The first Suzaku/WAM Gamma-ray Burst catalog

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Abstract

Gamma-ray bursts (GRBs) are one of the most powerful explosion phenomena. Many GRB catalogs have been published to study the origin of the prompt emission so far, but the physical mechanisms remain unresolved. In order to investigate systematic properties of GRBs, we are constructing the GRB catalog for GRBs observed by the wide-band all-sky monitor (WAM) onboard the Suzaku satellite. The WAM energy range is 50 – 5000 keV, and its on-axis effective area is large in comparison with other GRB instruments: 800 cm^2 at 100 keV and 400 cm^2 at 1 MeV. In the first WAM GRB catalog, we will summarize results from 1464 GRBs detected between August 4, 2005 and December 29, 2010. Ohmori et al. (2016) already reported the duration distributions with two distinct peaks at 0.38 sec and 19 sec, which confirms the presence of short/hard and long/soft GRBs. As a next step, we are performing spectral analysis with the three models (power-law, power-law with an exponential cutoff, and the Band function) using 412 GRBs localized by Swift/BAT, Fermi/GBM and interplanetary network (IPN). In this paper, we report on the status of the catalog project, focusing on distributions of spectral parameters, fluence, and 1-s peak flux.

Key words: workshop: proceedings — gamma-ray burst: general — catalogs

1. Introduction

Gamma-ray bursts (GRBs) are one of the most powerful explosion phenomena. Since the Suzaku satellite was launched on 2005 July, the wide-band all sky monitor (WAM) succeeded in detecting many GRBs. The WAM energy range is 50 – 5000 keV, and its on-axis effective area is large in comparison with other GRB instruments: 800 cm^2 at 100 keV and 400 cm^2 at 1 MeV (Yamaoka et al. 2009). For now we will summarize results from 1464 GRBs detected between August 4, 2005 and December 29, 2010 in first Suzaku/WAM GRB catalog. So far we already reported the duration distributions. These results showed that the duration distributions with two distinct peaks at 0.38 sec and 19 sec, which confirms the presence of short/hard and long/soft GRBs (Ohmori et al. 2016). Next we are performing spectral analysis using 412 GRBs localized by Swift/BAT, Fermi/GBM and interplanetary network (IPN). In this paper, we report on the status of the catalog project using 193 GRBs out of 412 GRBs, focusing on distributions of spectral parameters, fluence, and 1-s peak flux.

2. Analysis

In analysis, the spectra made using `hxdmkbstspec` and `hxdmkwamspec` in the HEASOFT version 6.19. The spectral fitting tool used `Xspec` version 12.8. To fit WAM GRB spectra, we chose three models, which are power-law (PL), power-law with an exponential cutoff (CPL), and the Band function (GRB) models(Band et al. 1993). We fitted total and 1-s peak spectra for each GRBs, and estimated energy fluence and 1-s peak photon flux.

3. Results

Table 1 shows number list of WAM spectral best fit model. The WAM E_{peak} can be determined by CPL and GRB models for ∼31% out of 193 GRBs.

Table 1. Number list of the best fit model

Model	PL(short:long)	CPL(short:long)	GRB(short:long)
Number	133 (25:108)	54 (16:38)	6 (0:6)

Figure 1 shows spectral parameter distributions of CPL and GRB models for long and short GRB in different detector. First, we compared WAM spectral parameter distributions between long and short GRBs. The central value of α distributions for short GRB is shallower than that of long GRBs, which values are around -1 in long GRB and -0.6 in short GRB. This result shows that short GRBs tend to have harder spectra than long GRB. The average value of WAM β distributions in long GRB is -2.83. More sample for GRB model are needed. The WAM E_{peak} in long and short GRBs distributes around 500 keV and 1 MeV, respectively.

Next, we also compared results with that of other detectors, which are Swift/BAT, CGRO/BATSE, and Fermi/GBM. Table 2 shows average and median for each spectral parameter distributions in different detector(Lien et al. 2016; Goldstein et al. 2013; Gruber et al. 2014). These value shows that the α and β are similar among detectors, but E_{peak} is so different. These E_{peak} distributions are strongly detector dependent.

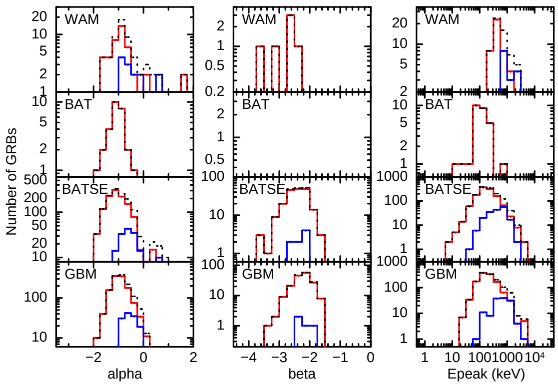

Fig. 1. From left to right, the spectral parameter α, β, and E_{peak} distributions for long GRB (red), short GRB (blue), and all data (black). Also from top to bottom, WAM, BAT, BATSE, and GBM.

Figure 2 and 3 show integral distribution of fluence and 1-s peak flux in 100 – 1000 keV. These value are estimated from information of spectral best fit model. The energy fluence distribution of long and short GRB are spread from 4×10^{-7} to 2×10^{-4} erg cm^{-2} and 1×10^{-7} to 7×10^{-5} erg cm^{-2}, respectively. Also, the 1-s peak photon flux distribution of long and short GRB are spread from 0.4 to 40 photons cm^{-2} s^{-1}, and 0.4 to 15 photons cm^{-2} s^{-1}, respectively. The uncertainties of the WAM energy responce (∼20%) are not taken into account in this analysis. This uncertainly will be estimated using the cross-calibration results and published spectral parameters in the future.

Table 2. Average and median list for each spectral parameter

Detector	α average(median)	β average(median)	E_{peak} [keV] average(median)
	long GRB		
WAM	-0.80(-0.94)	-2.83(-2.74)	552(437)
BAT	-1.07(-1.12)	-	140(102)
BATSE	-1.02(-1.08)	-2.44(-2.43)	255(171)
GBM	-0.94(-0.96)	-2.24(-2.22)	279(179)
	short GRB		
WAM	-0.36(-0.59)	-	1230(910)
BAT	-	-	1
BATSE	-0.29(-0.54)	-2.32(-2.44)	533(472)
GBM	-0.56(-0.58)	-2.15(-2.34)	761(607)

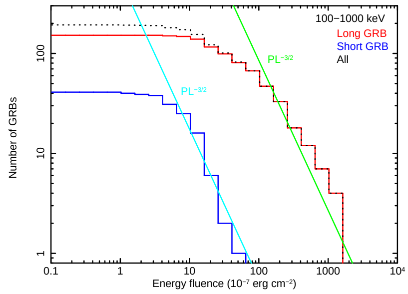

Fig. 2. Integral distribution of WAM energy fluence in 100 – 1000 keV. The lines show long GRB (red), short GRB (blue), and all data (black). Green and light blue color lines show power-law with a slope of -3/2. These lines are drawn to guide the eye.

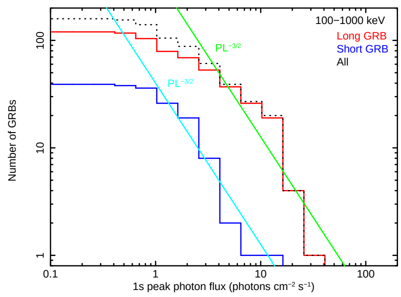

Fig. 3. Integral distribution of WAM 1-s peak photon flux in 100 – 1000 keV. The lines show long GRB (red), short GRB (blue), and all data (black). Green and light blue color lines show power-law with a slope of -3/2. These lines are drawn to guide the eye.

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