A comparison of the properties of long and short GRBs:

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&

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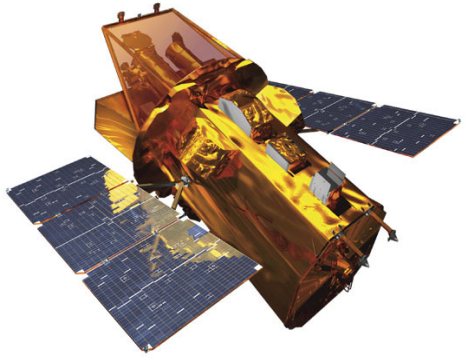
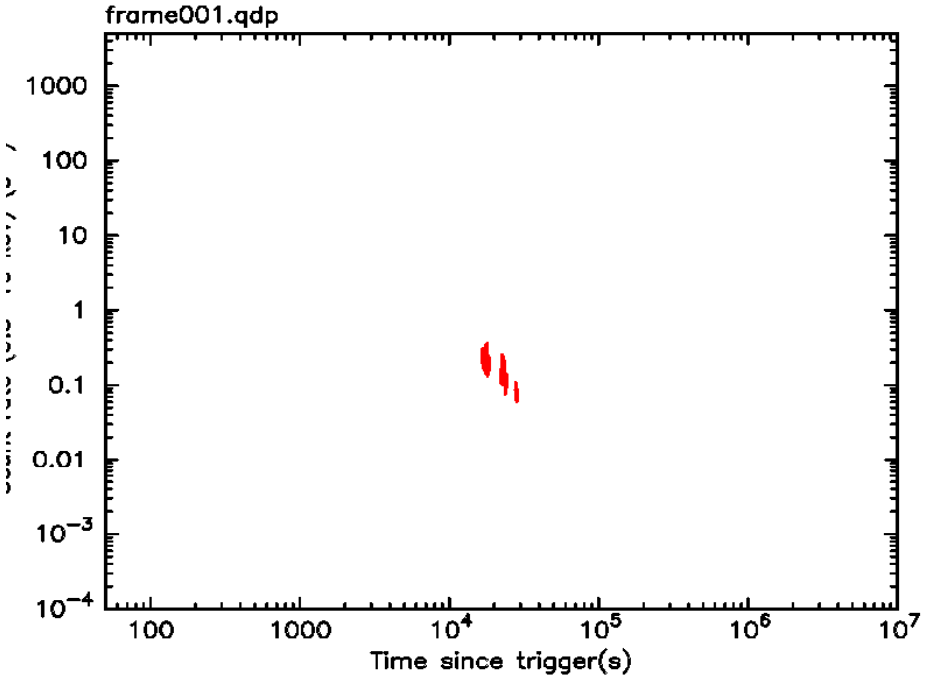
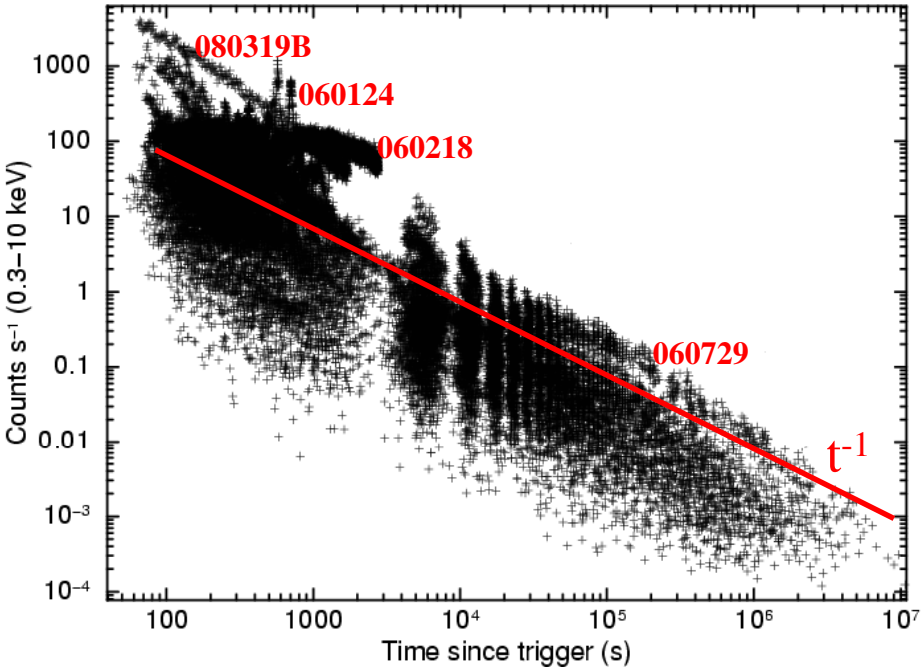


Swift era X-ray light curves





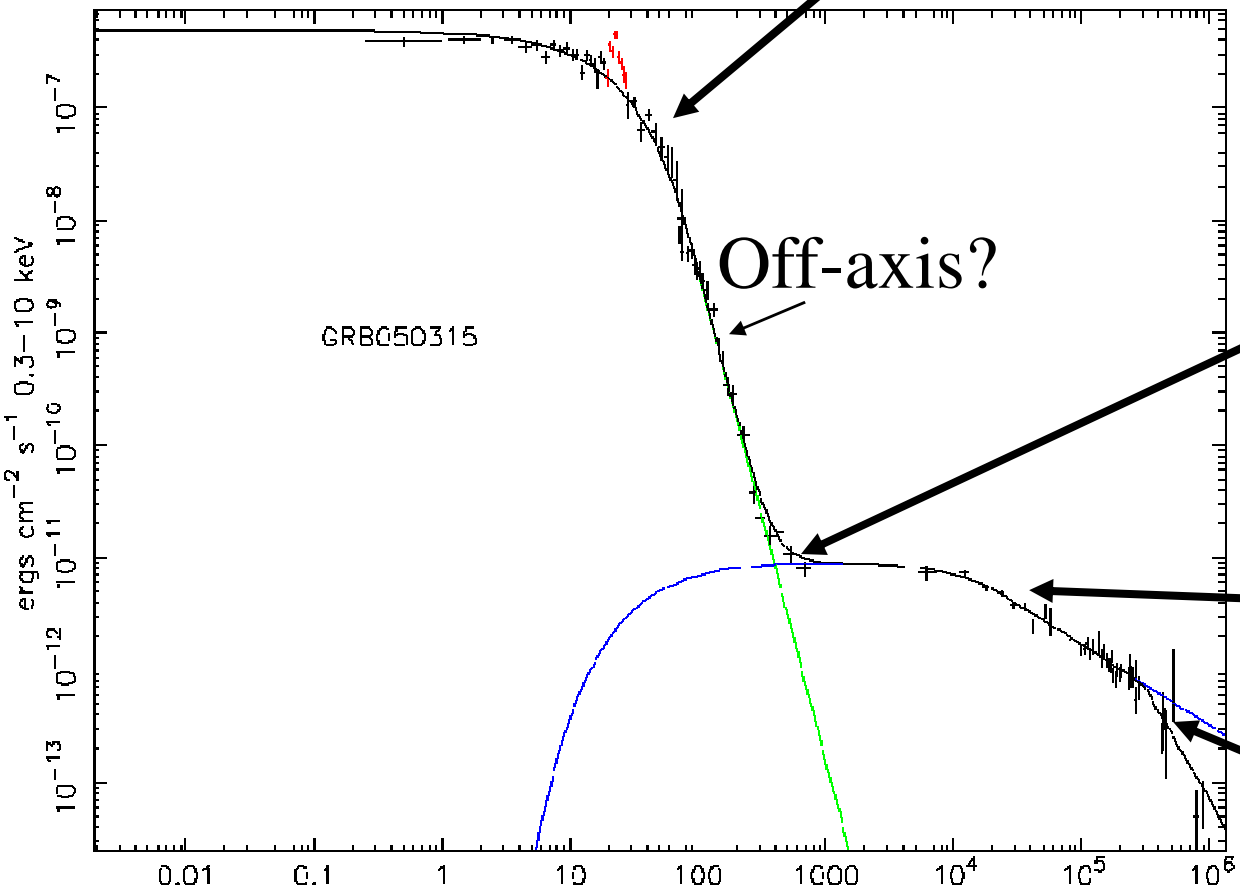
Large range in light curve shapes implies we observe a mixture of several internal and external processes but can it be one "process"?

- Fast decay and flares appear internal – engine – dominated
- Slow decays and plateau external – afterglow – dominated

Example decay phases

Bright prompt emission stops?

Flux $\propto T^{-\alpha} \upsilon^{-\beta}$



Off-axis?

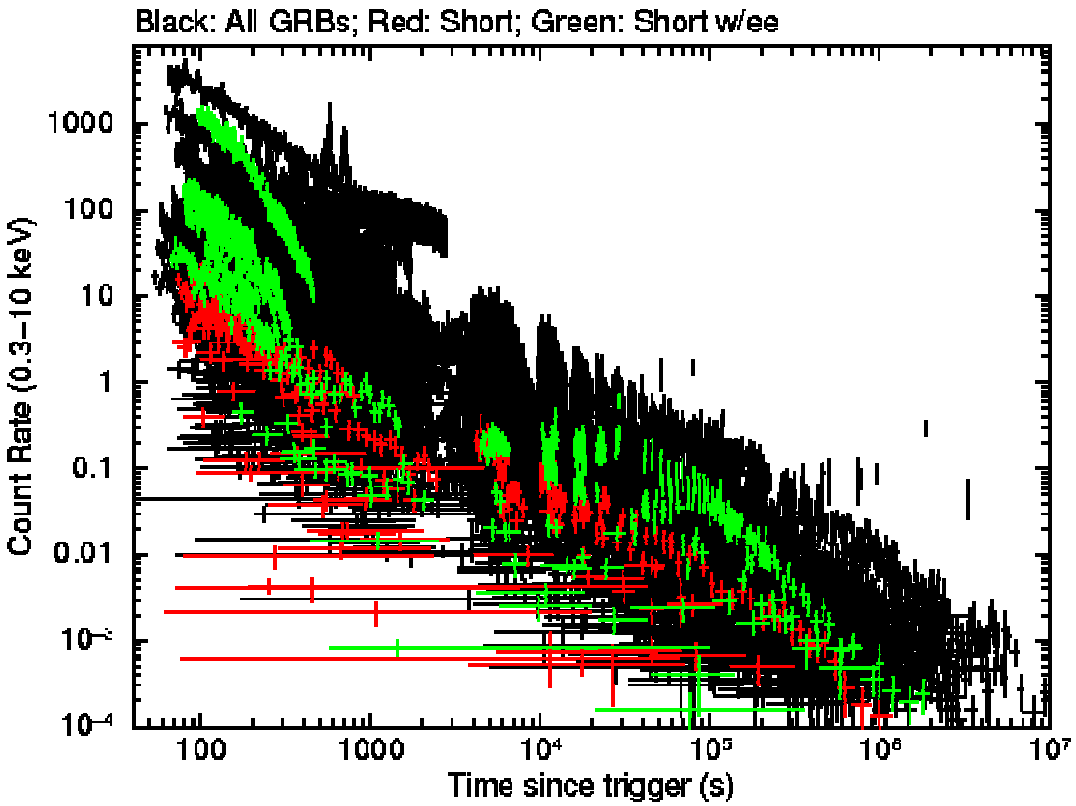
External, forward shock becomes visible

Final decay starts

Late break

(rare, collimation?)

Short GRBs vs. Long GRBs



Short compared to long GRB

Prompt emission

$\langle E_{iso} \rangle_{long} \sim 10^{52} - 10^{53}$ erg

$\langle E_{iso} \rangle_{short} \sim 10^{49} - 10^{50}$ erg

X-ray afterglow (after 10 hrs):

$\langle L_X \rangle_{long} \sim 10^{46} - 10^{47}$ erg s^{-1}

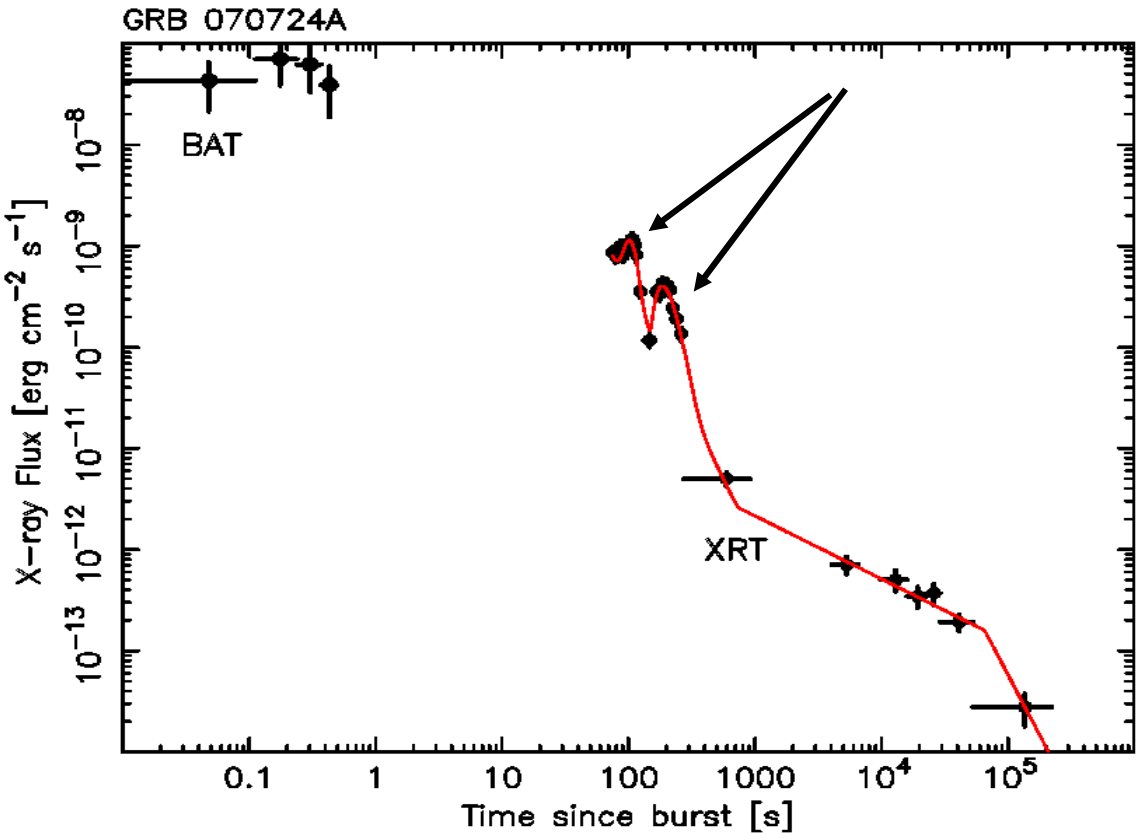
$\langle L_X \rangle_{short} < 10^{45}$ erg s^{-1}

Optical afterglow:

~50% of long GRBs detected

<30% of short GRBs detected

Short GRB X-ray flares

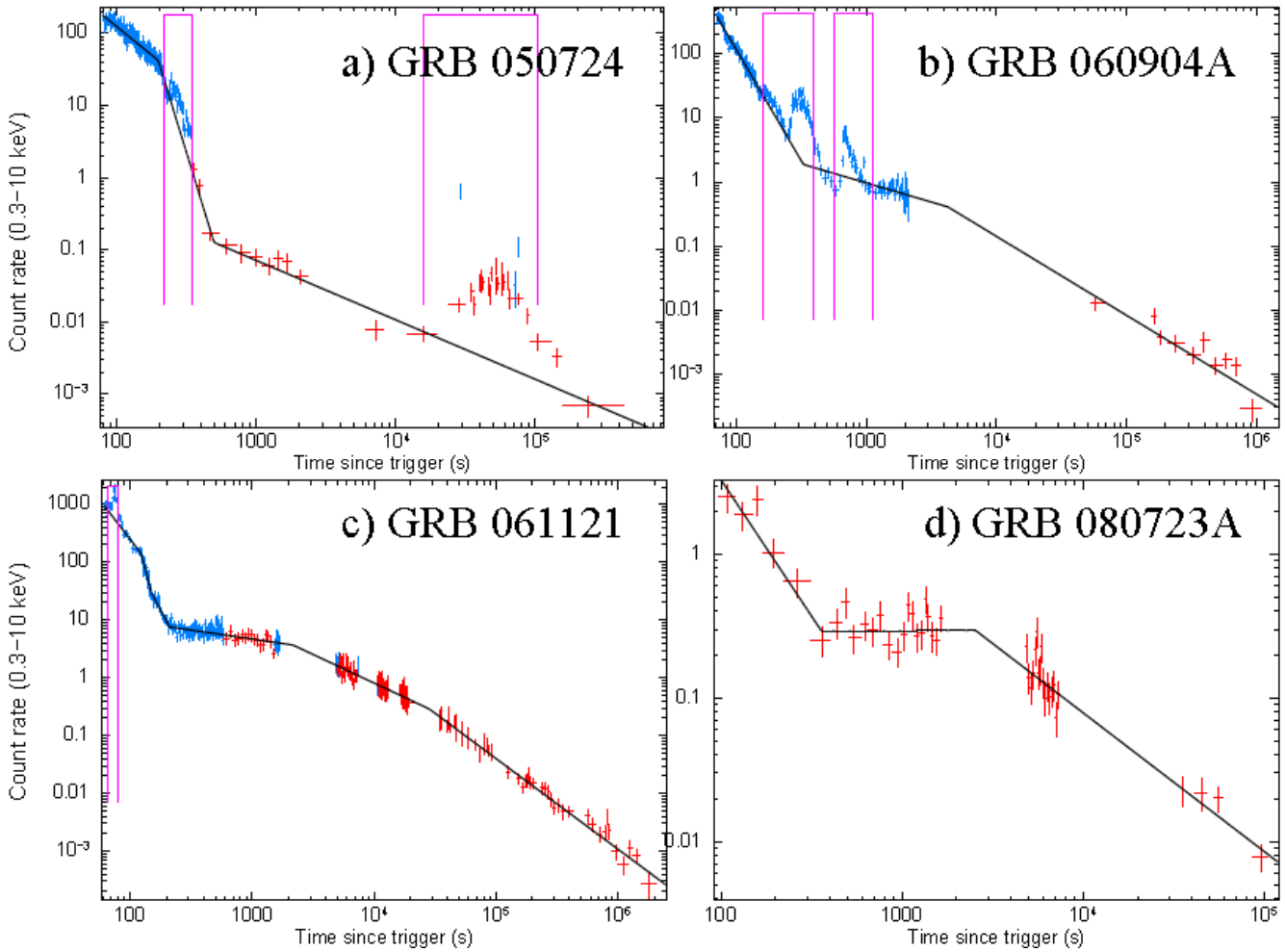


Sudden re-brightening in the X-ray light curve.

Present in 10-20% of the *Swift* sample of short bursts (cf. 40-50% of longs, but shorts are fainter)

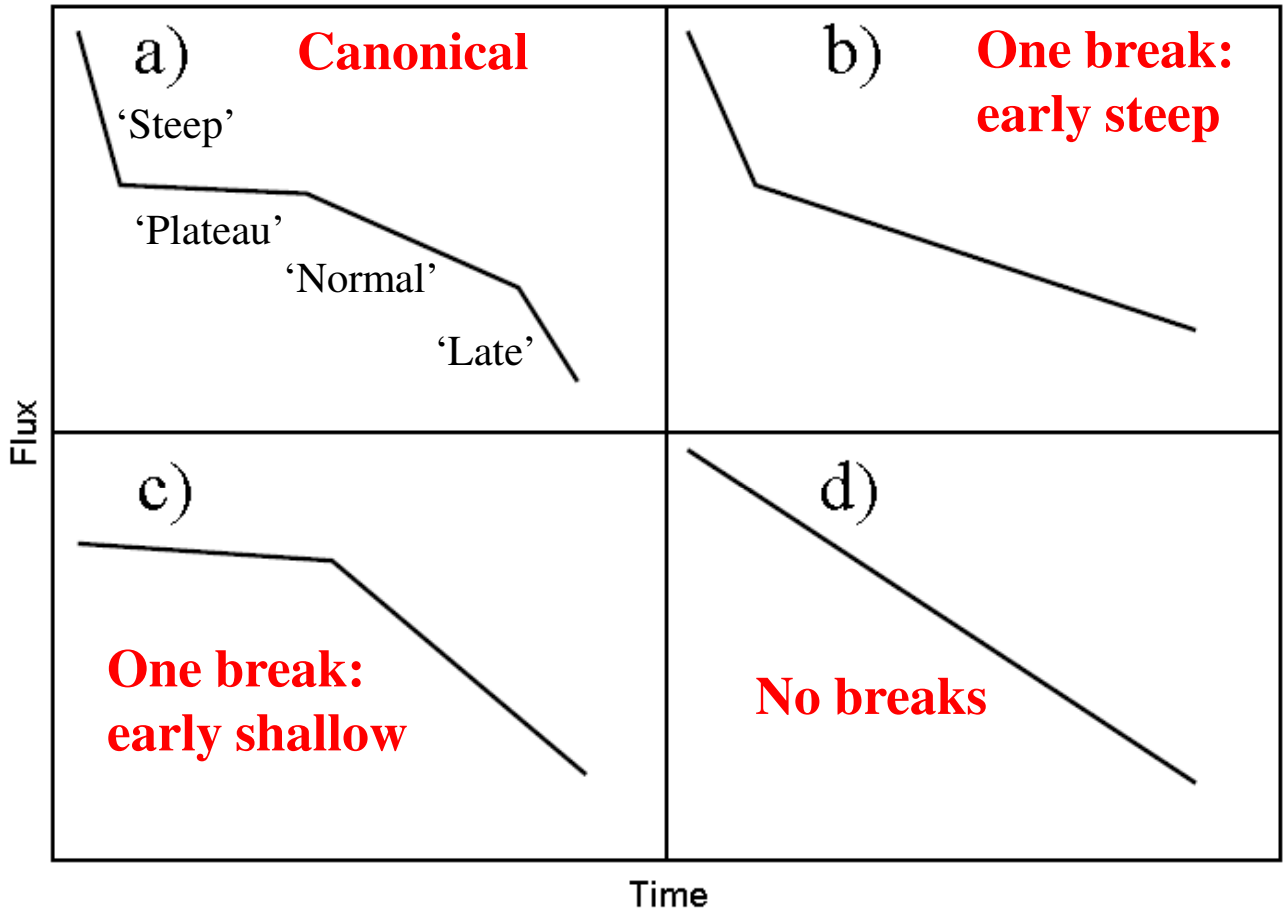
Usually the timescales involved are too short to be explained by afterglow models (e. g. density variations of the external medium).

Automated l.c. Fitting (Evans et al. (2009)



Use method on 318 GRBs (up to mid-2008)

How many are 'canonical'?



42%

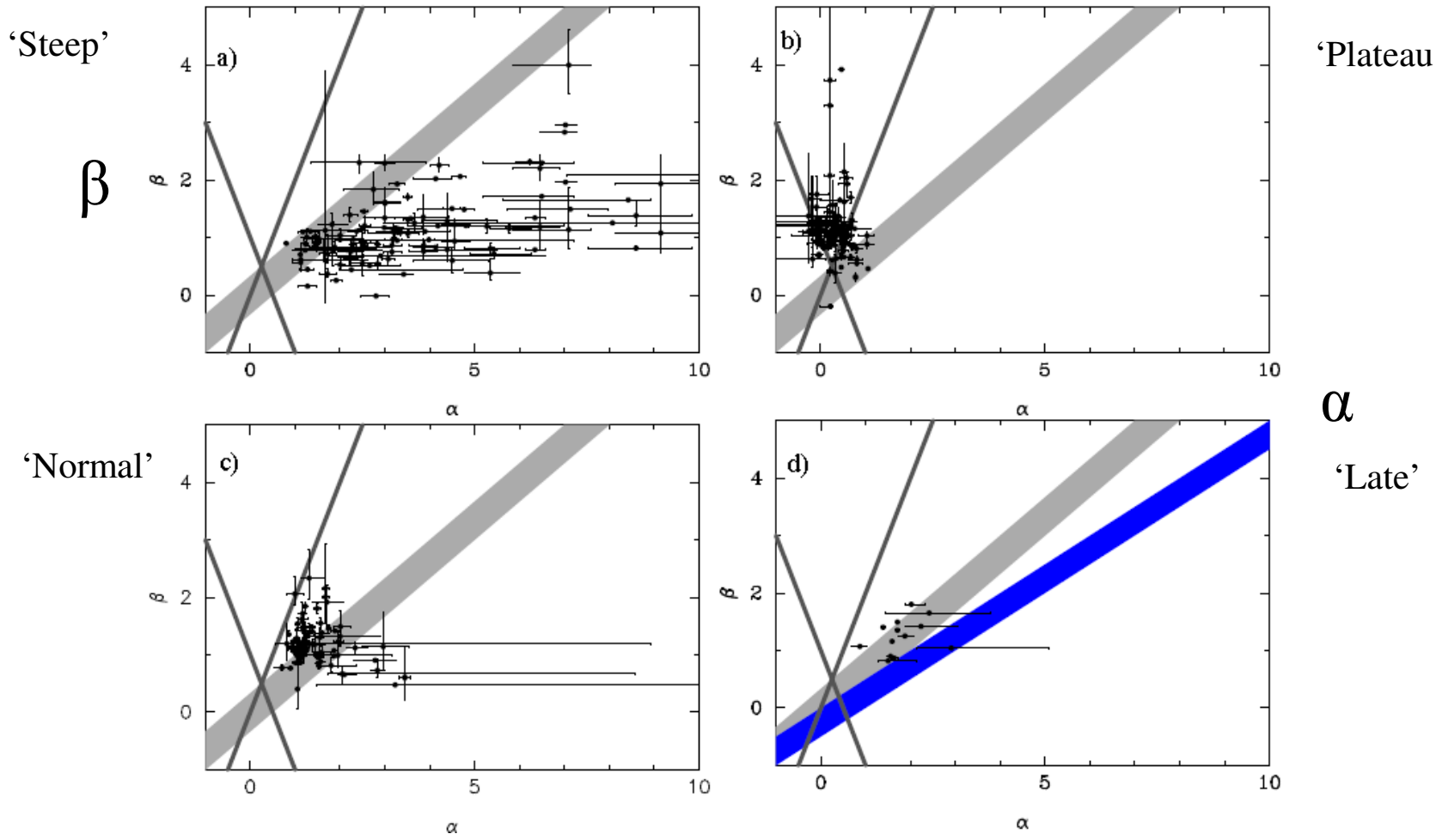
15%

15%

4%

(24% other)

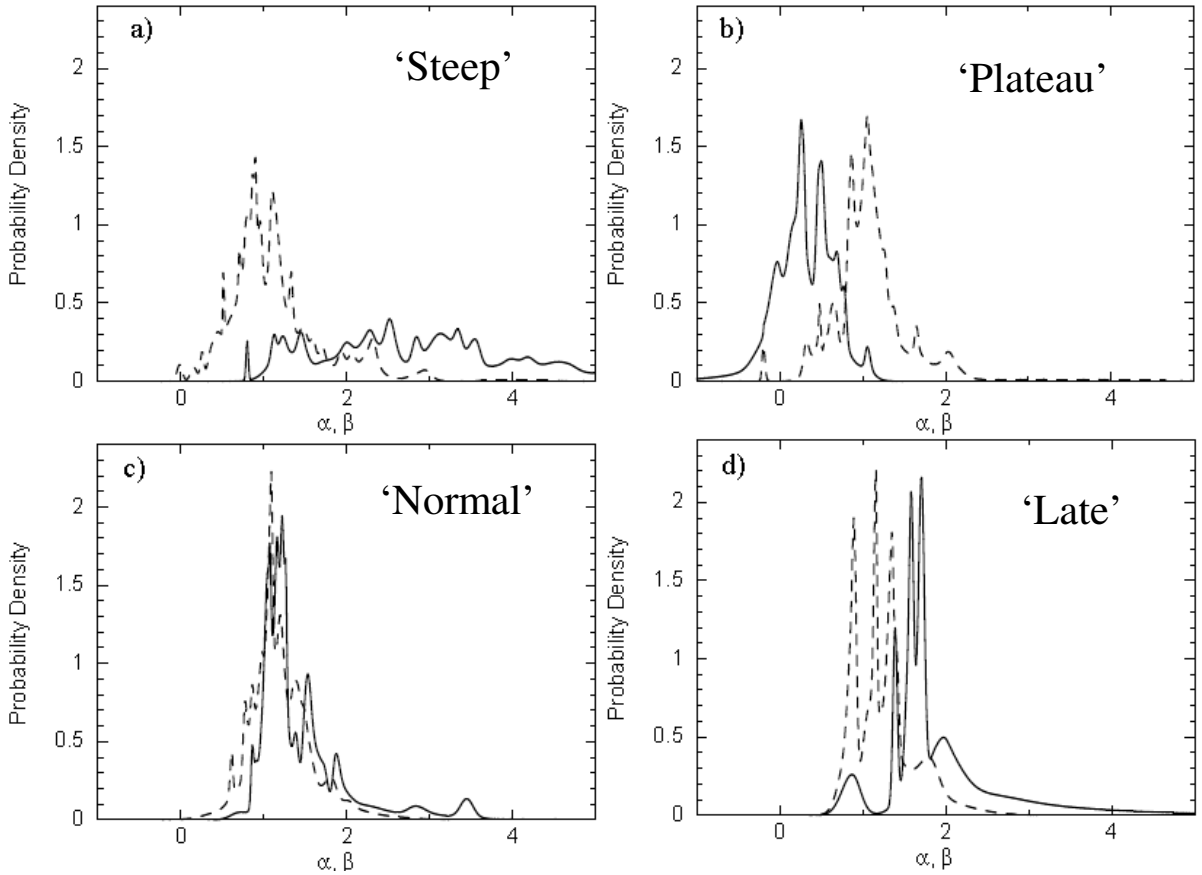
Canonical behaviour



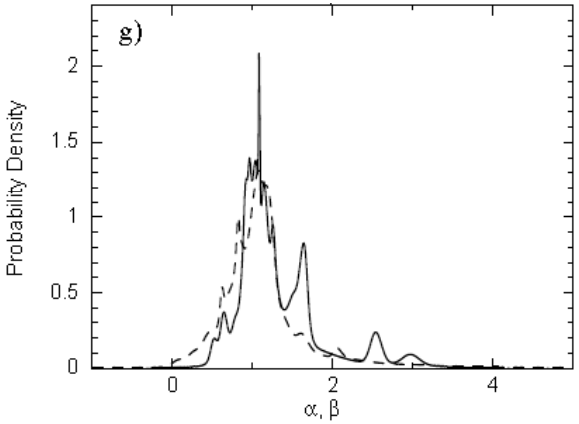
Grey bands :closure relation regions for standard and fast-cooling regimes;
Blue band: post jet-break.

Decay vs. Spectral index

Canonical



No breaks

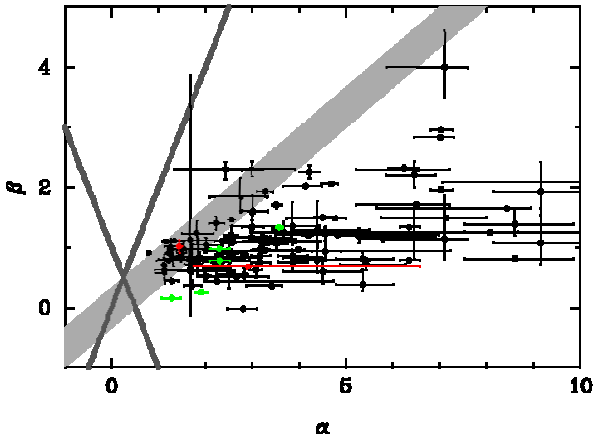


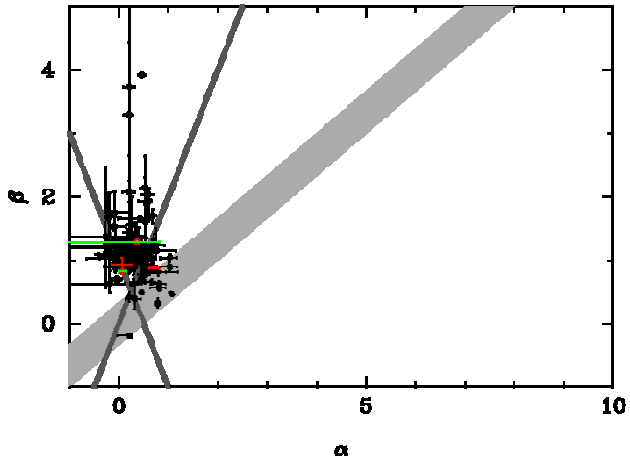
Solid: α ; dashed: β

β distribution similar in all cases!

Short GRBs vs. Long GRBs

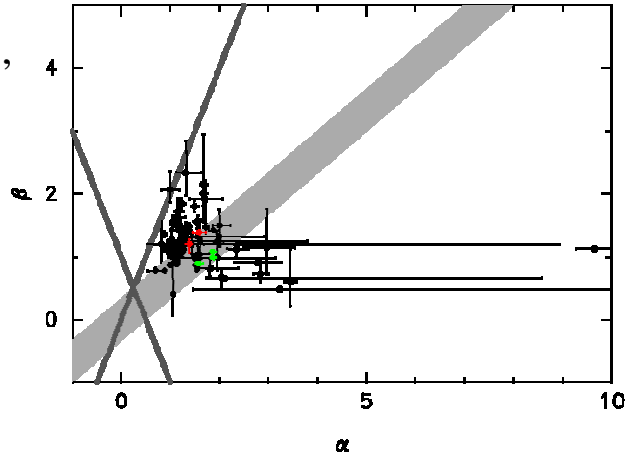
‘Steep’

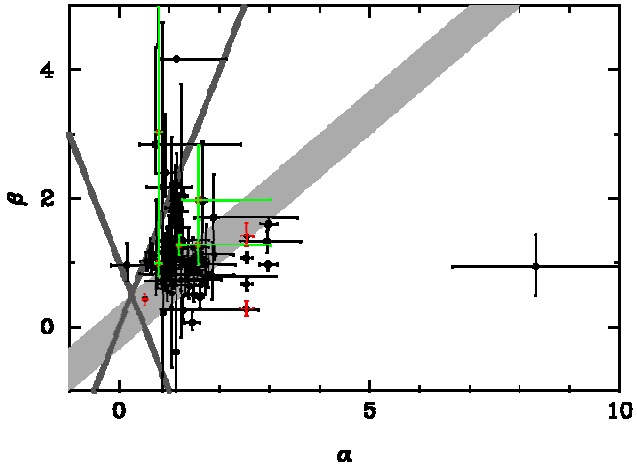




‘Plateau’

‘Normal’





‘No breaks’

Red: short with no EE Green: short with EE

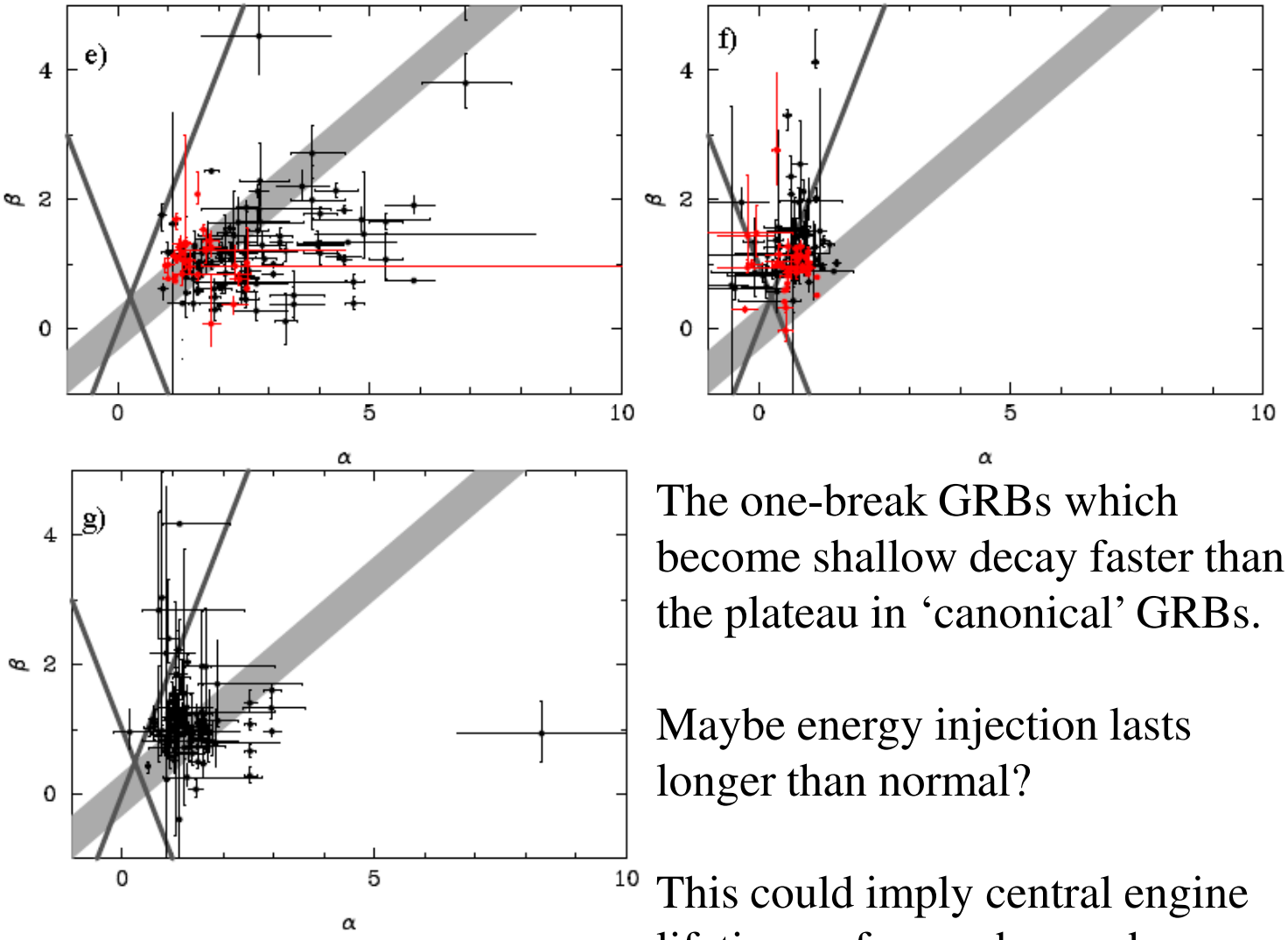
Short GRBs appear to have shallower steep decays and fewer temporal breaks, but no large-scale differences with long GRBs

Behaviour of other types

Black points:
One break:
early steep
then shallow

Red points:
One break:
early shallow
then steep

No breaks:
Most consistent with "standard" models



The one-break GRBs which become shallow decay faster than the plateau in 'canonical' GRBs.

Maybe energy injection lasts longer than normal?

This could imply central engine lifetimes of many hours-days

Conclusions

- See a wide variety of GRB light curves
- Only half show full 'canonical' light curve features
- Another 30% show some similarity but not identical
- No very clear distinction between short and long GRB X-ray light curve behaviour although short bursts are less luminous

XRT light curves and spectra of GRBs are online at:

http://www.swift.ac.uk/xrt_products

Method described in Evans et al., 2009 (arXiV: 0812.3662)