	bll	Peña-Herazo et al. (2021)
4FGL J1503.5+4759	225.8955	47.9959	4FGL J1503.5+4759	LSP	bll	Peña-Herazo et al. (2021)
...	...	...	SDSS J134240.02+094752.4	...	...	Peña-Herazo et al. (2021)
...	...	...	5BZG J0006+1051	...	...	Peña-Herazo et al. (2021)
4FGL J0022.0+0006	5.5154	0.1134	5BZG J0022+0006	HSP	bll	Peña-Herazo et al. (2021)
4FGL J0303.3+0555	45.8465	5.9249	5BZG J0303+0554	HSP	bll	Peña-Herazo et al. (2021)
...	...	...	5BZG J0751+1730	...	...	Peña-Herazo et al. (2021)
...	...	...	5BZG J0756+3834	...	...	Peña-Herazo et al. (2021)
4FGL J0916.7+5238	139.1906	52.6454	5BZG J0916+5238	HSP	bll	Peña-Herazo et al. (2021)
4FGL J1001.1+2911	150.2938	29.1880	5BZB J1001+2911	LSP	bll	Peña-Herazo et al. (2021)
4FGL J1043.2+2408	160.8053	24.1460	5BZQ J1043+2408	LSP	fsrq	Peña-Herazo et al. (2021)
...	...	...	5BZQ J1054+3855	...	...	Peña-Herazo et al. (2021)
4FGL J1056.0+0253	164.0027	2.8935	5BZG J1056+0252	...	bll	Peña-Herazo et al. (2021)
...	...	...	5BZG J1103+0022	...	...	Peña-Herazo et al. (2021)
4FGL J1106.0+2813	166.5020	28.2254	5BZQ J1106+2812	LSP	fsrq	Peña-Herazo et al. (2021)
...	...	...	5BZQ J1243+4043	...	...	Peña-Herazo et al. (2021)
4FGL J1321.1+2216	200.2958	22.2808	5BZQ J1321+2216	LSP	fsrq	Peña-Herazo et al. (2021)
4FGL J1326.1+1232	201.5493	12.5348	5BZG J1326+1229	HSP	bll	Peña-Herazo et al. (2021)
...	...	...	5BZQ J1343+2844	...	...	Peña-Herazo et al. (2021)
4FGL J1402.6+1600	210.6584	16.0016	5BZB J1402+1559	ISP	bll	Peña-Herazo et al. (2021)
4FGL J1449.5+2746	222.3956	27.7686	5BZG J1449+2746	ISP	rdg	Peña-Herazo et al. (2021)
...	...	...	5BZG J1504−0248	...	...	Peña-Herazo et al. (2021)
4FGL J1512.2+0202	228.0702	2.0403	5BZG J1512+0203	LSP	fsrq	Peña-Herazo et al. (2021)
4FGL J1730.8+3715	262.7026	37.2641	5BZG J1730+3714	ISP	bll	Peña-Herazo et al. (2021)
...	...	...	5BZG J1733+4519	...	...	Peña-Herazo et al. (2021)
...	...	...	5BZG J2346+4024	...	...	Peña-Herazo et al. (2021)
4FGL J0833.9+4223	128.4759	42.3989	SDSS J083353.88+422401.8	LSP	fsrq	Ruan et al. (2014)
4FGL J1016.0+0512	154.0093	5.2089	SDSS J101603.13+051302.3	LSP	fsrq	Ruan et al. (2014)
4FGL J1308.5+3547	197.1286	35.7918	SDSS J130823.70+354637.0	LSP	fsrq	Ruan et al. (2014)
4FGL J2206.8−0032	331.7087	-0.5461	SDSS J220643.28−003102.5	LSP	bll	Ruan et al. (2014)
4FGL J1250.6+0217	192.6513	2.2876	SDSS J125032.57+021632.1	LSP	bll	Ruan et al. (2014)
...	...	...	SDSS J143758.67+300207.1	...	...	Ruan et al. (2014)
...	...	...	SDSS J083223.22+491321.0	...	...	Ruan et al. (2014)
4FGL J0058.4+3315	14.6101	33.2505	1FGL J0058.0+3314	LSP	fsrq	Shaw et al. (2012)
4FGL J0923.5+4125	140.8949	41.4283	1FGL J0923.2+4121	LSP	fsrq	Shaw et al. (2012)

Table 18 *continued on next page*

Table 18 *(continued)*

4FGL name	R.A.	Decl.	ASSOC name	SED	4FGL	Reference
(1)	(2)	(3)	(4)	(5)	(6)	(7)
4FGL J1001.1+2911	150.2938	29.1880	1FGL J1000.9+2915	LSP	bll	Shaw et al. (2012)
4FGL J1607.0+1550	241.7745	15.8447	1FGL J1607.1+1552	LSP	bll	Shaw et al. (2012)
4FGL J2032.0+1219	308.0040	12.3279	1FGL J2031.5+1219	LSP	bll	Shaw et al. (2012)
4FGL J2244.2+4057	341.0614	40.9597	1FGL J2243.4+4104	LSP	fsrq	Shaw et al. (2012)
4FGL J0430.3−2507	67.5751	-25.1283	1FGL J0430.4−2509	ISP	bll	Shaw et al. (2012)
4FGL J0516.7−6207	79.1798	-62.1248	1FGL J0516.7−6207	LSP	bll	Shaw et al. (2012)
4FGL J1058.4+0133	164.6240	1.5641	1FGL J1058.4+0134	LSP	bll	Shaw et al. (2012)
4FGL J2236.3+2828	339.0962	28.4832	1FGL J2236.2+2828	LSP	fsrq	Shaw et al. (2012)
4FGL J2315.6−5018	348.9140	-50.3127	1FGL J2315.9−5014	LSP	bll	Shaw et al. (2012)
4FGL J0058.4+3315	14.6101	33.2505	MG3 J005830+3311	LSP	fsrq	Ghisellini et al. (2011)
4FGL J0210.7−5101	32.6946	-51.0218	PKS 0208−512	LSP	fsrq	Ghisellini et al. (2011)
4FGL J0538.8−4405	84.7089	-44.0862	PKS 0537−441	LSP	bll	Ghisellini et al. (2011)
4FGL J0811.4+0146	122.8610	1.7756	OJ 014	LSP	bll	Ghisellini et al. (2011)
4FGL J0238.6+1637	39.6680	16.6179	PKS 0235+164	LSP	bll	Ghisellini et al. (2011)
4FGL J0428.6−3756	67.1730	-37.9403	PKS 0426−380	LSP	bll	Ghisellini et al. (2011)
4FGL J2202.7+4216	330.6946	42.2821	BL Lac (prototype)	LSP	bll	[a]Vermeulen et al. (1995)
4FGL J1422.3+3223	215.5772	32.3911	B2 1420+32	LSP	fsrq	[b]Mishra et al. (2021)
...	...	...	5BZB J0724+2621	...	...	[c]Álvarez Crespo et al. (2016)
...	...	...	J211354.71+112125.3	...	...	[d]Pasham & Wevers (2019)
...	...	...	(AT2019evq)	...	...	[d]Pasham & Wevers (2019)
4FGL J1153.4+4931	178.3505	49.5169	4C+29.22 (S4 1150+49)	LSP	fsrq	[e]Cutini et al. (2014)
4FGL J0509.4+0542	77.3593	5.7014	TXS 0506+056	ISP	bll	[f]Padovani et al. (2019)
4FGL J2151.8−3027	327.9655	-30.4600	PKS 2149−306	LSP	fsrq	[g]Bianchin et al. (2009)
4FGL J2345.2−1555	356.3030	-15.9182	PMN J2345−1555	LSP	fsrq	Ghisellini et al. (2012)
4FGL J0035.2+1514	8.8123	15.2405	RX J0035.2+1515	ISP	bll	Ghisellini et al. (2013)
4FGL J0537.7−5717	84.4251	-57.2909	SUMMS J053748−571828	HSP	bll	Ghisellini et al. (2013)
4FGL J0630.9−2406	97.7414	-24.1110	CRATES J0630−2406	HSP	bll	Ghisellini et al. (2013)
4FGL J1312.4−2156	198.1108	-21.9380	CRATES 1312−2156	HSP	bll	Ghisellini et al. (2013)
3FGL J0049.7+0237	00 49 43.23	+02 37 03.77	5BZBJ0049+0237	LSP	bll	Fan & Wu (2019)
3FGL J0141.4−0929	01 41 25.83	−09 28 43.67	5BZBJ0141−0928	LSP	bll	Fan & Wu (2019)
3FGL J0238.6+1636	02 38 38.93	+16 36 59.27	5BZBJ0238+1636	LSP	bll	Fan & Wu (2019)
3FGL J0334.3−4008	03 34 13.65	−40 08 25.39	5BZBJ0334−4008	LSP	bll	Fan & Wu (2019)
3FGL J0407.5+0740	04 07 29.08	+07 42 07.47	5BZBJ0407+0742	LSP	bll	Fan & Wu (2019)
3FGL J0428.6−3756	04 28 40.42	−37 56 19.58	5BZBJ0428−3756	LSP	bll	Fan & Wu (2019)
3FGL J0433.6+2905	04 33 37.82	+29 05 55.47	5BZBJ0433+2905	LSP	bll	Fan & Wu (2019)
3FGL J0434.0−2010	04 34 07.91	−20 15 17.13	5BZBJ0434−2015	LSP	bll	Fan & Wu (2019)
3FGL J0438.8−4519	04 39 00.85	−45 22 22.56	5BZBJ0439−4522	LSP	bll	Fan & Wu (2019)
3FGL J0538.8−4405	05 38 50.36	−44 05 08.93	5BZBJ0538−4405	LSP	bll	Fan & Wu (2019)
3FGL J0629.4−1959	06 29 23.76	−19 59 19.72	5BZBJ0629−1959	LSP	bll	Fan & Wu (2019)
3FGL J0738.1+1741	07 38 07.39	+17 42 18.99	5BZBJ0738+1742	LSP	bll	Fan & Wu (2019)

Table 18 *continued on next page*

Table 18 *(continued)*

4FGL name	R.A.	Decl.	ASSOC name	SED	4FGL	Reference
(1)	(2)	(3)	(4)	(5)	(6)	(7)
3FGL J0811.3+0146	08 11 26.7	+01 46 52.22	5BZBJ0811+0146	LSP	bll	Fan & Wu (2019)
3FGL J0818.2+4223	08 18 15.99	+42 22 45.41	5BZBJ0818+4222	LSP	bll	Fan & Wu (2019)
3FGL J0826.0+0307	08 25 50.33	+03 09 24.51	5BZBJ0825+0309	LSP	bll	Fan & Wu (2019)
3FGL J1058.5+0133	10 58 29.6	+01 33 58.82	5BZUJ1058+0133	LSP	bll	Fan & Wu (2019)
3FGL J1218.0−0029	12 17 58.72	−00 29 46.29	5BZBJ1217−0029	LSP	bll	Fan & Wu (2019)
3FGL J1250.5+0217	12 50 32.58	+02 16 32.17	5BZBJ1250+0216	LSP	bll	Fan & Wu (2019)
3FGL J1303.0+2435	13 03 03.21	+24 33 55.72	5BZBJ1303+2433	LSP	bll	Fan & Wu (2019)
3FGL J1522.6−2730	15 22 37.67	−27 30 10.78	5BZBJ1522−2730	LSP	bll	Fan & Wu (2019)
3FGL J1540.8+1449	15 40 49.49	+14 47 45.88	5BZBJ1540+1447	LSP	bll	Fan & Wu (2019)
3FGL J1748.6+7005	17 48 32.84	+70 05 50.76	5BZBJ1748+7005	LSP	bll	Fan & Wu (2019)
3FGL J1800.5+7827	18 00 45.68	+78 28 04.01	5BZBJ1800+7828	LSP	bll	Fan & Wu (2019)
3FGL J1824.2+5649	18 24 07.06	+56 51 01.49	5BZBJ1824+5651	LSP	bll	Fan & Wu (2019)
3FGL J2031.8+1223	20 31 54.99	+12 19 41.34	5BZUJ2031+1219	LSP	bll	Fan & Wu (2019)
3FGL J2134.1−0152	21 34 10.3	−01 53 17.23	5BZBJ2134−0153	LSP	bll	Fan & Wu (2019)
3FGL J2152.4+1735	21 52 24.81	+17 34 37.79	5BZBJ2152+1734	LSP	bll	Fan & Wu (2019)
3FGL J2206.9−0031	22 06 43.28	−00 31 02.49	5BZBJ2206−0031	LSP	bll	Fan & Wu (2019)
3FGL J2217.0+2421	22 17 00.82	+24 21 45.95	5BZBJ2217+2421	LSP	bll	Fan & Wu (2019)
3FGL J2236.3+2829	22 36 22.47	+28 28 57.41	5BZQJ2236+2828	LSP	bll	Fan & Wu (2019)
3FGL J2243.4−2541	22 43 26.4	−25 44 30.68	5BZBJ2243−2544	LSP	bll	Fan & Wu (2019)
3FGL J2244.1+4057	22 44 12.73	+40 57 13.62	5BZQJ2244+4057	LSP	bll	Fan & Wu (2019)
3FGL J2315.7−5018	23 15 44.33	−50 18 39.7	5BZBJ2315−5018	LSP	bll	Fan & Wu (2019)
4FGL J0238.6+1637	39.6680	16.6179	PKS 0235 +164	LSP	bll	Pei et al. (2022)
4FGL J0538.8−4405	84.7089	-44.0862	PKS 0537−441	LSP	bll	Pei et al. (2022)
4FGL J1302.8+5748	195.7209	57.8146	TXS 1300+580	LSP	bll	Cheng et al. (2022)
4FGL J2346.7+8008	356.6867	80.1366	WN B2344.2+7951	LSP	bll	Cheng et al. (2022)
4FGL J2357.4−0152	359.3674	-1.8703	PKS 2354−021	LSP	bll	Cheng et al. (2022)
4FGL J2200.3+1029	330.0887	10.4956	TXS 2157+102	LSP	bll	Cheng et al. (2022)
4FGL J2241.2+4120	340.3087	41.3396	B3 2238+410	LSP	bll	Cheng et al. (2022)
4FGL J1224.9+4334	186.2371	43.5691	B3 1222+438	LSP	bll	Cheng et al. (2022)
4FGL J0359.4−2616	59.8713	-26.2734	PKS 0357−264	LSP	bll	Cheng et al. (2022)
4FGL J0403.5−2437	60.8989	-24.6168	TXS 0401−248	LSP	bll	Cheng et al. (2022)
4FGL J0208.5−0046	32.135	-0.7768	PKS 0205−010	LSP	bll	Cheng et al. (2022)
4FGL J0610.1−1848	92.5455	-18.8076	PMN J0610−1847	LSP	bll	Cheng et al. (2022)
4FGL J1439.7+4958	219.9411	49.9775	GB6 J1439+4958	LSP	bll	Cheng et al. (2022)
4FGL J1445.9−1626	221.4978	-16.4498	PKS B1443−162	LSP	bll	Cheng et al. (2022)
4FGL J1148.6+1841	177.1542	18.6861	TXS 1146+189	LSP	bll	Cheng et al. (2022)
4FGL J1954.6−1122	298.6693	-11.3815	TXS 1951−115	LSP	bll	Cheng et al. (2022)
4FGL J1201.7+1429	180.4471	14.4852	OM 198	LSP	bll	Cheng et al. (2022)
4FGL J2315.6−5018	348.914	-50.3127	PKS 2312−505	LSP	bll	Cheng et al. (2022)
4FGL J0209.9+7229	32.4979	72.4877	S5 0205+722	LSP	bll	Cheng et al. (2022)

Table 18 *continued on next page*

Table 18 *(continued)*

4FGL name	R.A.	Decl.	ASSOC name	SED	4FGL	Reference
(1)	(2)	(3)	(4)	(5)	(6)	(7)
4FGL J0832.4+4912	128.1078	49.2127	OJ 448	LSP	bll	Cheng et al. (2022)
4FGL J1427.6−3305	216.913	-33.094	PKS 1424−328	LSP	bll	Cheng et al. (2022)
4FGL J1329.0−5607	202.2672	-56.1186	PMN J1329−5608	LSP	bll	Cheng et al. (2022)
4FGL J1500.7+4752	225.1837	47.8716	TXS 1459+480.	LSP	bll	Cheng et al. (2022)
4FGL J1410.1+0202	212.5287	2.0354	PKS 1407+022.	LSP	bll	Cheng et al. (2022)
4FGL J2257.5+0748	344.3874	7.8014	OY 91	LSP	bll	Cheng et al. (2022)
4FGL J1315.1−5333	198.7978	-53.5649	PMN J1315−5334	LSP	bll	Cheng et al. (2022)
4FGL J0113.7+0225	18.4279	2.4196.	UGC 773	LSP	bll	Cheng et al. (2022)
4FGL J0710.9+4733	107.7323	47.553	S4 0707+47	LSP	bll	Cheng et al. (2022)
4FGL J2152.5+1737	328.137	17.6173	S3 2150+17	LSP	bll	Cheng et al. (2022)
4FGL J0407.5+0741	61.8921	7.6998	TXS 0404+075	LSP	bll	Cheng et al. (2022)
4FGL J2056.7−3209	314.178	-32.1612	PKS 2053−323	LSP	bll	Cheng et al. (2022)
4FGL J2050.0+0408	312.5181	4.1401	PKS 2047+039	LSP	bll	Cheng et al. (2022)
4FGL J2049.9+1002	312.4782	10.0407	PKS 2047+098	LSP	bll	Cheng et al. (2022)
4FGL J1516.9+1934	229.2442	19.5805	PKS 1514+197	LSP	bll	Cheng et al. (2022)
4FGL J1717.5−3342	259.3985	-33.7003	TXS 1714−336	LSP	bll	Cheng et al. (2022)
4FGL J1941.3−6210	295.3468	-62.1753	PKS 1936−623	LSP	bll	Cheng et al. (2022)
4FGL J2216.9+2421	334.238	24.3575	B2 2214+24B	LSP	bll	Cheng et al. (2022)
4FGL J0438.9−4521	69.7447	-45.3584	PKS 0437−454	LSP	bll	Cheng et al. (2022)
4FGL J2010.0+7229	302.5159	72.4874	4C +72.28.	LSP	bll	Cheng et al. (2022)
4FGL J1330.4+3157	202.6002	31.963	MG2 J132953+3153	LSP	bll	Cheng et al. (2022)
4FGL J0747.3−3310	116.8328	-33.1778	PKS 0745−330	LSP	bll	Cheng et al. (2022)
4FGL J1326.8−5256	201.7201	-52.9376	PMN J1326−5256	LSP	bll	Cheng et al. (2022)
4FGL J2032.0+1219	308.004	12.3279	PKS 2029+121	LSP	bll	Cheng et al. (2022)
4FGL J1604.5−4441	241.1277	-44.6903	PMN J1604−4441	LSP	bll	Cheng et al. (2022)
4FGL J1824.1+5651	276.0393	56.8585	4C +56.27	LSP	bll	Cheng et al. (2022)
4FGL J1641.9−0621	250.4892	-6.3529	TXS 1639−062	LSP	bll	Cheng et al. (2022)
4FGL J1650.3−5045	252.5894	-50.7515	PMN J1650−5044	LSP	bll	Cheng et al. (2022)
4FGL J2134.2−0154	323.5699	-1.9042	PKS 2131−021	LSP	bll	Cheng et al. (2022)
4FGL J2025.3+3341	306.3412	33.6891	B2 2023+33	LSP	bll	Cheng et al. (2022)
4FGL J0003.9−1149	0.9986	-11.8251	PMN J0004−1148	LSP	bll	Kang et al. 2023
4FGL J0006.3−0620	1.5992	-6.3493	PKS 0003−066	LSP	bll	Kang et al. 2023
4FGL J0013.1−3955	3.2802	-39.9272	PKS 0010−401	LSP	bll	Kang et al. 2023
4FGL J0014.1+1910	3.5368	19.1713	MG3 J001356+1910	LSP	bll	Kang et al. 2023
4FGL J0019.6+2022	4.9070	20.3755	PKS 0017+200	LSP	bll	Kang et al. 2023
4FGL J0049.7+0237	12.4377	2.6273	PKS 0047+023	LSP	bll	Kang et al. 2023
4FGL J0056.8+1626	14.2020	16.4360	TXS 0054+161	LSP	bll	Kang et al. 2023
4FGL J0105.1+3929	16.2913	39.4963	GB6 J0105+3928	LSP	bll	Kang et al. 2023
4FGL J0107.4+0334	16.8508	3.5691	PMN J0107+0333	LSP	bll	Kang et al. 2023
4FGL J0113.7+0225	18.4279	2.4196	UGC 773	LSP	bll	Kang et al. 2023

Table 18 *continued on next page*

Table 18 *(continued)*

4FGL name	R.A.	Decl.	ASSOC name	SED	4FGL	Reference
(1)	(2)	(3)	(4)	(5)	(6)	(7)
4FGL J0125.3−2548	21.3474	-25.8074	PKS 0122−260	LSP	bll	Kang et al. 2023
4FGL J0141.4−0928	25.3626	-9.4825	PKS 0139−09	LSP	bll	Kang et al. 2023
4FGL J0144.6+2705	26.1502	27.0899	TXS 0141+268	LSP	bll	Kang et al. 2023
4FGL J0202.7+4204	30.6862	42.0714	B3 0159+418	LSP	bll	Kang et al. 2023
4FGL J0203.6+7233	30.9114	72.5530	S5 0159+723	LSP	bll	Kang et al. 2023
4FGL J0203.7+3042	30.9327	30.7139	NVSS J020344+304238	LSP	bll	Kang et al. 2023
4FGL J0208.5−0046	32.1350	-0.7768	PKS 0205−010	LSP	bll	Kang et al. 2023
4FGL J0209.9+7229	32.4979	72.4877	S5 0205+722	LSP	bll	Kang et al. 2023
4FGL J0217.2+0837	34.3163	8.6234	ZS 0214+083	LSP	bll	Kang et al. 2023
4FGL J0238.6+1637	39.6680	16.6179	PKS 0235+164	LSP	bll	Kang et al. 2023
4FGL J0301.0−1652	45.2714	-16.8688	PMN J0301−1652	LSP	bll	Kang et al. 2023
4FGL J0334.2−4008	53.5566	-40.1450	PKS 0332−403	LSP	bll	Kang et al. 2023
4FGL J0340.5−2118	55.1477	-21.3158	PKS 0338−214	LSP	bll	Kang et al. 2023
4FGL J0348.6−1609	57.1532	-16.1654	PKS 0346−163	LSP	bll	Kang et al. 2023
4FGL J0354.7+8009	58.6919	80.1647	S5 0346+80	LSP	bll	Kang et al. 2023
4FGL J0359.4−2616	59.8713	-26.2734	PKS 0357−264	LSP	bll	Kang et al. 2023
4FGL J0403.5−2437	60.8989	-24.6168	TXS 0401−248	LSP	bll	Kang et al. 2023
4FGL J0407.5+0741	61.8921	7.6998	TXS 0404+075	LSP	bll	Kang et al. 2023
4FGL J0424.7+0036	66.1945	0.6028	PKS 0422+00	LSP	bll	Kang et al. 2023
4FGL J0424.9−5331	66.2498	-53.5257	PMN J0425−5331	LSP	bll	Kang et al. 2023
4FGL J0438.9−4521	69.7447	-45.3584	PKS 0437−454	LSP	bll	Kang et al. 2023
4FGL J0502.5+1340	75.6341	13.6685	PKS 0459+135	LSP	bll	Kang et al. 2023
4FGL J0513.9−3746	78.4961	-37.7774	NVSS J051404−374607	LSP	bll	Kang et al. 2023
4FGL J0516.7−6207	79.1798	-62.1248	PKS 0516−621	LSP	bll	Kang et al. 2023
4FGL J0538.8−4405	84.7089	-44.0862	PKS 0537−441	LSP	bll	Kang et al. 2023
4FGL J0610.1−1848	92.5455	-18.8076	PMN J0610−1847	LSP	bll	Kang et al. 2023
4FGL J0625.3+4439	96.3288	44.6648	GB6 J0625+4440	LSP	bll	Kang et al. 2023
4FGL J0628.8−6250	97.2174	-62.8405	PKS 0628−627	LSP	bll	Kang et al. 2023
4FGL J0629.3−1959	97.3478	-19.9999	PKS 0627−199	LSP	bll	Kang et al. 2023
4FGL J0647.7−6058	101.9314	-60.9781	PMN J0647−6058	LSP	bll	Kang et al. 2023
4FGL J0706.9+6109	106.7319	61.1595	TXS 0702+612	LSP	bll	Kang et al. 2023
4FGL J0710.9+4733	107.7323	47.5530	S4 0707+47	LSP	bll	Kang et al. 2023
4FGL J0712.7+5033	108.1876	50.5506	GB6 J0712+5033	LSP	bll	Kang et al. 2023
4FGL J0743.1+1713	115.7753	17.2198	TXS 0740+173	LSP	bll	Kang et al. 2023
4FGL J0753.0+5353	118.2530	53.8891	4C +54.15	LSP	bll	Kang et al. 2023
4FGL J0754.7+4823	118.6929	48.3932	GB1 0751+485	LSP	bll	Kang et al. 2023
4FGL J0757.1+0956	119.2856	9.9491	PKS 0754+100	LSP	bll	Kang et al. 2023
4FGL J0800.9+4401	120.2457	44.0181	B3 0757+441	LSP	bll	Kang et al. 2023
4FGL J0814.6+6430	123.6654	64.5050	GB6 J0814+6431	LSP	bll	Kang et al. 2023
4FGL J0819.0+2746	124.7636	27.7772	5C 07.119	LSP	bll	Kang et al. 2023

Table 18 *continued on next page*

Table 18 *(continued)*

4FGL name	R.A.	Decl.	ASSOC name	SED	4FGL	Reference
(1)	(2)	(3)	(4)	(5)	(6)	(7)
4FGL J0825.8+0309	126.4567	3.1656	PKS 0823+033	LSP	bll	Kang et al. 2023
4FGL J0831.8+0429	127.9732	4.4941	PKS 0829+046	LSP	bll	Kang et al. 2023
4FGL J0832.4+4912	128.1078	49.2127	OJ 448	LSP	bll	Kang et al. 2023
4FGL J0839.4+1803	129.8695	18.0606	TXS 0836+182	LSP	bll	Kang et al. 2023
4FGL J0847.9−0702	131.9945	-7.0434	TXS 0845−068	LSP	bll	Kang et al. 2023
4FGL J0848.9+0205	132.2375	2.0870	PMN J0849+0206	LSP	bll	Kang et al. 2023
4FGL J0854.8+2006	133.7071	20.1159	OJ 287	LSP	bll	Kang et al. 2023
4FGL J0901.2+6742	135.3164	67.7129	TXS 0856+679	LSP	bll	Kang et al. 2023
4FGL J0925.7+3126	141.4454	31.4470	B2 0922+31B	LSP	bll	Kang et al. 2023
4FGL J0929.3+5014	142.3265	50.2352	GB6 J0929+5013	LSP	bll	Kang et al. 2023
4FGL J0930.3+8612	142.5994	86.2021	S5 0916+864	LSP	bll	Kang et al. 2023
4FGL J0930.7+3502	142.6813	35.0334	B2 0927+35	LSP	bll	Kang et al. 2023
4FGL J0942.3−0800	145.5856	-8.0076	PMN J0942−0800	LSP	bll	Kang et al. 2023
4FGL J0958.7+6534	149.6897	65.5678	S4 0954+65	LSP	bll	Kang et al. 2023
4FGL J1001.1+2911	150.2938	29.1880	GB6 J1001+2911	LSP	bll	Kang et al. 2023
4FGL J1008.0+0620	152.0136	6.3475	MG1 J100800+0621	LSP	bll	Kang et al. 2023
4FGL J1019.7+6321	154.9263	63.3527	GB6 J1019+6319	LSP	bll	Kang et al. 2023
4FGL J1024.8+2332	156.2101	23.5462	MG2 J102456+2332	LSP	bll	Kang et al. 2023
4FGL J1058.0+4305	164.5181	43.0938	B3 1055+433	LSP	bll	Kang et al. 2023
4FGL J1058.4+0133	164.6240	1.5641	4C +01.28	LSP	bll	Kang et al. 2023
4FGL J1058.6−8003	164.6600	-80.0640	PKS 1057−79.	LSP	bll	Kang et al. 2023
4FGL J1105.8+3944	166.4589	39.7426	GB6 J1105+3946	LSP	bll	Kang et al. 2023
4FGL J1128.8+3757	172.2042	37.9657	NVSS J112903+375655	LSP	bll	Kang et al. 2023
4FGL J1138.2+4115	174.5711	41.2562	NVSS J113812+411353	LSP	bll	Kang et al. 2023
4FGL J1147.0−3812	176.7600	-38.2006	PKS 1144−379	LSP	bll	Kang et al. 2023
4FGL J1148.6+1841	177.1542	18.6861	TXS 1146+189	LSP	bll	Kang et al. 2023
4FGL J1154.1−3243	178.5423	-32.7189	PKS 1151−324	LSP	bll	Kang et al. 2023
4FGL J1201.7+1429	180.4471	14.4852	OM 198	LSP	bll	Kang et al. 2023
4FGL J1218.0−0028	184.5136	-0.4832	PKS 1215−002	LSP	bll	Kang et al. 2023
4FGL J1218.5−0119	184.6388	-1.3270	PKS 1216−010	LSP	bll	Kang et al. 2023
4FGL J1223.8+8039	185.9707	80.6598	S5 1221+80	LSP	bll	Kang et al. 2023
4FGL J1224.9+4334	186.2371	43.5691	B3 1222+438	LSP	bll	Kang et al. 2023
4FGL J1227.1−4437	186.7859	-44.6274	PKS 1224−443	LSP	bll	Kang et al. 2023
4FGL J1239.4+0728	189.8620	7.4709	PKS 1236+077	LSP	bll	Kang et al. 2023
4FGL J1250.6+0217	192.6513	2.2876	PKS 1247+025	LSP	bll	Kang et al. 2023
4FGL J1254.9−4426	193.7280	-44.4441	PKS 1252−441	LSP	bll	Kang et al. 2023
4FGL J1259.7−3223	194.9449	-32.3898	LEDA 4075145	LSP	bll	Kang et al. 2023
4FGL J1302.8+5748	195.7209	57.8146	TXS 1300+580	LSP	bll	Kang et al. 2023
4FGL J1303.0+2434	195.7571	24.5821	MG2 J130304+2434	LSP	bll	Kang et al. 2023
4FGL J1305.6+7853	196.4126	78.8923	S5 1304+79	LSP	bll	Kang et al. 2023

Table 18 *continued on next page*

Table 18 *(continued)*

4FGL name	R.A.	Decl.	ASSOC name	SED	4FGL	Reference
(1)	(2)	(3)	(4)	(5)	(6)	(7)
4FGL J1309.7+1153	197.4377	11.8969	4C +12.46	LSP	bll	Kang et al. 2023
4FGL J1330.4+3157	202.6002	31.9630	MG2 J132953+3153	LSP	bll	Kang et al. 2023
4FGL J1353.0−4413	208.2566	-44.2260	PKS 1349−439	LSP	bll	Kang et al. 2023
4FGL J1353.3+1434	208.3355	14.5755	OP 186.	LSP	bll	Kang et al. 2023
4FGL J1407.6−4301	211.9194	-43.0234	SUMSS J140739−430231	LSP	bll	Kang et al. 2023
4FGL J1410.1+0202	212.5287	2.0354	PKS 1407+022	LSP	bll	Kang et al. 2023
4FGL J1419.8+5423	214.9550	54.3937	OQ 530	LSP	bll	Kang et al. 2023
4FGL J1427.6−3305	216.9130	-33.0940	PKS 1424−328	LSP	bll	Kang et al. 2023
4FGL J1439.7+4958	219.9411	49.9775	GB6 J1439+4958	LSP	bll	Kang et al. 2023
4FGL J1440.0−1530	220.0072	-15.5154	PKS 1437−153	LSP	bll	Kang et al. 2023
4FGL J1445.9−1626	221.4978	-16.4498	PKS B1443−162	LSP	bll	Kang et al. 2023
4FGL J1458.6+3722	224.6733	37.3726	B3 1456+375	LSP	bll	Kang et al. 2023
4FGL J1500.7+4752	225.1837	47.8716	TXS 1459+480	LSP	bll	Kang et al. 2023
4FGL J1505.0−3433	226.2581	-34.5546	PMN J1505−3432	LSP	bll	Kang et al. 2023
4FGL J1516.9+1934	229.2442	19.5805	PKS 1514+197	LSP	bll	Kang et al. 2023
4FGL J1522.6−2730	230.6642	-27.5059	PKS 1519−273	LSP	bll	Kang et al. 2023
4FGL J1536.8−3155	234.2127	-31.9224	PKS 1533−317	LSP	bll	Kang et al. 2023
4FGL J1540.7+1449	235.1903	14.8220	4C +14.60	LSP	bll	Kang et al. 2023
4FGL J1546.5+1816	236.6338	18.2826	MG1 J154628+1817	LSP	bll	Kang et al. 2023
4FGL J1549.6+1710	237.4120	17.1784	MG1 J154930+1708	LSP	bll	Kang et al. 2023
4FGL J1553.3+0600	238.3284	6.0127	NVSS J155331+060143	LSP	bll	Kang et al. 2023
4FGL J1603.8+1104	240.9601	11.0701	MG1 J160340+1106	LSP	bll	Kang et al. 2023
4FGL J1604.7+1734	241.1857	17.5717	NVSS J160436+173324	LSP	bll	Kang et al. 2023
4FGL J1607.0+1550	241.7745	15.8447	4C +15.54	LSP	bll	Kang et al. 2023
4FGL J1624.6+5651	246.1715	56.8504	SBS 1623+569	LSP	bll	Kang et al. 2023
4FGL J1641.9−0621	250.4892	-6.3529	TXS 1639−062	LSP	bll	Kang et al. 2023
4FGL J1642.3−8108	250.5855	-81.1375	PKS 1633−810	LSP	bll	Kang et al. 2023
4FGL J1701.3+3956	255.3340	39.9406	B3 1659+399	LSP	bll	Kang et al. 2023
4FGL J1751.5+0938	267.8776	9.6456	OT 081	LSP	bll	Kang et al. 2023
4FGL J1800.6+7828	270.1730	78.4674	S5 1803+784	LSP	bll	Kang et al. 2023
4FGL J1806.8+6949	271.7108	69.8270	3C 371	LSP	bll	Kang et al. 2023
4FGL J1824.1+5651	276.0393	56.8585	4C +56.27	LSP	bll	Kang et al. 2023
4FGL J1830.0−5225	277.5117	-52.4188	SUMSS J183004−522618	LSP	bll	Kang et al. 2023
4FGL J1834.7−5858	278.6874	-58.9818	PKS 1830−589	LSP	bll	Kang et al. 2023
4FGL J1849.4+2745	282.3543	27.7542	MG2 J184929+2748	LSP	bll	Kang et al. 2023
4FGL J1925.8−2220	291.4665	-22.3410	TXS 1922−224	LSP	bll	Kang et al. 2023
4FGL J1927.5+6117	291.8822	61.2940	S4 1926+61	LSP	bll	Kang et al. 2023
4FGL J1941.3−6210	295.3468	-62.1753	PKS 1936−623	LSP	bll	Kang et al. 2023
4FGL J1954.6−1122	298.6693	-11.3815	TXS 1951−115	LSP	bll	Kang et al. 2023
4FGL J2005.5+7752	301.3930	77.8829	S5 2007+77	LSP	bll	Kang et al. 2023

Table 18 *continued on next page*

Table 18 *(continued)*

4FGL name	R.A.	Decl.	ASSOC name	SED	4FGL	Reference
(1)	(2)	(3)	(4)	(5)	(6)	(7)
4FGL J2010.0+7229	302.5159	72.4874	4C +72.28	LSP	bll	Kang et al. 2023
4FGL J2012.2−1646	303.0719	-16.7729	PMN J2012−1646	LSP	bll	Kang et al. 2023
4FGL J2015.2−0137	303.8074	-1.6254	PKS 2012−017	LSP	bll	Kang et al. 2023
4FGL J2022.5+7612	305.6459	76.2007	S5 2023+760	LSP	bll	Kang et al. 2023
4FGL J2032.0+1219	308.0040	12.3279	PKS 2029+121	LSP	bll	Kang et al. 2023
4FGL J2049.9+1002	312.4782	10.0407	PKS 2047+098	LSP	bll	Kang et al. 2023
4FGL J2050.0+0408	312.5181	4.1401	PKS 2047+039	LSP	bll	Kang et al. 2023
4FGL J2056.7−3209	314.1780	-32.1612	PKS 2053−323	LSP	bll	Kang et al. 2023
4FGL J2134.2−0154	323.5699	-1.9042	PKS 2131−021	LSP	bll	Kang et al. 2023
4FGL J2152.5+1737	328.1370	17.6173	S3 2150+17	LSP	bll	Kang et al. 2023
4FGL J2200.3+1029	330.0887	10.4956	TXS 2157+102	LSP	bll	Kang et al. 2023
4FGL J2202.7+4216	330.6946	42.2821	BL Lac	LSP	bll	Kang et al. 2023
4FGL J2206.8−0032	331.7087	-0.5461	PMN J2206−0031	LSP	bll	Kang et al. 2023
4FGL J2216.9+2421	334.2380	24.3575	B2 2214+24B	LSP	bll	Kang et al. 2023
4FGL J2224.0−1127	336.0241	-11.4658	PKS 2221−116	LSP	bll	Kang et al. 2023
4FGL J2236.2−1706	339.0648	-17.1066	PKS 2233−173	LSP	bll	Kang et al. 2023
4FGL J2236.5−1433	339.1444	-14.5557	PKS 2233−148	LSP	bll	Kang et al. 2023
4FGL J2243.4−2544	340.8654	-25.7363	PKS 2240−260	LSP	bll	Kang et al. 2023
4FGL J2247.4−0001	341.8670	-0.0263	PKS 2244−002	LSP	bll	Kang et al. 2023
4FGL J2250.7−2806	342.6903	-28.1114	PMN J2250−2806	LSP	bll	Kang et al. 2023
4FGL J2256.6−2011	344.1728	-20.1986	PKS 2254−204	LSP	bll	Kang et al. 2023
4FGL J2257.5+0748	344.3874	7.8014	OY 91	LSP	bll	Kang et al. 2023
4FGL J2315.6−5018	348.9140	-50.3127	PKS 2312−505	LSP	bll	Kang et al. 2023
4FGL J2330.6−3726	352.6603	-37.4346	PKS 2327−376	LSP	bll	Kang et al. 2023
4FGL J2346.7+8008	356.6867	80.1366	WN B2344.2+7951	LSP	bll	Kang et al. 2023
4FGL J2353.7−3037	358.4321	-30.6219	PKS 2351−309	LSP	bll	Kang et al. 2023
4FGL J2357.4−0152	359.3674	-1.8703	PKS 2354−021	LSP	bll	Kang et al. 2023
4FGL J0001.2−0747	0.3151	-7.7971	PMN J0001−0746	LSP	bll	Kang et al. 2023
4FGL J0003.2+2207	0.8058	22.1302	2MASX J00032450+2204559	LSP	bll	Kang et al. 2023
4FGL J0022.5+0608	5.6376	6.1343	PKS 0019+058	LSP	bll	Kang et al. 2023
4FGL J0029.0−7044	7.2509	-70.7414	PKS 0026−710	LSP	bll	Kang et al. 2023
4FGL J0032.4−2849	8.1076	-28.8224	PMN J0032−2849	LSP	bll	Kang et al. 2023
4FGL J0124.8−0625	21.2178	-6.4328	PMN J0124−0624	LSP	bll	Kang et al. 2023
4FGL J0142.7−0543	25.6754	-5.7332	PKS 0140−059	LSP	bll	Kang et al. 2023
4FGL J0224.0−7941	36.0056	-79.6934	PMN J0223−7940	LSP	bll	Kang et al. 2023
4FGL J0241.0−0505	40.2509	-5.0943	PKS 0238−052	LSP	bll	Kang et al. 2023
4FGL J0314.3−5103	48.5929	-51.0550	PMN J0314−5104	LSP	bll	Kang et al. 2023
4FGL J0422.3+1951	65.5868	19.8618	MS 0419.3+1943	LSP	bll	Kang et al. 2023
4FGL J0428.6−3756	67.1730	-37.9403	PKS 0426−380	LSP	bll	Kang et al. 2023
4FGL J0617.2+5701	94.3162	57.0249	87GB 061258.1+570222	LSP	bll	Kang et al. 2023

Table 18 *continued on next page*

Table 18 *(continued)*

4FGL name	R.A.	Decl.	ASSOC name	SED	4FGL	Reference
(1)	(2)	(3)	(4)	(5)	(6)	(7)
4FGL J0811.4+0146	122.8610	1.7756	OJ 014	LSP	bll	Kang et al. 2023
4FGL J0817.8−0934	124.4734	-9.5777	TXS 0815−094	LSP	bll	Kang et al. 2023
4FGL J0818.2+4222	124.5572	42.3819	S4 0814+42	LSP	bll	Kang et al. 2023
4FGL J0850.0+4855	132.5083	48.9217	GB6 J0850+4855	LSP	bll	Kang et al. 2023
4FGL J0909.6+0159	137.4222	1.9917	PKS 0907+022	LSP	bll	Kang et al. 2023
4FGL J0934.3+3926	143.5861	39.4365	GB6 J0934+3926	LSP	bll	Kang et al. 2023
4FGL J0941.9+2724	145.4936	27.4136	GB6 J0941+2721	LSP	bll	Kang et al. 2023
4FGL J1018.1+1905	154.5480	19.0963	NVSS J101808+190614	LSP	bll	Kang et al. 2023
4FGL J1129.1+3703	172.2959	37.0644	CRATES J112916+370317	LSP	bll	Kang et al. 2023
4FGL J1143.1+6122	175.7881	61.3801	GB6 J1143+6122	LSP	bll	Kang et al. 2023
4FGL J1153.7+3822	178.4464	38.3684	B3 1151+386	LSP	bll	Kang et al. 2023
4FGL J1223.3+1213	185.8415	12.2312	MG1 J122332+1208	LSP	bll	Kang et al. 2023
4FGL J1226.8−1329	186.7188	-13.4940	PMN J1226−1328	LSP	bll	Kang et al. 2023
4FGL J1238.3−1959	189.5936	-19.9945	PMN J1238−1959	LSP	bll	Kang et al. 2023
4FGL J1259.1−2311	194.7798	-23.1925	PKS B1256−229	LSP	bll	Kang et al. 2023
4FGL J1304.0+3704	196.0075	37.0710	WISE J130407.31+370908.1	LSP	bll	Kang et al. 2023
4FGL J1311.8+3954	197.9598	39.9010	FIRST J131146.0+395317	LSP	bll	Kang et al. 2023
4FGL J1331.2−1325	202.8192	-13.4282	PMN J1331−1326	LSP	bll	Kang et al. 2023
4FGL J1424.2+0433	216.0508	4.5628	TXS 1421+048	LSP	bll	Kang et al. 2023
4FGL J1431.1−3120	217.7962	-31.3468	PKS 1428−311	LSP	bll	Kang et al. 2023
4FGL J1451.4+6355	222.8554	63.9172	RX J1451.4+6354	LSP	bll	Kang et al. 2023
4FGL J1455.0+0247	223.7616	2.7958	87GB 145233.9+030210	LSP	bll	Kang et al. 2023
4FGL J1456.0+5051	224.0181	50.8500	RGB J1456+508	LSP	bll	Kang et al. 2023
4FGL J1516.8+3651	229.2217	36.8505	MG2 J151646+3650	LSP	bll	Kang et al. 2023
4FGL J1539.9+4220	234.9771	42.3381	87GB 153741.6+422719	LSP	bll	Kang et al. 2023
4FGL J1549.3+6310	237.3324	63.1780	WN B1549+6319	LSP	bll	Kang et al. 2023
4FGL J1558.8+5625	239.7179	56.4268	TXS 1557+565	LSP	bll	Kang et al. 2023
4FGL J1616.7+4107	244.1821	41.1234	B3 1615+412	LSP	bll	Kang et al. 2023
4FGL J1643.0−7714	250.7719	-77.2488	PKS 1636−77	LSP	bll	Kang et al. 2023
4FGL J1643.0+3223	250.7585	32.3982	NVSS J164301+322104	LSP	bll	Kang et al. 2023
4FGL J1647.5+4950	251.8923	49.8336	SBS 1646+499	LSP	bll	Kang et al. 2023
4FGL J1704.2+1234	256.0599	12.5752	NVSS J170409+123421	LSP	bll	Kang et al. 2023
4FGL J1719.2+1745	259.8062	17.7533	PKS 1717+177	LSP	bll	Kang et al. 2023
4FGL J1745.4−0753	266.3636	-7.8894	TXS 1742−078	LSP	bll	Kang et al. 2023
4FGL J1749.0+4321	267.2554	43.3616	B3 1747+433	LSP	bll	Kang et al. 2023
4FGL J1813.6+0614	273.4084	6.2408	TXS 1811+062	LSP	bll	Kang et al. 2023
4FGL J1849.4−4313	282.3623	-43.2214	PMN J1849−4314	LSP	bll	Kang et al. 2023
4FGL J1858.3+4321	284.5967	43.3590	NVSS J185813+432452	LSP	bll	Kang et al. 2023
4FGL J2017.5−3753	304.3957	-37.8970	PKS 2014−380	LSP	bll	Kang et al. 2023
4FGL J2039.0−1046	309.7581	-10.7731	TXS 2036−109	LSP	bll	Kang et al. 2023

Table 18 *continued on next page*

Table 18 *(continued)*

4FGL name	R.A.	Decl.	ASSOC name	SED	4FGL	Reference
(1)	(2)	(3)	(4)	(5)	(6)	(7)
4FGL J2115.9−0113	318.9959	-1.2306	NVSS J211603−010828	LSP	bll	Kang et al. 2023
4FGL J2225.5−1114	336.3957	-11.2422	PKS 2223−114	LSP	bll	Kang et al. 2023
4FGL J2241.2+4120	340.3087	41.3396	B3 2238+410	LSP	bll	Kang et al. 2023
4FGL J2307.6+1451	346.9222	14.8644	MG1 J230734+1449	LSP	bll	Kang et al. 2023
4FGL J2311.0+0205	347.7661	2.0995	NVSS J231101+020504	LSP	bll	Kang et al. 2023
4FGL J0114.8+1326	18.712	13.434	GB6 J0114+1325	ISP	bll	Zhang et al. 2022
4FGL J0203.7+3042	30.933	30.714	NVSS J020344+304238	LSP	bll	Zhang et al. 2022
4FGL J0325.5−5635	51.379	-56.591	1RXS J032521.8−563543	HSP	bll	Zhang et al. 2022
4FGL J0334.2−4008	53.557	-40.145	PKS 0332−403	LSP	bll	Zhang et al. 2022
4FGL J0407.5+0741	61.892	7.700	TXS 0404+075	LSP	bll	Zhang et al. 2022
4FGL J0428.6−3756	67.173	-37.940	PKS 0426−380	LSP	bll	Zhang et al. 2022
4FGL J0430.3−2507	67.575	-25.128	PMN J0430−2507	ISP	bll	Zhang et al. 2022
4FGL J0433.1+3227	68.290	32.461	NVSS J043307+322840	HSP	bll	Zhang et al. 2022
4FGL J0434.1−2014	68.529	-20.244	TXS 0431−203	ISP	bll	Zhang et al. 2022
4FGL J0438.9−4521	69.745	-45.358	PKS 0437−454	LSP	bll	Zhang et al. 2022
4FGL J0516.7−6207	79.180	-62.125	PKS 0516−621	LSP	bll	Zhang et al. 2022
4FGL J0538.8−4405	84.709	-44.086	PKS 0537−441	LSP	bll	Zhang et al. 2022
4FGL J0629.3−1959	97.348	-20.000	PKS 0627−199	LSP	bll	Zhang et al. 2022
4FGL J0644.6+6039	101.162	60.656	NVSS J064435+603849	ISP	bll	Zhang et al. 2022
4FGL J0747.2+4529	116.822	45.499	NVSS J074654+453231	ISP	bcu	Zhang et al. 2022
4FGL J0749.7+7450	117.431	74.846	RX J0749.4+7451	ISP	bll	Zhang et al. 2022
4FGL J0811.4+0146	122.861	1.776	OJ 014	LSP	bll	Zhang et al. 2022
4FGL J0833.9+4223	128.476	42.399	OJ 451	LSP	fsrq	Zhang et al. 2022
4FGL J0854.8+2006	133.707	20.116	OJ 287	LSP	bll	Zhang et al. 2022
4FGL J0856.8+2056	134.200	20.946	TXS 0853+211	ISP	bll	Zhang et al. 2022
4FGL J1001.1+2911	150.294	29.188	GB6 J1001+2911	LSP	bll	Zhang et al. 2022
4FGL J1015.0+4926	153.768	49.434	1H 1013+498	HSP	bll	Zhang et al. 2022
4FGL J1022.4−4231	155.622	-42.524	PMN J1022−4232	LSP	bll	Zhang et al. 2022
4FGL J1037.4−2933	159.356	-29.557	PKS 1034−293	LSP	fsrq	Zhang et al. 2022
4FGL J1048.0−1912	162.004	-19.212	PKS 1045−18	LSP	fsrq	Zhang et al. 2022
4FGL J1058.4+0133	164.624	1.564	4C +01.28	LSP	bll	Zhang et al. 2022
4FGL J1125.9+2005	171.491	20.091	4C +20.25	LSP	fsrq	Zhang et al. 2022
4FGL J1132.7+0034	173.196	0.574	PKS B1130+008	ISP	bll	Zhang et al. 2022
4FGL J1224.9+4334	186.237	43.569	B3 1222+438	LSP	bll	Zhang et al. 2022
4FGL J1440.0−1530	220.007	-15.515	PKS 1437−153	LSP	bll	Zhang et al. 2022
4FGL J1509.7+5556	227.441	55.942	SBS 1508+561	ISP	bll	Zhang et al. 2022
4FGL J1512.2+0202	228.070	2.040	PKS 1509+022	LSP	fsrq	Zhang et al. 2022
4FGL J1615.6+4712	243.922	47.203	B3 1614+473	ISP	fsrq	Zhang et al. 2022
4FGL J1616.7+4107	244.182	41.123	B3 1615+412	LSP	bll	Zhang et al. 2022
4FGL J1751.5+0938	267.878	9.646	OT 081	LSP	bll	Zhang et al. 2022

Table 18 *continued on next page*

Table 18 *(continued)*

4FGL name	R.A.	Decl.	ASSOC name	SED	4FGL	Reference
(1)	(2)	(3)	(4)	(5)	(6)	(7)
4FGL J1754.5−6425	268.639	-64.418	PMN J1754−6423		bll	Zhang et al. 2022
4FGL J1800.6+7828	270.173	78.467	S5 1803+784	LSP	bll	Zhang et al. 2022
4FGL J1811.3+0340	272.826	3.679	NVSS J181118+034113	HSP	bll	Zhang et al. 2022
4FGL J1924.8−2914	291.214	-29.247	PKS B1921−293	LSP	fsrq	Zhang et al. 2022
4FGL J2032.0+1219	308.004	12.328	PKS 2029+121	LSP	bll	Zhang et al. 2022
4FGL J2152.5+1737	328.137	17.617	S3 2150+17	LSP	bll	Zhang et al. 2022
4FGL J2206.8−0032	331.709	-0.546	PMN J2206−0031	LSP	bll	Zhang et al. 2022
4FGL J2243.7−1231	340.927	-12.526	RBS 1888		bll	Zhang et al. 2022
4FGL J2247.4−0001	341.867	-0.026	PKS 2244−002	LSP	bll	Zhang et al. 2022
4FGL J2315.6−5018	348.914	-50.313	PKS 2312−505	LSP	bll	Zhang et al. 2022
4FGL J2353.7−3037	358.432	-30.622	PKS 2351−309	LSP	bll	Zhang et al. 2022

Note—The 4FGL name are presented in Column 1. Columns 2 and 3 are the J2000 coordinates. The counterpart names are listed in Column 4. Column 5 lists the optical class, column 4 is the spectral energy distribution (SED) class reported in 4FGL catalog, respectively. The optical class before and after the predictions (transition) in Zhang et al. (2022) are presented in Columns 7.

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