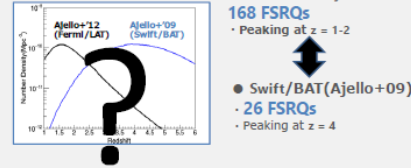


# Cosmological Evolution of Flat-Spectrum Radio Quasars Based on the Swift/BAT 105 month Catalog and their contribution to the Cosmic MeV Gamma-ray Background Radiation

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## Cosmological Evolution of FSRQ



X-ray sample is still poor.

## MeV gamma-ray background radiation

Origin is still unclear

Candidates

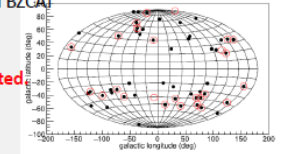
- Nonthermal emission from AGN corona (Inoue+08, 19)
- Blazar FSRQ (Ajello+09,12)
- Dark Matter (Olive85, Ahn05)

1. Inoue, Y et al. 2008  
2. Ajello, M, Shaw, M S, Romani, R W, et al. 2012  
3. Morabito, F, Hartmann, D L, et al. 1999  
4. Ahn, K, Komatsu, E. 2005

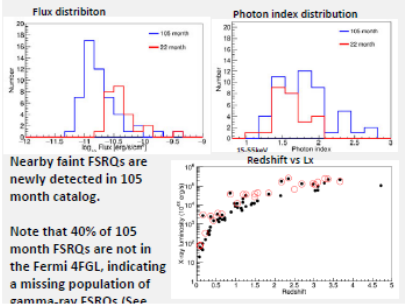
## Swift/BAT 105 month catalog

- Selection criteria of sample FSRQs
1. 10 arcmin separation between BAT catalog & BZCAT catalog
  2. Redshift difference <0.01 for z < 0.05, <0.05 for z > 0.05
  3. |b| > 15 deg

53 FSRQs are selected (26 FSRQs in 22 month)



## Comparison of FSRQs between 22 and 105 month

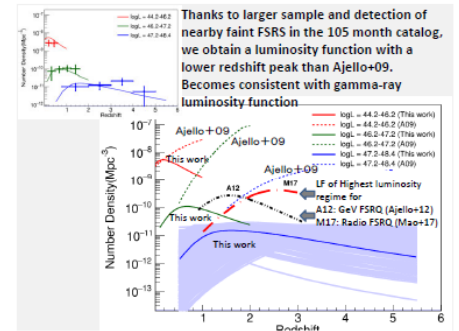
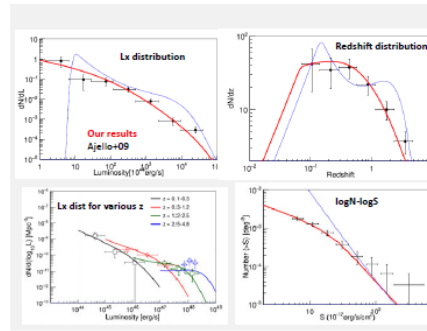


## Luminosity-Dependent Density Evolution model for Luminosity Function (LDDE)

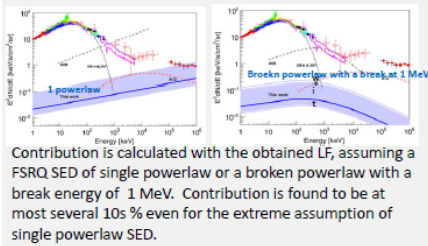
$$\Phi(L_X, z) = \frac{A}{\ln(10)L_X} \left[ \left( \frac{L_X}{L_X^*} \right)^{\gamma_1} + \left( \frac{L_X}{L_X^*} \right)^{\gamma_2} \right]^{-1} \left[ \left( \frac{1+z}{1+z_0} \right)^{p_1} + \left( \frac{1+z}{1+z_0} \right)^{p_2} \right]^{-1}$$

### Likelihood Analysis

	logL #	y1	y2	p1	p2	α	zc
Ueda14 (Se-Fert X-ray)	43.97 0.06	0.96 0.04	2.71 0.09	4.78 0.16		0.29 0.02	1.86 0.07
Ajello12 (Fermi)	44.59 0.70	0.38 0.16	1.60 0.30	7.71 1.84	-4.44 1.78	0.18 0.03	1.39 0.18
This work (BAT)	51.0 +0.05 -0.08	0.80 +0.05 -0.08	5.0 (fix)	3.58 +0.42 -3.08	-7.7 +1.5 -0.3	0.42 +0.18 -0.06	1.36 +0.64 -1.03

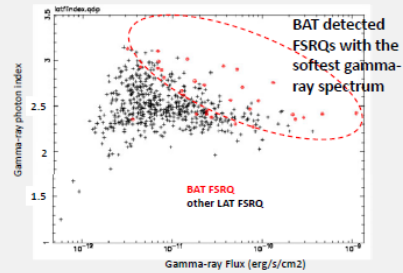


## Contribution of FSRQs to the MeV gamma-ray background radiation



MeV background cannot be explained by only FSRQs

## Appendix: BAT 105mon FSRQ and Fermi 8year catalog (4FGL)



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