The Rising X-ray Afterglow of GRB 080307

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with

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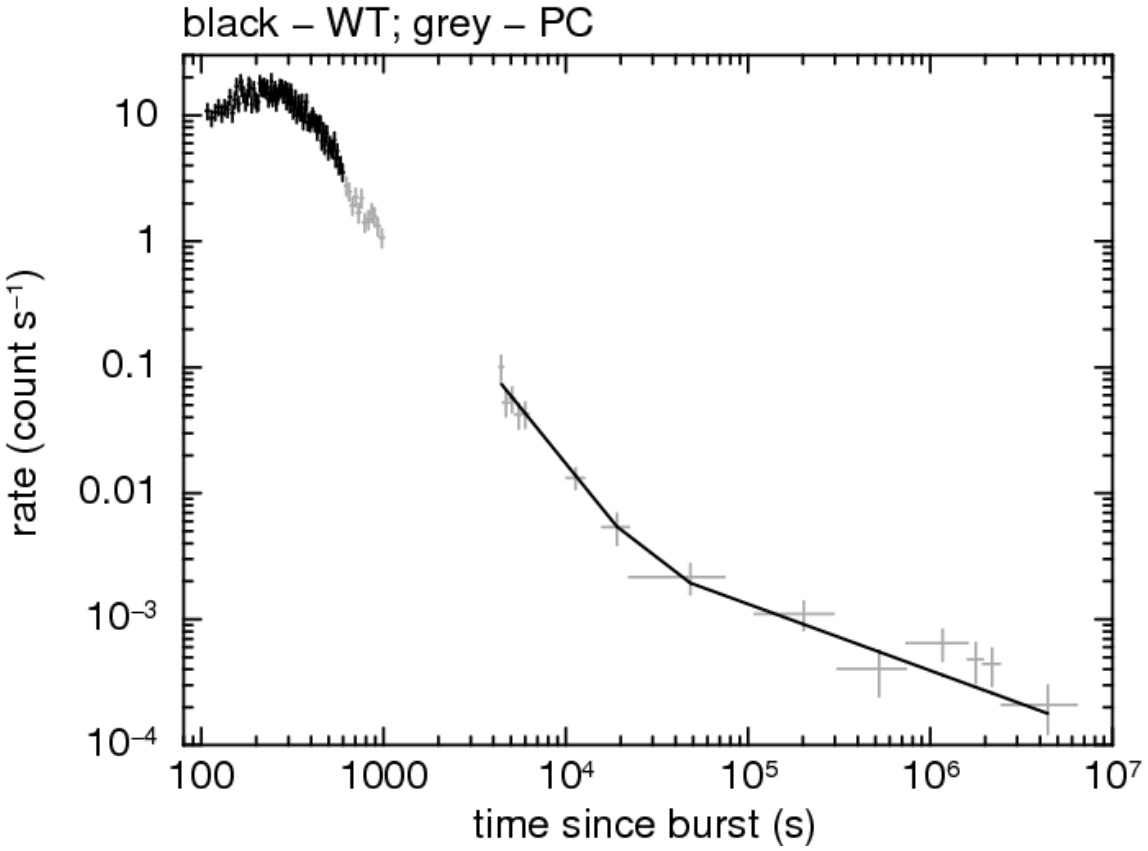
In the beginning…

At first, the XRT light-curve of GRB 080307 had two unusual features: the initial humpiness and then a late onset, long-lasting plateau phase.



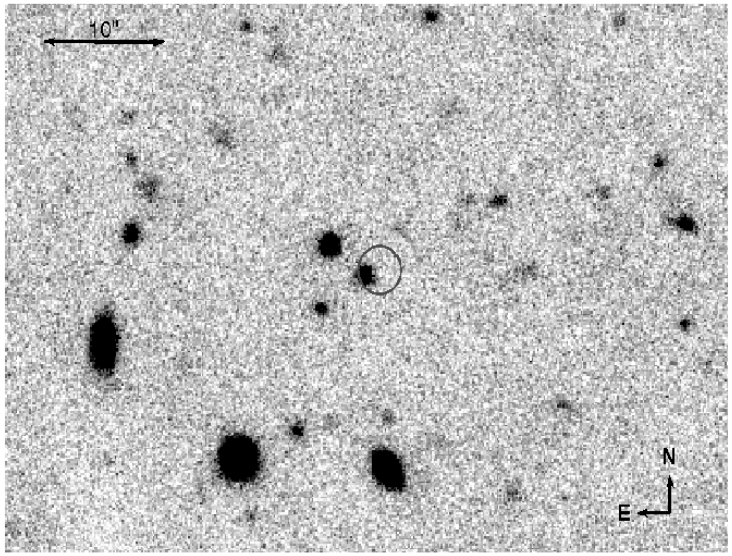
Contamination

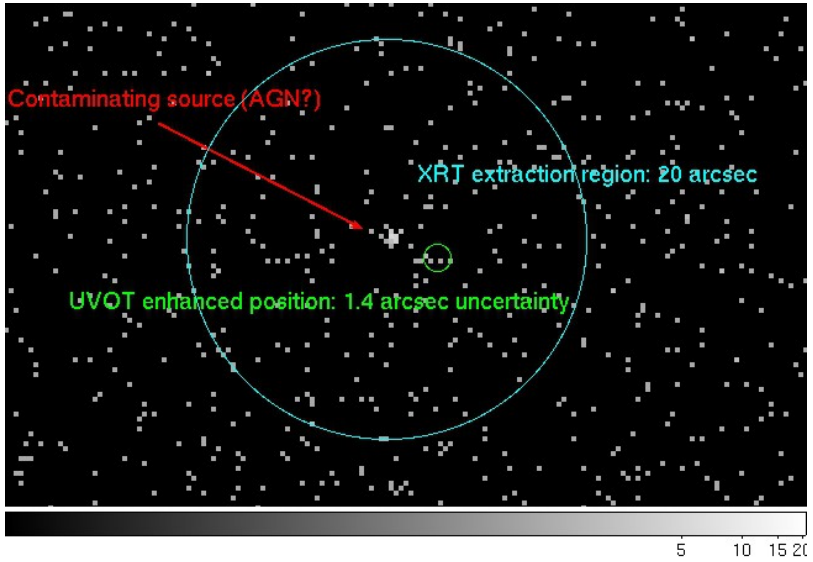
While looking for the afterglow/host in Gemini data, other nearby sources were noted.

Obtained a Chandra DDT to see whether

a) the decay was still very slow 6.5 months after the trigger

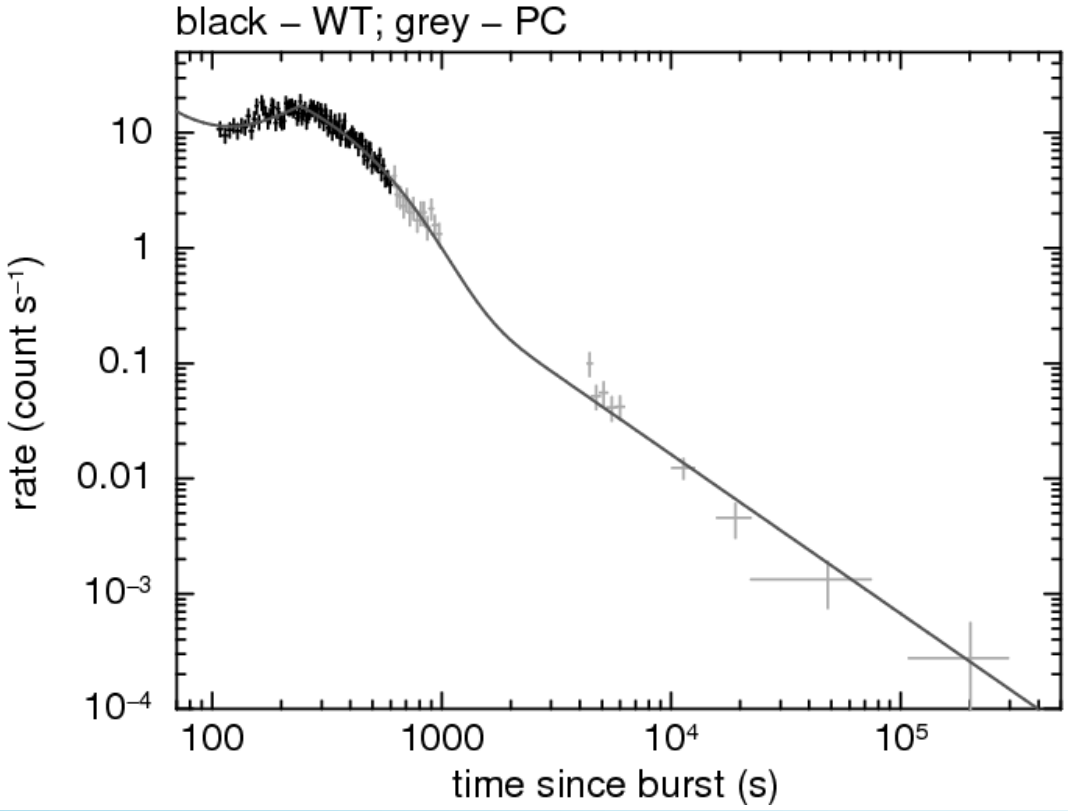
b) there was source confusion.





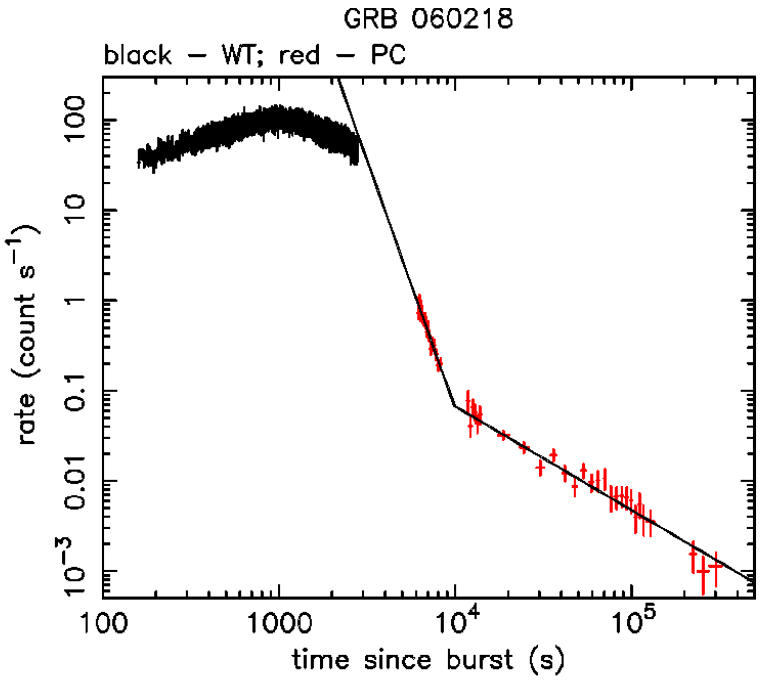
Corrected light-curve

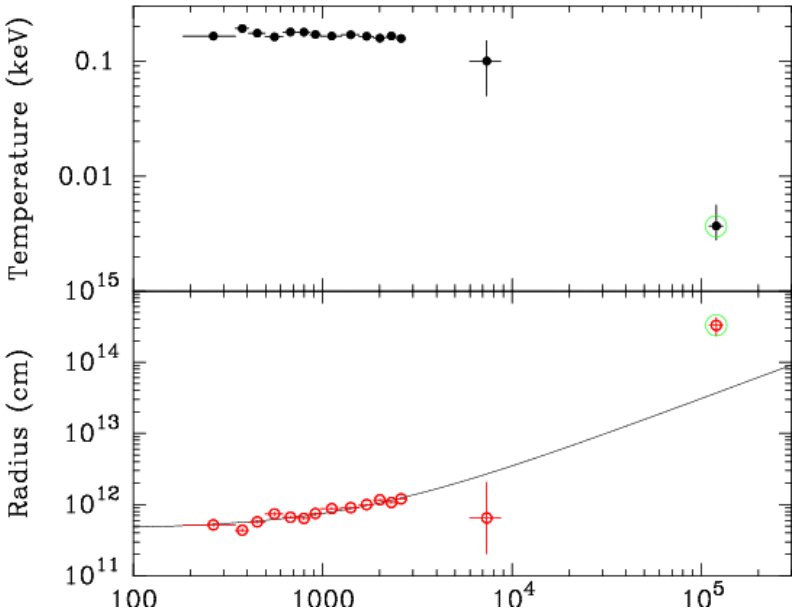
The long plateau now disappears – in fact, we just see a single decay after the initial humpy orbit. This is also relatively unusual, since only ~15% of promptly followed-up Swift bursts show no break before 100 ks (Evans et al. in prep).



Comparison with GRB 060218

The start of the light-curve is reminiscent of the SN GRB 060218. The spectra during that smooth hump showed evidence for an expanding and cooling thermal component, as well as a power-law (Campana et al. 2006).





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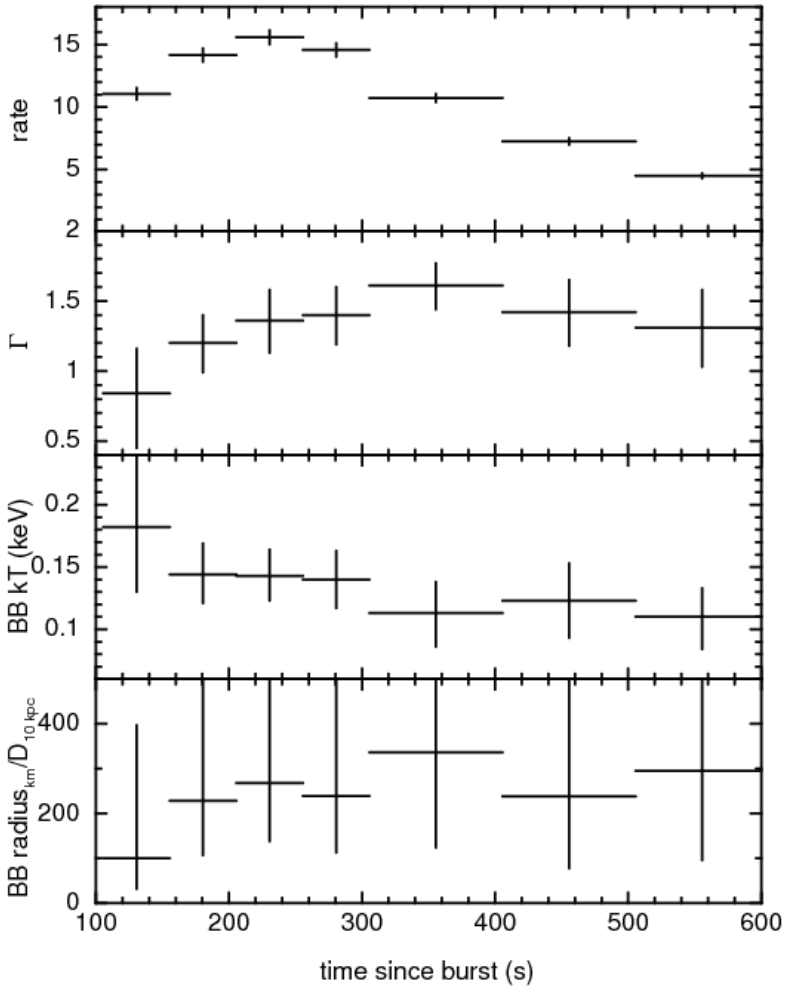
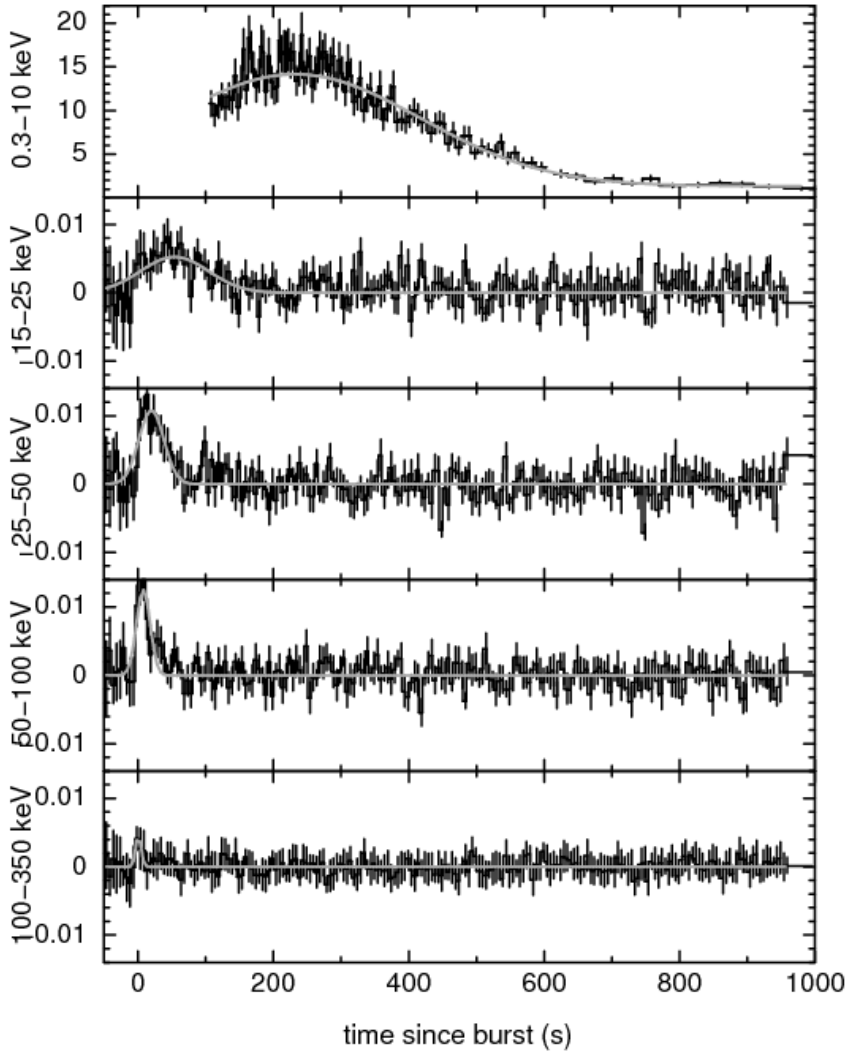


Considering the later-time data for GRB 080307, there is some evidence (<3 σ) that there is excess N_H. In this case, we need multiple components to fit the humpy spectra. However, a BB does not show the same evolution as GRB 060218 and there's no sign of a SN in the optical data.

Without the excess N_H, a single power-law fits the hump spectra well.

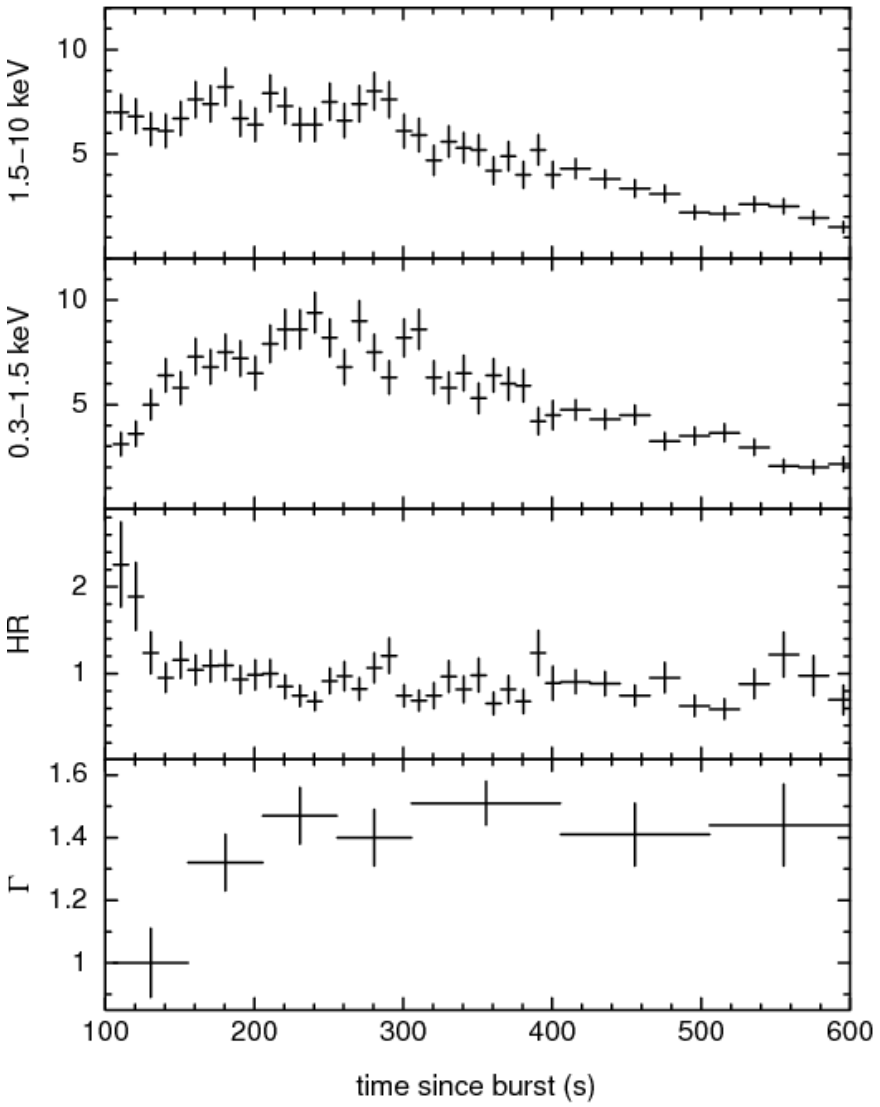
Not a flare?



From the BAT and XRT light-curves, it almost looks like the X-ray data are continuing the gamma-ray trend. However, the hump is much longer than is expected at early times (Chincarini et al. 2007).

Also, we generally expect flares to harden at the start, but…

Spectral Evolution

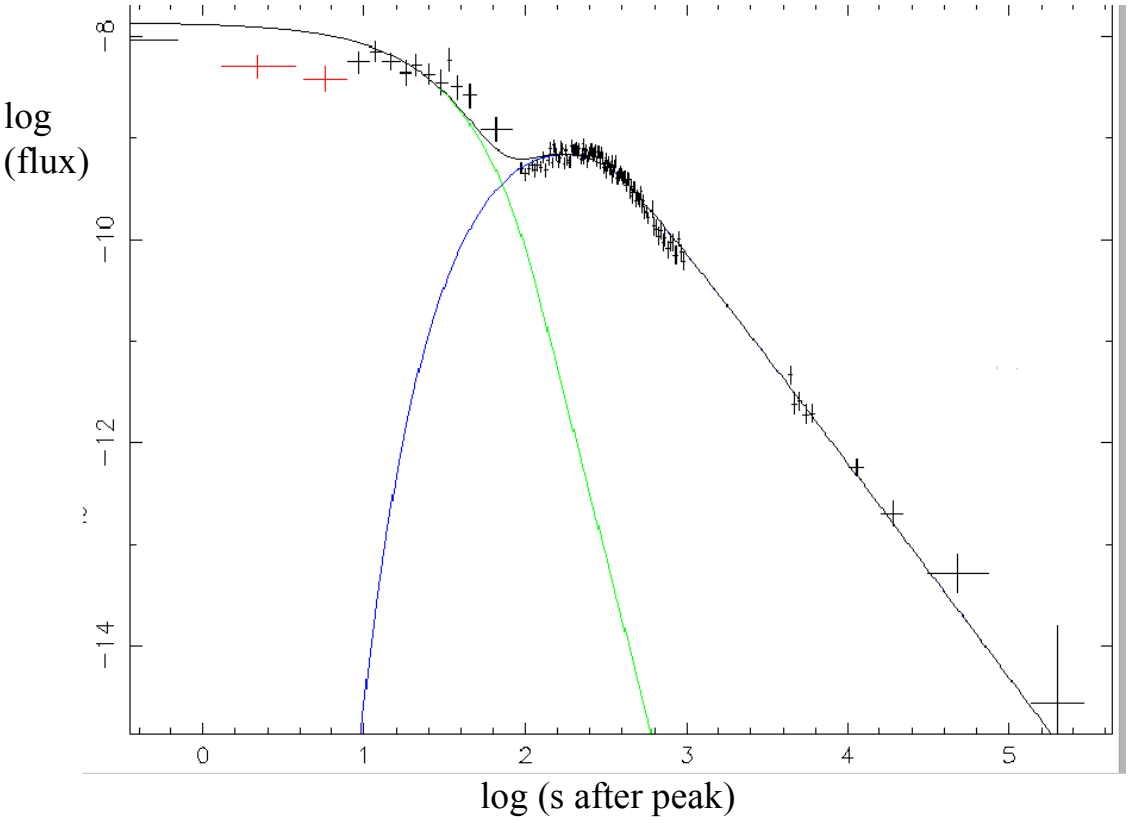


The soft band rises, whereas the hard band remains constant. This leads to an unusual hardness ratio for a flare.

Flares also tend to continue to evolve beyond the time of their peak. Here, the softening stops after about 40 s, well before the peak of the hump.

Rising Afterglow?

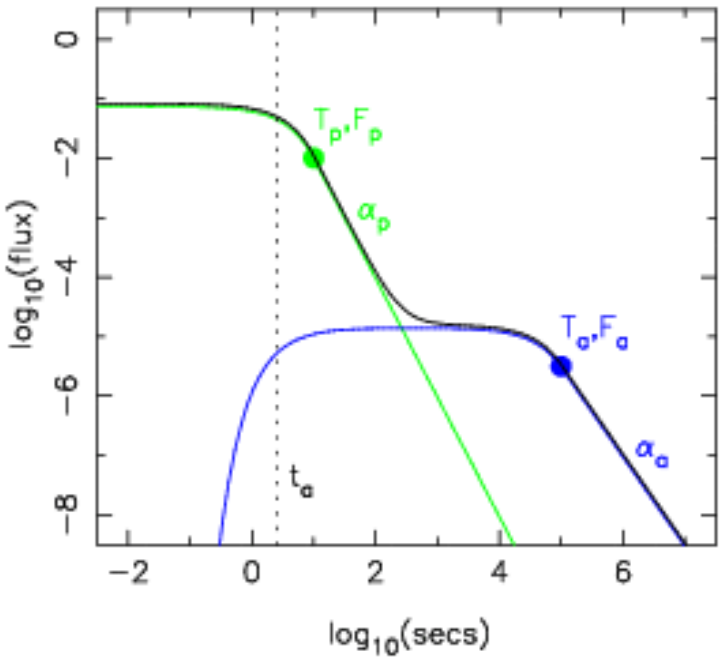
Some bursts show the optical data rising to a peak (e.g. Panaitescu & Vestrand 2008; Molinari et al. 2007). Kobayashi & Zhang (2007) show that a smooth bump can be produced by forward shock emission.



Using the model in O'Brien et al. (2006) and Willingale et al. (2007), we obtain an acceptable parameterisation of the total light-curve.

The second exponential-to-power-law model fits the rise reasonably well.

Unusual to see rise

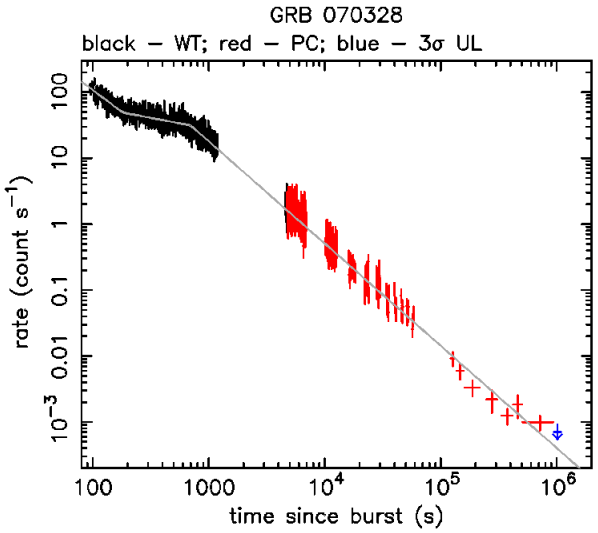


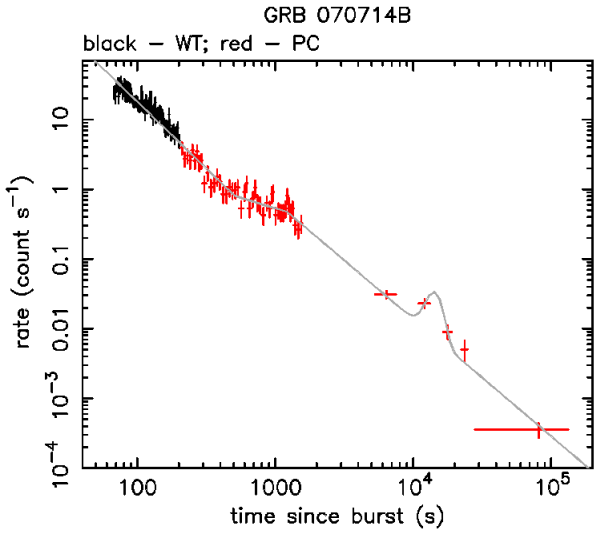
From the exponential-to-power-law model, the afterglow rise is typically hidden by the decaying prompt emission.

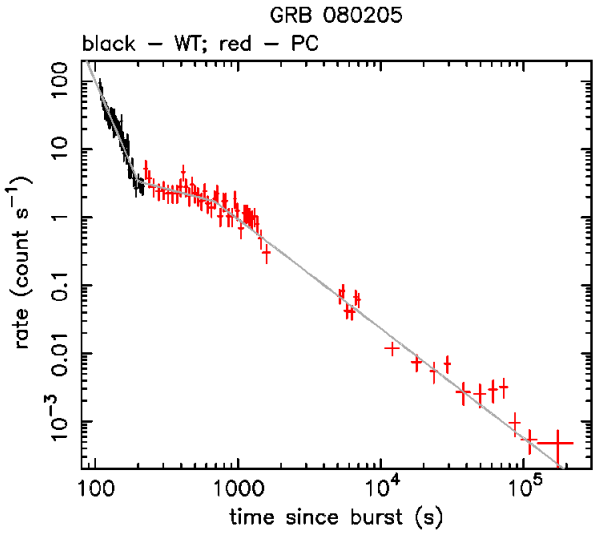
For GRB 080307, the gamma-rays drop off very abruptly, which may be why we see the actual rise, rather than just the plateau.

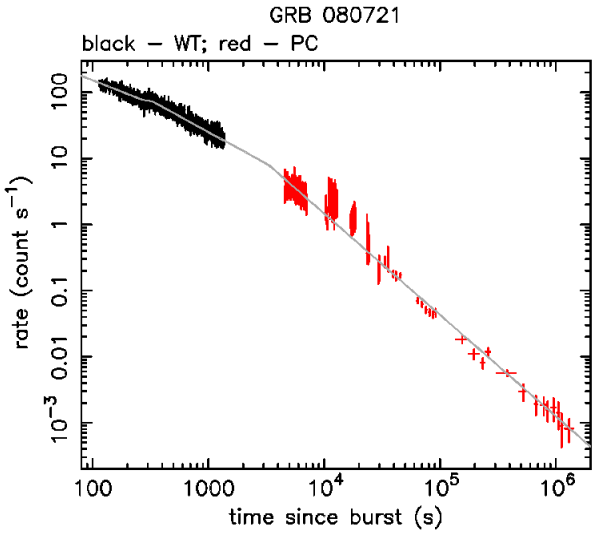
If we had arrived on target about 50 s later, we would just have seen a short flat period. There are a few other bursts which show possible rises – but you have to squint!

Possible Humps









Conclusions

GRB 080307 shows an unusual humpiness at the start of its X-ray light-curve.

There is a ~1 % probability that a small extraction region will contain a background X-ray source; other Swift light-curves could be affected.

The hump does not fit in very well with "standard" flare parameters (too long for such an early time and the spectral evolution is abnormal).

We suggest that we are seeing the onset of the X-ray afterglow, and that this is possible because the gamma-rays drop off very suddenly.