CHARACTERIZING "PRECURSOR" EMISSION FROM BATSE TO Swift-BAT

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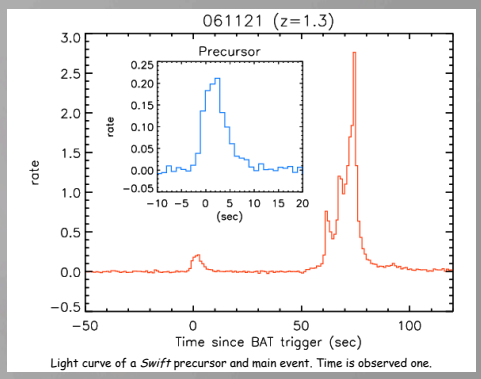
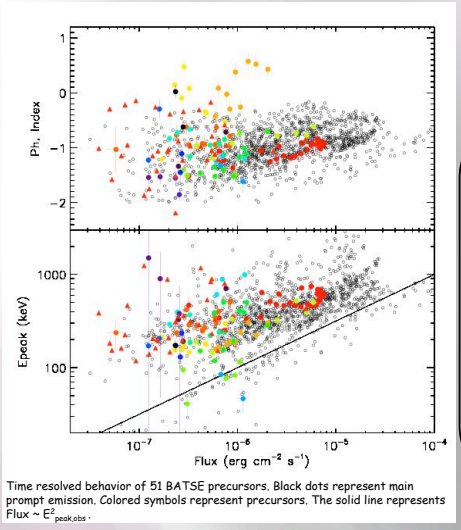
Gamma Ray Bursts are sometimes preceded by dimmer emission episodes, called "precursors", whose nature is still a puzzle. Theoretical models predicted a thermal spectrum, generally softer than the following main prompt emission.

How to define a "precursor"? Since there is no obvious *a priori* criterion. We called "precursor" an initial signal which
(1) had a smaller peak flux than the main event in the same energy band;
(2) the flux returned to the background level before the start of the main event.



Light curve of a *Swift* precursor and main event. Time is observed one.



Time resolved behavior of 51 BATSE precursors. Black dots represent main prompt emission. Colored symbols represent precursors. The solid line represents Flux ~ $E^2_{peak,obs}$.

We showed that **precursors and main events in BATSE**:

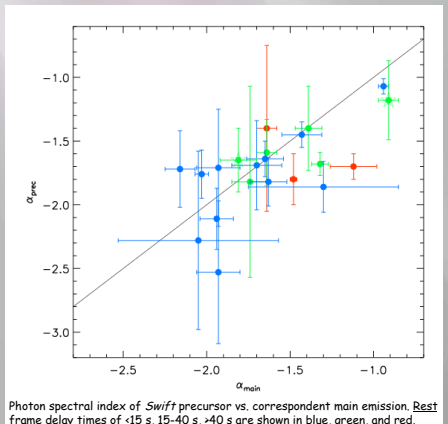
(1) span the same parameter space in the planes E_{peak} *vs.* Flux, and Ph. Index *vs.* Flux;

(2) seem to be consistent with the relation Flux ~ $E^2_{peak,obs}$ (Liang et al. 2004, Firmani et al. 2009);

(3) $\langle\alpha_{prec}\rangle$ = −1.03 ± 0.27 and $\langle\alpha_{main}\rangle$ = −0.94 ± 0.34 (KS null prob 10^{-2});

(4) $\langle\log(E_{peak,prec})\rangle$ = 2.49±0.35 and $\langle\log(E_{peak,main})\rangle$ = 2.60±0.24 (KS null prob ~ 10^{-4}).

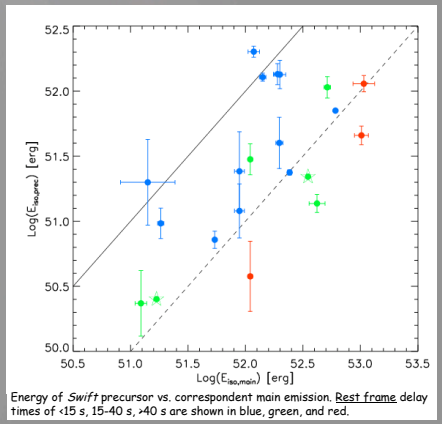
Precursors do not represent any different physical process



Photon spectral index of *Swift* precursor vs. correspondent main emission. Rest frame delay times of <15 s, 15-40 s, >40 s are shown in blue, green, and red.

(1) spetra are non-thermal and the photon indices are consistent and the is no difference for 3 quiescence intervals in the rest frame;

(2) the energy is huge (~30% of main event) and there is no clear dependence on quiescence.



Energy of *Swift* precursor vs. correspondent main emission. Rest frame delay times of <15 s, 15-40 s, >40 s are shown in blue, green, and red.

Reference papers: Burlon, Ghirlanda, Ghisellini, Lazzati, Nava, Nardini, Celotti; 2008, ApJ 685:L19-L22 and references therein
Burlon, Ghirlanda, Ghisellini, Greiner, Celotti; 2009, A&A 505:509-575 and references therein