Relativistic Jet Properties of GeV AGNs. II.
Correlations among Jet, Disk, and Broad Line Region

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◆ **Introduction:** The jet launching is reported to be connected with the central black hole (BH), accretion disk, and corona (e.g., Merloni & Fabian 2002). The broad line region (BLR) is also widely acknowledged to be photoionized by the continuum from the accretion disk (e.g., Kwan & Krolik 1981). Hence the investigation of the correlations among jet, disk, and BLR may shed light on the jet formation mechanism. Hence, the GeV FSRQs and NLS1s in which the SEDs are dominated by the jet emission and the thermal emission from accretion disk are also observed, are the good candidates for investigating this issue.

◆ **Method:** By fitting SEDs, we get their jet power (P_{jet}) and disk luminosity (L_{disk}). The luminosity of BLR (L_{BLR}) is obtained with the luminosities of emission lines. Twin jets are considered for calculation of P_{jet}.

◆ **L_{BLR} is strongly correlated with L_{disk}.** The Kolmogorov−Smirnov tests show that the L_{BLR}–L_{disk} relation of the GeV-FSRQs is not distinguished from a large radio-quiet quasar sample (RQQs), but is marginally indistinguishable with a radio-loud quasar sample (RLQs). This is due to the marginally different distributions of L_{disk} among the three samples, which also results in the different BLR covering factors (L_{BLR}/L_{disk}), as shown in Fig. 1.

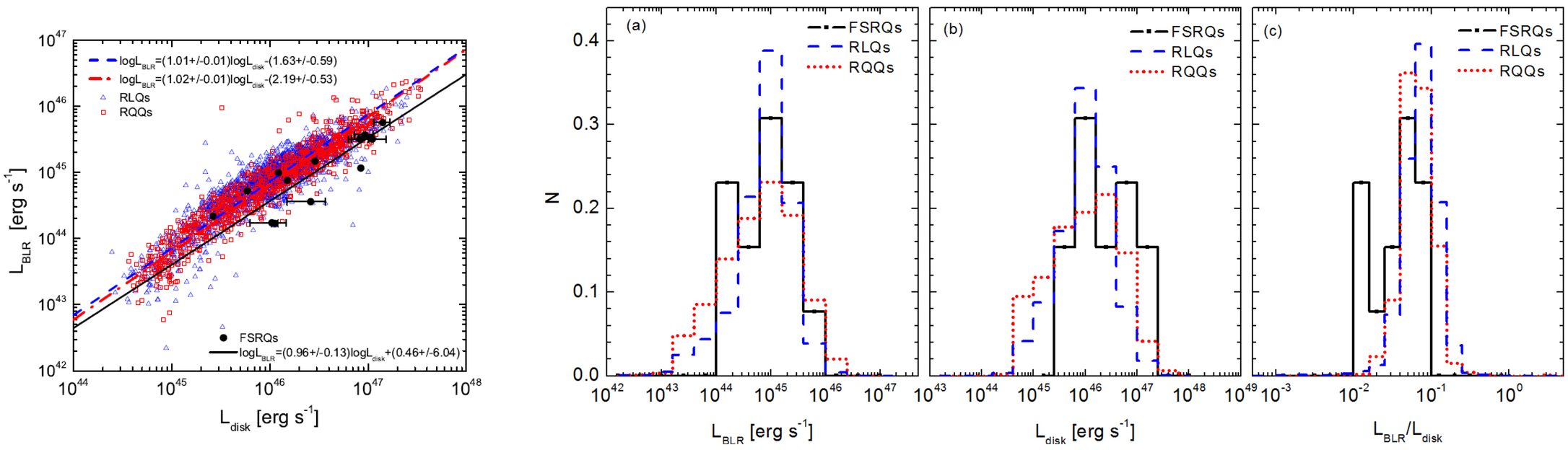

Fig. 1 L_{BLR} as a function of L_{disk}, and the normalized distributions of L_{BLR}, L_{disk}, and the BLR covering factor (L_{BLR}/L_{disk}) for GeV FSRQs. The data for the large sample of RQQs and RLQs taken from Shen et al. (2011) are also presented.

◆ **No correlation between P_{jet} with L_{disk} and L_{BLR} is found for the GeV FSRQs.** Their P_{jet} are lower than the accretion power of BH (L_{disk}/0.1), indicating that the total accretion power of BH is sufficient to drive their jets, but the noncorrelation of L_{disk}–P_{jet} may suggest that their jets are launched by the BZ process via extracting the rotational energy of BH.

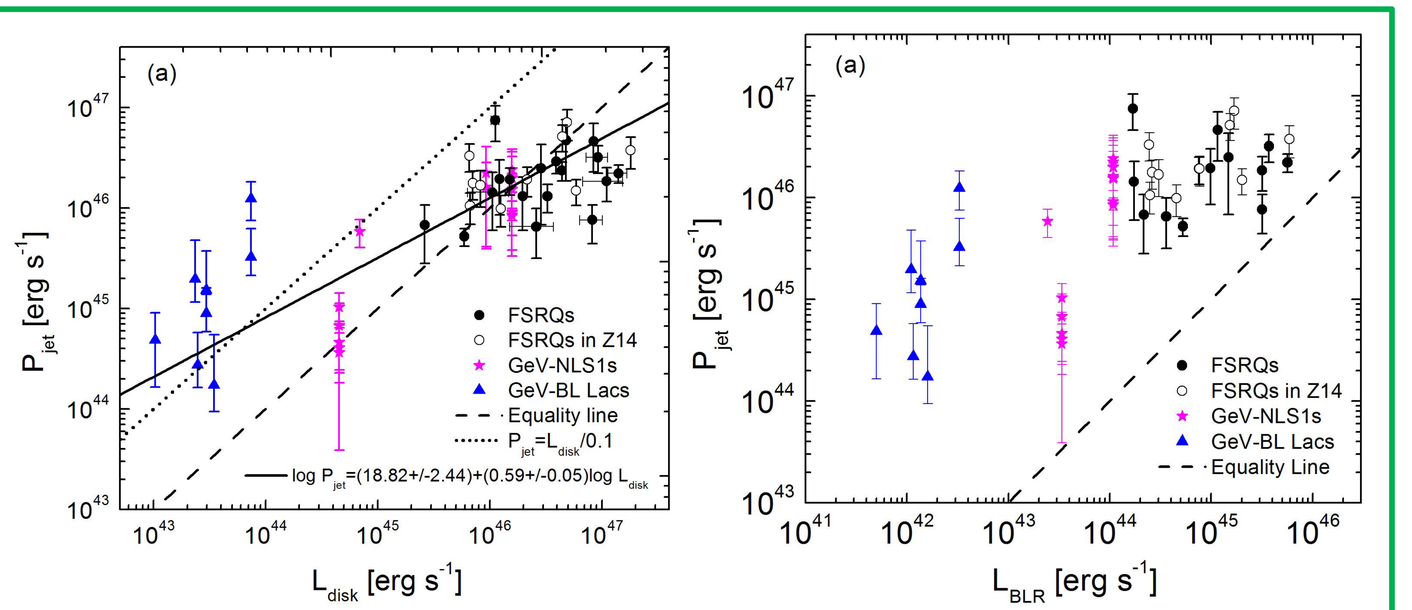

Fig.2 P_{jet} as functions of L_{disk} and $L_{BLR.}$ The data of other GeV AGNs are taken from our previous works. L_{disk} of BL Lacs are estimated with L_{BLR} with the L_{BLR}–L_{disk} relation of FSRQs.

◆**P_{jet} would be strongly correlated with L_{disk} and Eddington ratio (L_{disk}/L_{Edd}) if taking all the GeV AGNs into account.** **P_r is also correlated with L_{disk} and L_{BLR} for all GeV AGNs, and lower than L_{disk}. It is interesting to find that BL Lacs, GeV NLS1 galaxies, and FSRQs form a sequence in the L_{disk}–P_r plane.**

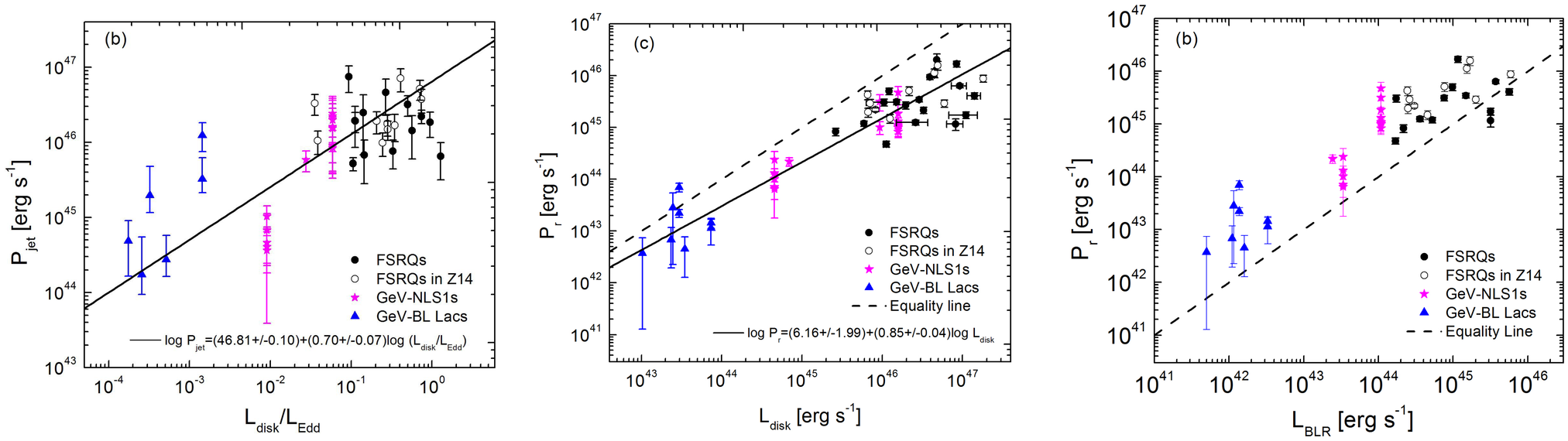

Fig. 3 P_{jet} as a function of L_{disk}/L_{edd}, P_r as functions of L_{disk} and L_{BLR} for GeV AGNs. The solid lines are the best linear fits.

◆ Eddington Ratio and Jet Formation of GeV AGNs:

With a lager sample, it is found that the distributions of L_{BLR} and L_{disk}/L_{Edd} form a sequence along BL Lac-NLS1-FSRQ as shown in Fig 4, likely implying that the Eddington ratio may be the fundamental in the unified framework among different types of GeV AGNs, which may correspond to the change of the accretion disk structure and the transformation of the dominant mechanism for jet launching.

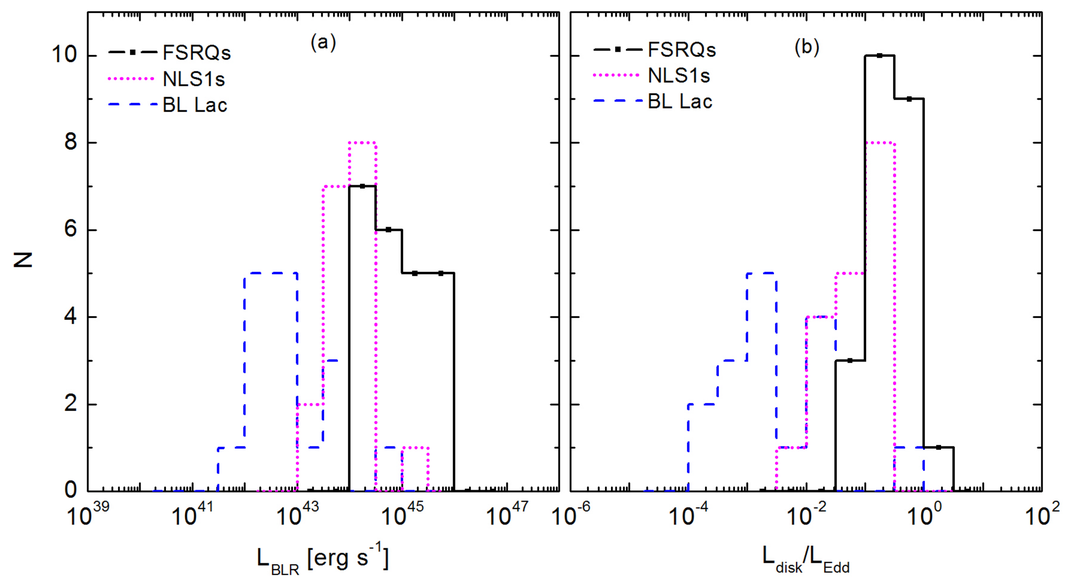

Fig 4. Distributions of L_{BLR} and L_{disk}/L_{Edd} for BL Lacs, very RL NLS1s, and GeV FSRQs. The L_{BLR} of BL Lacs are taken from Ghisellini et al. (2011) and Sbarrato et al. (2012). The L_{BLR} and BH mass of very RL NLS1s are from Yuan et al. (2008) and Calderone et al. (2013).

◆ Conclusions:

- **L_{BLR} is strongly correlated with L_{disk}, and thus L_{BLR} can be used to estimate L_{disk}.**
- **No correlation between P_{jet} with L_{disk} and L_{BLR} is found. P_{jet} is lower than the accretion power of BH, indicating that the total accretion power of BH is sufficient to drive FSRQ jets, but the uncorrelated L_{disk} - P_{jet} relation of FSRQs in our sample may suggest that their jets are launched by the BZ process via extracting the rotational energy of BH.**
- **It is found that along with the BL Lac–NLS1–FSRQ sequence L_{BLR} and (L_{disk}/L_{Edd}) increase, which may correspond to the change of the accretion disk structure and the transformation of the dominant mechanism for jet launching. This is also consistent with the division of their parent populations, i.e., the low/high-excitation radio galaxies (e.g., Mingo et al. 2014).**

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For further details and all references, please refer to our full papers:

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