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; Documentation for the IDL GRB simulator, GRBfullsim.pro, extracted from its comment lines.  
;  
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;  
; Overview:  
; (1) The main routine calls GRBglobal; sets up arrays; loops through the number of bursts to be  
; generated, calling makeGRB for each burst; optionally records the photon list per burst in  
; an output file; optionally plots the burst time profile.  
; (2) Module GRBglobal computes the number of bursts/year (Nbsim) within GLAST FOV  
; and calls procedures { get_durs, get_fluxes, get_plaws } which return Nbsim samples from  
; each of the distributions { durations, peak fluxes, power-law indices }, respectively.  
; (3) Module makeGRB computes the number of photons for this burst, and calls maketimes.  
; (4) Module maketimes makes BATSE-like time profiles, but with pulse widths extrapolated to  
; GLAST energies, generated in a call to module pickwidth; photons are distributed within a  
; given pulse according to an energy-dependent formulation.  
;
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pro GRBglobal, iseed, Zen_Norm

;
; The program computes the number of bursts per year expected in the GLAST
; field of view. It then calls procedures which return samples from global
; distributions for GRBs: durations, peak fluxes, and power-law indices.

; **INPUT:**

; none

; **OUTPUT:**

; durs, the duration array

; dur_gt2s, flag indicating if duration is $\{<\>\}$ 2 seconds

; Frats, the array of ratios of peak flux to maximum

; Fp, the array of ratios of peak fluxes

; betas, the array of power-law indices

; Nbsim, the number of bursts to manufacture

;

; Assume zenith acceptance angle = 75 degrees, 810 bursts/yr all-sky,

; and scanning mode. Then we simulate in this solid angle acceptance

; Nbsim bursts per year.

pro makeGRB, isim, Ethres, iseed, madeburst

;
; Computes number of photons for this burst, **N_inc**:
; SpecNorm units, integrated Peak Flux: photons cm⁻² s⁻¹ (> Ethres). Researches on normalization:
; (1) Bonnell's fits to bright BATSE bursts; (2) comparison with EGRET norms for bright bursts –
; Catelli's, Dingus' and Schneid's works; and definitively (3) analysis of Preece et al. spectroscopy catalog
; of bright BATSE bursts (see JPN routine Specanal.pro).
;
; The cofactors for SpecNorm are: (a) {average flux / peak flux} = ~ 1/7;
; (b) scaling by (peak_flux)^{1.5}, determined from inspection of Preece et al.;
; (c) duration (seconds); (d) 282743 cm² (6-meter dia. illuminated disk);
; (e) scaling to integral above Ethres (e.g., 0.03 GeV) for case beta = -2;
; (f) dispersion (dynrange) to approximately replicate the scatter in peak flux
; vs. normalization at 1 MeV as estimated from Preece et al. catalog; and
; (g) a dependence on power-law index as estimated from Preece et al. catalog.
;
; Thus, **N_inc** is number of photons normally incident on projected disk of GLAST illumination sphere,
; integrated above Ethres, for chosen peak flux & duration. Energies distributed as power-law, index beta.

; **INPUTS:** (1) Ethres, minimum energy photon for set of simulated bursts; (2) Frats(isim), ratio of this
; burst's peak flux to the maximum; (3) duration, this burst's total duration, (4) beta, this burst's
; power-law index; (5) Npuls, this burst's number of pulses.

; **OUTPUTS:**
; The program returns:
; Specnorm, the spectral normalization described above
; N_inc [Nphotons(isim)], the total number of photons for which times will be chosen
; GRBenergies, the array of photon energies
; madeburst, a flag {y,n} indicating whether or not a burst was made

pro get_durs, iseed

;

**; The program chooses durations from the BATSE bimodal duration distribution,
; where the measurement process is described by Bonnell et al. (1997, ApJ, 490, 79).**

; The parent sample is same as for peak fluxes: from GRB 910421 (trig# 105) to

; GRB 990123 (trig# 7343). This partial sample (1262) includes bursts where

; backgrounds could be fitted, and peak fluxes subsequently measured.

; The sample spans 7.75 years.

; INPUTS:

; none

; OUTPUTS:

; The program returns a float array of durations (durs), and an integer array

; (dur_gt2s: 0 or 1) indicating whether the burst's duration is from the

; long mode (1) or short mode (0); this array is used to determine which

; peak-flux distribution to choose from. Size of returned arrays = Nbsim.

pro get_fluxes, iseed

;
; The program chooses peak fluxes from the BATSE log N - log P; see Bonnell
; et al. 1997, ApJ, 490, 79, which duplicates the procedure specified by
; Pendleton*. The measurement procedure is applied uniformly for that part
; of the BATSE sample from GRB 910421 (trig# 105) to GRB 990123 (trig# 7343).
; (*Pendleton used a different PF estimation technique for the initial BATSE Catalog.)
;
; This partial sample (1262) includes bursts where backgrounds could be fitted,
; and peak fluxes subsequently measured. It spans 7.75 years. Therefore,
; in order to draw from a PF distribution representing 1 year, we truncate
; at the eighth brightest burst in 7.75 ~ 8 years. The peak flux measure
; in Bonnell et al. is for 256-ms accumulations.

; **INPUTS:**

; The integer array dur_gt2s (0 or 1) indicating whether the burst's duration
; is from the short mode (0) or long mode (1). This array is used to determine
; which peak-flux distribution to choose from, {N,P} for longs, {M,Q} for shorts.

; **OUTPUTS:**

; The program returns an array of peak fluxes (Fp), and an array of peak flux
; ratios (Frats), normalized to the brightest burst in one year.
; Size of returned arrays = Nbsim.

pro get_plaws, iseed

;
; The program chooses spectral power-law indices from the BATSE power-law
; distribution, as measured by Preece et al. (1999)

; **INPUTS:**

; none

; **OUTPUTS:**

; The program returns an array of power-law indices.
; Size of returned arrays = Nbsim.

pro pickwidth, UnivFWHM, duration, Ethres, iseed

;
; The program chooses a universal width for the pulses within a given burst.
; A given GRB tends to have pulses of comparable widths. Therefore (see Fig 3a
; of Norris et al. 1996 "attributes" paper), pick one pulse width from the
; distribution of fitted widths of "All" pulses, 50-300 keV, in bright, long
; BATSE GRBs. Then, since (a) $\sim 1/4$ of GRBs are short, and (b) short GRBs have
; pulse widths $\sim 1/10$ - $1/20$ that of long GRBs -- multiply pulse widths for one
; quarter of the GRBs by compression factor of $1/10$. Then using $\text{Width} \sim E^{(-0.333)}$
; relationship, scale chosen width to Ethres, from 100 keV.

; **INPUTS:**

; Ethres, the minimum energy photon for this set of simulated bursts
; duration, this burst's total duration

; **OUTPUTS:**

; The program returns a FWHM width to be using in making pulses for one burst.

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pro maketimes, GRBtimes, GRBenergies, N_inc, Npuls, duration, Ethres, iseed
;
; make BATSE-like GRB time profiles, placing GLAST photons a la
; cumulative BATSE intensity, but in narrower pulses:
; (1) Npuls = number of pulses, proportional to BATSE duration.
; (2) pulse peak amplitude is random (0.0=>1.0); sort amps in descending amp order.
; (3) scramble amps of {1st,2nd} halves of pulses, separately (leaves profile asymmetric)
; (4) center of pulse time is random within duration. sort the times, ascending order.
; (5) pulse width is drawn from BATSE width distribution for bright bursts (attributes
; paper), scaled to GLAST energies, using width ~ E^-0.333 .
; (6) make Npuls pulses with "bisigma" shapes => sum to produce time profile
; (7) form cumulative distribution of BATSE intensity
; (8) distribute the N_inc photons according cumulative intensity => GRBtimes
; (9) offset the photon times according to (a) energy dependence, width ~ E^-0.333
; and (b) time of peak, also proportional to E^-0.333.

; INPUTS:
; Ethres, the minimum energy photon for this set of simulated bursts
; duration, this burst's total duration
; N_inc, the total number of photons for which times will be chosen
; GRBenergies, the array of photon energies

; OUTPUTS:
; The program returns:
; Npuls, the number of pulses in this burst
; amplitudes, the pulse peak amplitudes
; tmax, the times of peak amplitude
; GRBtimes, the array of photon times
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