J/A+A/589/A98 Swift GRBs individual power density spectra (Guidorzi+, 2016)

Individual power density spectra of Swift gamma-ray bursts.
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=2016A&A...589A..98G (SIMBAD/NED BibCode)

ADC_Keywords: Gamma rays ; Spectroscopy

Keywords: gamma-ray burst: general - methods: statistical

Abstract:

Timing analysis can be a powerful tool for shading light on the still obscure emission physics and geometry of the prompt emission of gamma-ray bursts (GRBs).

Fourier power density spectra (PDS) characterise time series as stochastic processes and can be used to search for coherent pulsations and, more in general, to investigate the dominant variability timescales in astrophysical sources. Because of the limited duration and of the statistical properties involved, modelling the PDS of individual GRBs is challenging, and only average PDS of large samples have been discussed in the literature thus far. We aim at characterising the individual PDS of GRBs to describe their variability in terms of a stochastic process, to explore their variety, and to carry out for the first time a systematic search for periodic signals and for a link between PDS properties and other GRB observables.

We present a Bayesian procedure which uses a Markov chain Monte Carlo technique and apply it to study the individual power density spectra of 215 bright long GRBs detected with the Swift Burst Alert Telescope in the 15-150keV band from January 2005 to May 2015.

The PDS are modelled with a power-law either with or without a break. Two classes of GRBs emerge: with or without a unique dominant time scale.

A comparison with active galactic nuclei (AGNs) reveals similar distributions of PDS slopes. Unexpectedly, GRBs with subsecond dominant timescales and duration longer than a few ten seconds in the source frame appear to be either very rare or altogether absent. Three GRBs are found with possible evidence for periodic signal at 3.0-3.2σ (Gaussian) significance, corresponding to a multi-trial chance probability of ~1%. Thus, we found no compelling evidence for periodic signal in GRBs.

The analogy between the PDS of GRBs and of AGNs could tentatively hint at similar stochastic processes that rule BH accretion across different BH mass scales and objects.

In addition, we find evidence that short dominant timescales and duration are not completely independent of each other, in contrast with commonly accepted paradigms.

Description:

Time intervals, redshifts, best-fit parameters of the power density spectra (PDS) for 215 bright long GRBs observed with the Swift Burst Alert Telescope (BAT) from January 2005 to May 2015.

Parameters refer to two alternative PDS models: either a power-law (PL) or a bent power-law (BPL) plus a constant background.

File Summary:

FileName	Lrecl	Records	Explanations
ReadMe	80	.	This file
table1.dat	70	215	Time intervals for calculating the PDS referred to trigger times, T90, redshifts
refs.dat	47	59	References
table2.dat	126	215	Best fit model and parameters (1 sigma) for total energy passband (15-150keV)
table3.dat	118	215	Best fit model and parameters (1 sigma) for soft energy channel (15-50keV)
table4.dat	118	215	Best fit model and parameters (1 sigma) for hard energy channel (50-150keV)

See also:

J/ApJ/777/132 : A search for progenitors of short GRBs (Dichiara+, 2013)
J/A+A/589/A97 : GRBs Ep and Fourier PDS slope correlation (Dichiara+, 2016)

Byte-by-byte Description of file: table1.dat

Bytes	Format	Units	Label	Explanations
1- 7	A7	---	GRB	GRB name
11- 18	F8.3	s	Tstart	Start since the trigger time

Bytes	Format	Units	Label	Explanations
22- 29	F8.3	s	Tstop	Stop since the trigger time
33- 40	F8.3	s	T7sigma	Duration of T(7sigma) interval
44- 51	F8.3	s	T90	Duration of T90 interval
55- 57	A3	---	Cat	Catalogue name used for T90 (1)
60- 65	F6.4	---	z	?=- GRB Redshift (NA when not available)
69- 70	I2	---	r_z	?=- Reference for redshift, in refs.dat file

Note (1): Code for Catalogue name used for T90 as follows:
S11 = from Sakamoto et al., 2011, Cat. J/ApJS/195/2
GCN = from Swift-BAT refined GCN circulars.

Byte-by-byte Description of file: refs.dat

Bytes	Format	Units	Label	Explanations
1- 2	I2	---	Ref	Reference code
4- 22	A19	---	BibCode	BibCode
24- 47	A24	---	Aut	Author's name

Byte-by-byte Description of file: table2.dat

Bytes	Format	Units	Label	Explanations
1- 7	A7	---	GRB	GRB name
10- 12	A3	---	Model	Best-fit model of the PDS
16- 21	F6.3	[-]	logN	Best-fit log10(normalisation) of the PDS
26- 30	F5.3	[-]	e_logN	Error (1 sigma) on logN
35- 40	F6.3	[Hz]	logfb	?=- Best-fit log10(break frequency/Hz) (--- when not available)
45- 49	F5.3	[Hz]	e_logfb	? Error (1 sigma) on logfb
54- 58	F5.3	---	alpha	Best-fit PDS slope (model parameter alpha)
63- 67	F5.3	---	e_alpha	Error (1 sigma) on alpha
75- 79	F5.3	---	B	Best-fit white noise level (model param B)
84- 88	F5.3	---	e_B	Error (1 sigma) on B
94- 98	F5.3	---	pTR	P-value of TR statistic
104-108	F5.3	---	pAD	P-value of Anderson-Darling statistic
114-118	F5.3	---	pKS	P-value of Kolmogorov-Smirnov statistic
125-126	I2	---	Np	Number of pulses as determined with MEPSA

Byte-by-byte Description of file: table3.dat

Bytes	Format	Units	Label	Explanations
1- 7	A7	---	GRB	GRB name
10- 12	A3	---	Model	Best-fit model of the PDS
16- 21	F6.3	[-]	logN	Best-fit log10(normalisation) of the PDS
26- 30	F5.3	[-]	e_logN	Error (1 sigma) on logN
35- 40	F6.3	[Hz]	logfb	?=- Best-fit log10(break frequency/Hz) (--- when not available)
45- 49	F5.3	[Hz]	e_logfb	? Error (1 sigma) on logfb
54- 58	F5.3	---	alpha	Best-fit PDS slope (model parameter alpha)
63- 67	F5.3	---	e_alpha	Error (1 sigma) on alpha
75- 79	F5.3	---	B	Best-fit white noise level (model param B)
84- 88	F5.3	---	e_B	Error (1 sigma) on B
94- 98	F5.3	---	pTR	P-value of TR statistic
104-108	F5.3	---	pAD	P-value of Anderson-Darling statistic
114-118	F5.3	---	pKS	P-value of Kolmogorov-Smirnov statistic

Byte-by-byte Description of file: table4.dat

Bytes	Format	Units	Label	Explanations
1- 7	A7	---	GRB	GRB name
10- 12	A3	---	Model	Best-fit model of the PDS
16- 21	F6.3	[-]	logN	Best-fit log10(normalisation) of the PDS
26- 30	F5.3	[-]	e_logN	Error (1 sigma) on logN
35- 40	F6.3	[Hz]	logfb	?=- Best-fit log10(break frequency/Hz) (--- when not available)
45- 49	F5.3	[Hz]	e_logfb	? Error (1 sigma) on logfb
54- 58	F5.3	---	alpha	Best-fit PDS slope (model parameter alpha)
63- 67	F5.3	---	e_alpha	Error (1 sigma) on Alpha
75- 79	F5.3	---	B	Best-fit white noise level (model param B)
84- 88	F5.3	---	e_B	Error (1 sigma) on B
94- 98	F5.3	---	pTR	P-value of TR statistic
104-108	F5.3	---	pAD	P-value of Anderson-Darling statistic
114-118	F5.3	---	pKS	P-value of Kolmogorov-Smirnov statistic

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