Ref. [26] (IT09) before the former was announced. IT09 calculated the EGRB from blazars by constructing a blazar gamma-ray luminosity function (GLF) model that is consistent with the flux and redshift distributions of the EGRET blazars, accounting for the blazar sequence as well as the luminosity-dependent density evolution (LDDE) scheme that describes well the evolution of the X-ray luminosity function (XLF) of AGNs. By introducing the blazar SED sequence, we were able to make a reasonable and non-trivial prediction of the EGRB spectrum that can be compared with observations including the new *Fermi* data.

Recently, Ref. [28] has shown that the EGRB in the MeV band can be naturally explained by normal (i.e., non-blazar) AGNs that compose the cosmic X-ray background. If so, they should also contribute to the EGRB at $\lesssim 1$ GeV. We will investigate what fraction of the observed EGRB can be explained by the sum of the blazar and non-blazar AGN components. The contribution of blazars to the EGRB in the MeV band is also discussed and compared with a recent study on the possible relevance of the so-called "MeV blazars" [29].

We will then make quantitative predictions for the *Fermi* Gamma-ray Space Telescope [30] for its five-year survey. The first *Fermi* catalog for bright gamma-ray sources including AGNs has recently been released [31, 32]. The number of currently detected blazars is about 100, larger than that of EGRET by a modest factor of about 2. We limit the discussion of the blazar data to only the EGRET sample in this work, to be considered as a theoretical prediction from the pre-*Fermi* era. In the future, a much larger number of blazars should be detected with *Fermi*, which can be compared further with our predictions.

We also discuss the highest-redshift blazars detectable by *Fermi*, by updating the IT09 GLF model with respect to high-redshift evolution. We briefly mention the possibility of utilizing such blazars to obtain information on the high-redshift extragalactic background light and early galaxy formation through spectral absorption features.

Throughout this paper, we adopt the standard cosmological parameters of $(h, \Omega_M, \Omega_\Lambda)$=(0.7,0.3,0.7).

II. THE BLAZAR SED SEQUENCE

Ref. [19, 20, 23] constructed an empirical blazar SED model to describe the SED sequence, based on fittings to observed SEDs from radio to γ-ray bands. These models are comprised of the two components (synchrotron and IC), and each of the two is described by a linear curve at low photon energies and a parabolic curve at high energies.

We construct our own SED sequence model mainly based on the SED model [23], because there is a mathematical discontinuity in the original model of Ref.

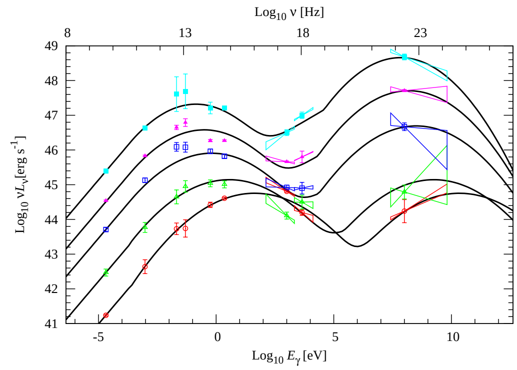

FIG. 1: The blazar SED sequence. The data points are the average SED of the blazars studied by Ref. [20, 23]. The solid curves are the empirical SED sequence models constructed and used in this paper. The model curves corresponds to the bolometric luminosities of $\log_{10}(P/\mathrm{erg\ s^{-1}})$ = 49.50, 48.64, 47.67, 46.37, and 45.99 (from top to bottom).

[23]. Our own SED sequence formula is described in the Appendix of Ref. [26] in detail. In Fig.1, we show this empirical blazar SED sequence model in comparison with the observed SED data [20, 23].

III. THE MODEL OF GAMMA-RAY LUMINOSITY FUNCTION OF BLAZARS

The cosmological evolution of AGN XLF has been investigated intensively [33–36]. These studies revealed that AGN XLF is well described by the LDDE model, in which peak redshift of density evolution increases with AGN luminosity. Here we construct blazar GLF models based on the two XLFs derived by Ref. [33] (hereafter U03; in hard X-ray band) and Ref. [34] (hereafter H05; in soft X-ray band). The use of LDDE in blazar GLF has been supported from the EGRET blazar data [6].

We simply assume that the bolometric luminosity of radiation from jet, P, is proportional to disk X-ray luminosity, L_X. We relate these two by the parameter q, as $P = 10^q L_X$. Here, we define the disk luminosity L_X to be that in the rest-frame 2–10 and 0.5–2 keV bands for the U03 XLF and the H05 XLF , respectively. Thus, the luminosity at rest 100 MeV, L_γ, and L_X have been related through P.

The blazar GLF ρ_γ is then obtained from the AGN XLF, ρ_X, as $\rho_\gamma(L_\gamma, z) = \kappa \frac{dL_X}{dL_\gamma} \rho_X(L_X, z)$, where ρ_γ and ρ_X are the comoving number densities per unit gamma-ray and X-ray luminosity, respectively. The parameter κ is a normalization factor, representing the fraction of AGNs observed as blazars. See the §3 in Ref. [26] for a detail.

We use the maximum likelihood method to search for the best-fit model parameters of the blazar GLF