30 YEARS OF UKIRT

Gamma-Ray Bursts

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Why UKIRT?

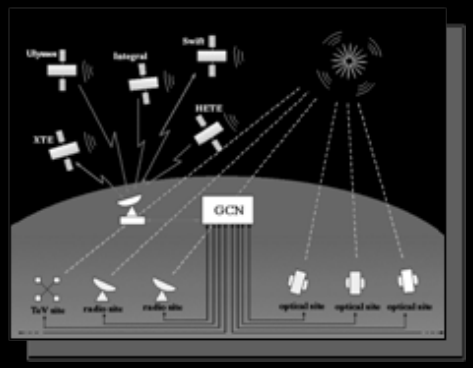
Integrated observing and data reduction systems expedite rapid triggering and analysis

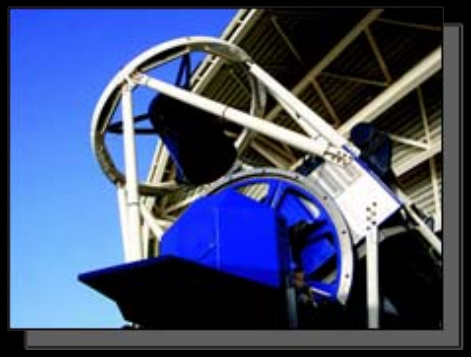
Great site with possibility of complementary observations at other scopes

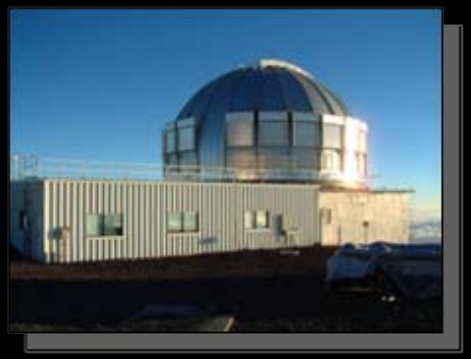
Observations during UK daytime!!

Flexible scheduling reduces disruption

Infrared allows search for high redshift or dusty sightlines







GCN

Event Bridge

Embedded Agent

Event Network

Event Client

User Agent

Embedded Agent

ORAC-DR

Insert MSBs into queue and sound alarm.

eSTAR

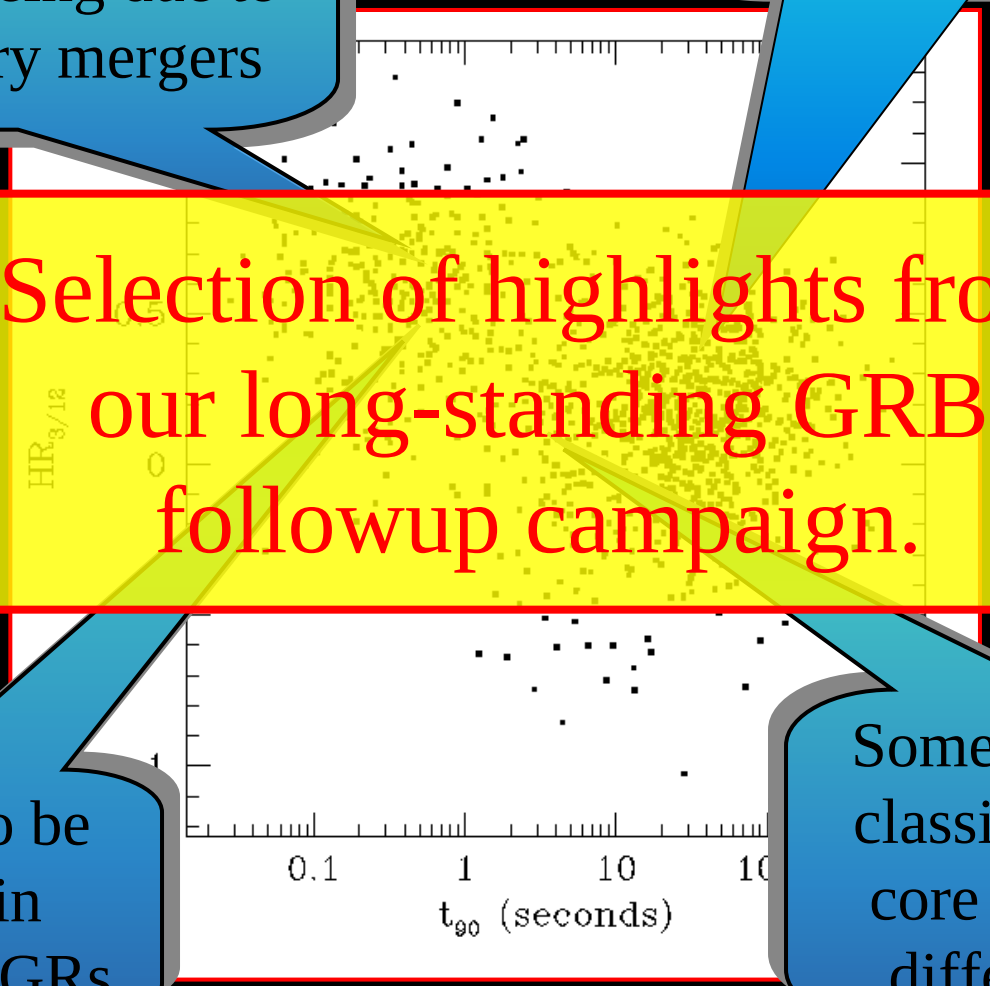
Developed at Exeter (Allan et al.)

GRBs

Short duration bursts are suspected of being due to compact binary mergers

Classical long bursts are associated with core collapse of H-stripped massive star

Selection of highlights from our long-standing GRB followup campaign.

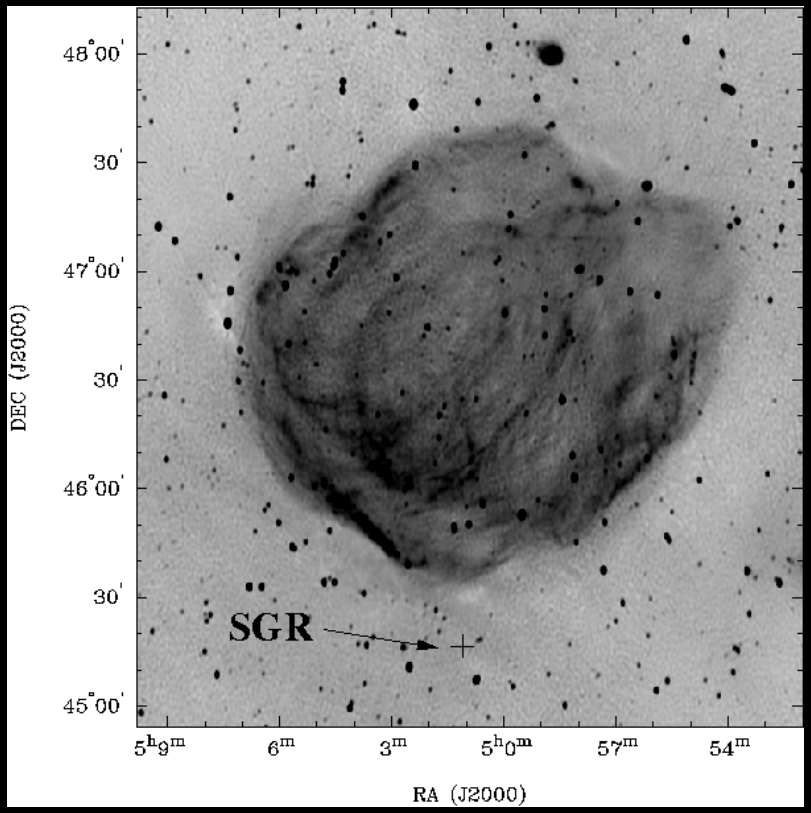


Some likely to be giant flares in extragalactic SGRs

Some bursts hard to classify and may be core collapse via a different channel

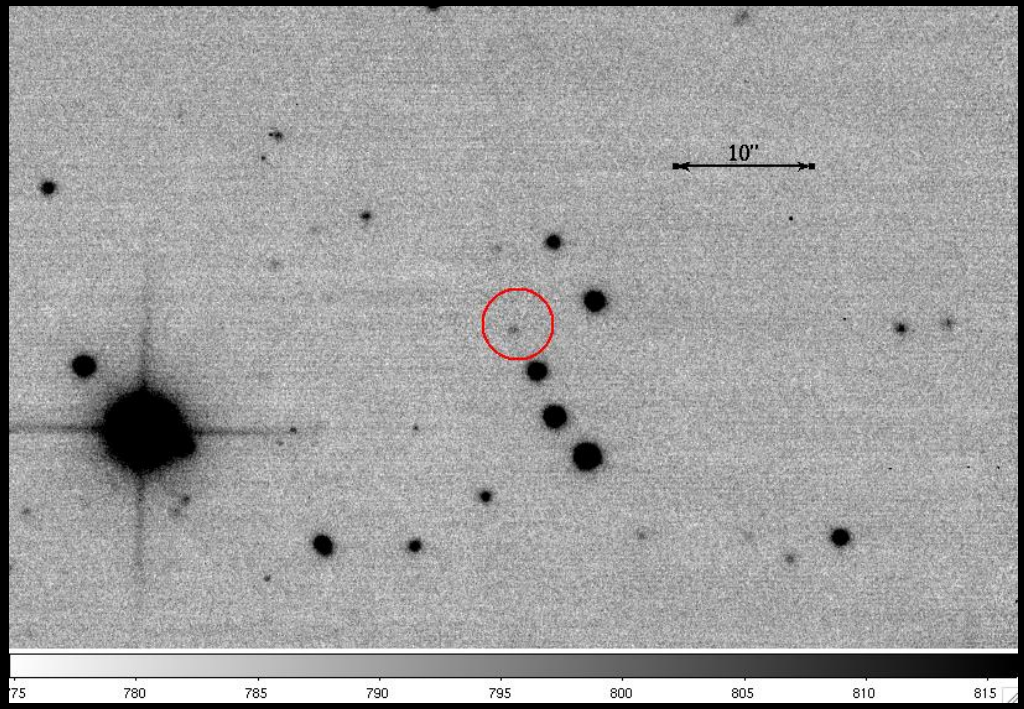
SGR 0501+4516

(The one that wasn't one)



- Swift triggers on outburst from SGR (reported as candidate GRB).
- Close proximity to HB9 supernova remnant - possibly kicked?

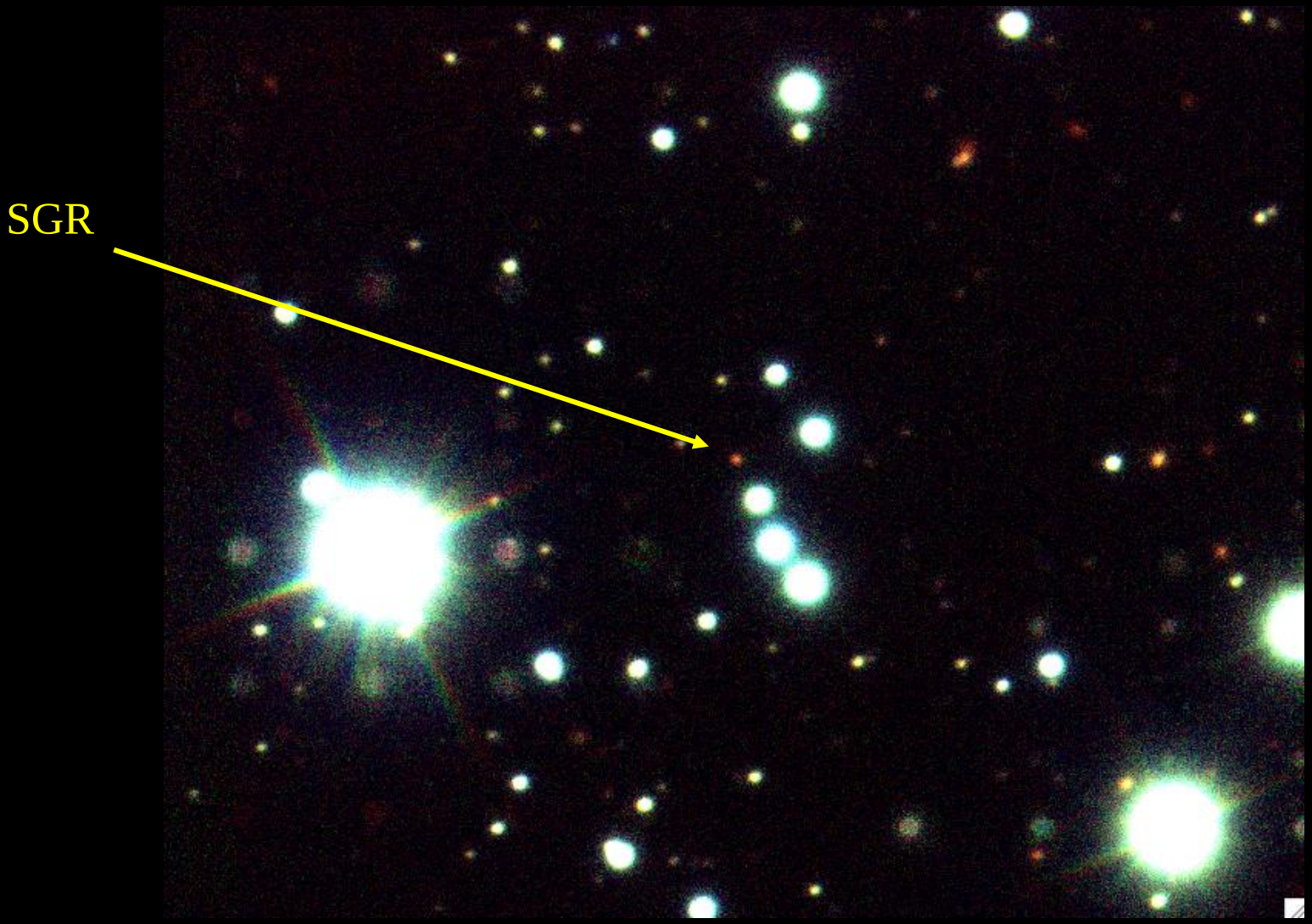
SGR 0501+4516



- First observations UKIRT (T+1.5 hours) obtaining JHK sequence.
- Identify likely IR counterpart - much the least crowded, least extincted and brightest such counterpart for an SGR.
- Initiate long-term monitoring campaign on various telescopes.

SGR 0501+4516

Gemini “true colour” JHK image



GRBs as probes - in brief

Pros:

- Extremely bright and visible into the era of reionization.
- Broad SEDs and detectable in gamma-rays through high intervening columns of gas and dust.
- Afterglows pinpoint their hosts - provide redshifts, chemical enrichment etc. for very faint galaxies.
- Trace massive star formation.

Cons:

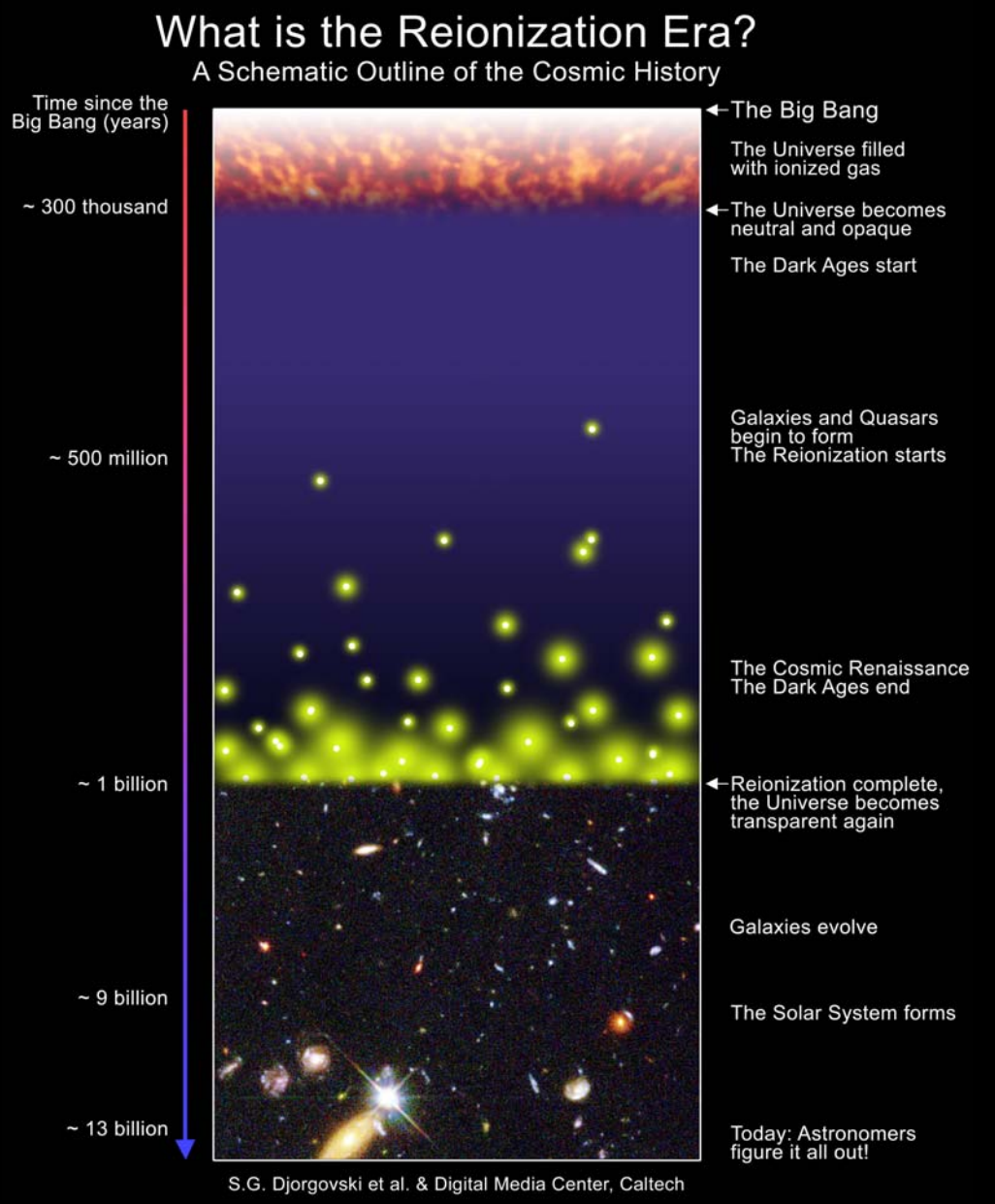
- Rare (~2 per day per universe to BATSE and Swift limits).
- Hard to follow up, so samples tend to be inhomogeneous and incomplete.

Reionization epoch - the final frontier!

The last major phase change in the universe.

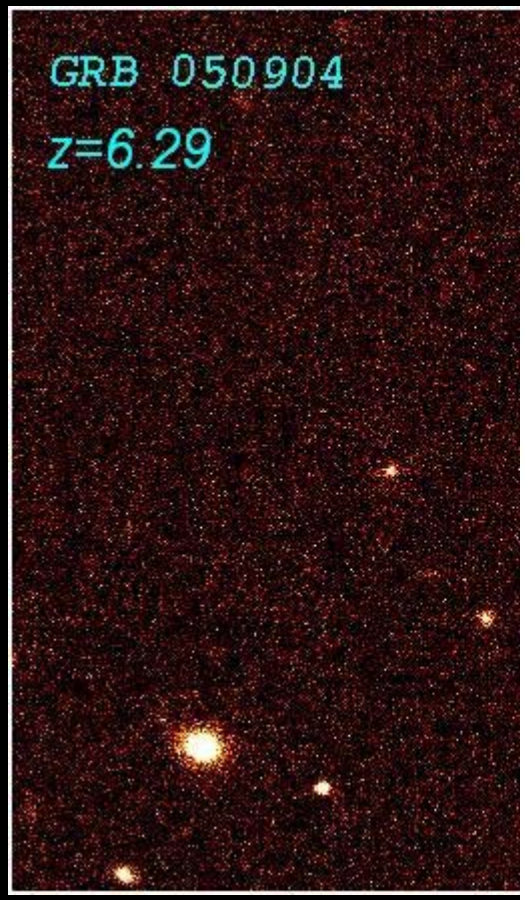
Tied to the formation of the first collapsed objects.

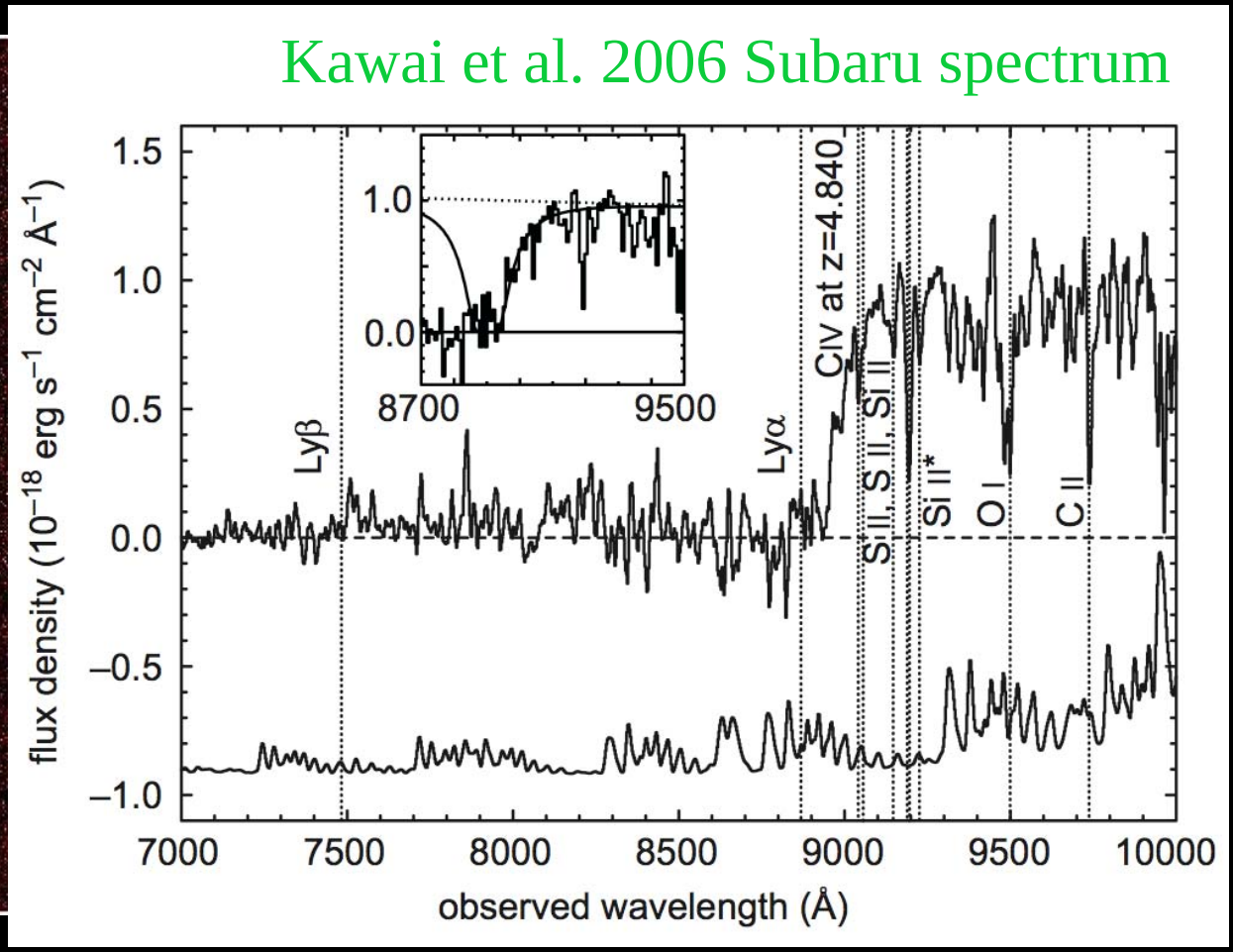
Very hard to study because only the brightest sources can be seen directly - limited flux means limited information- and they were also very rare beyond z=7.



GRB 050904

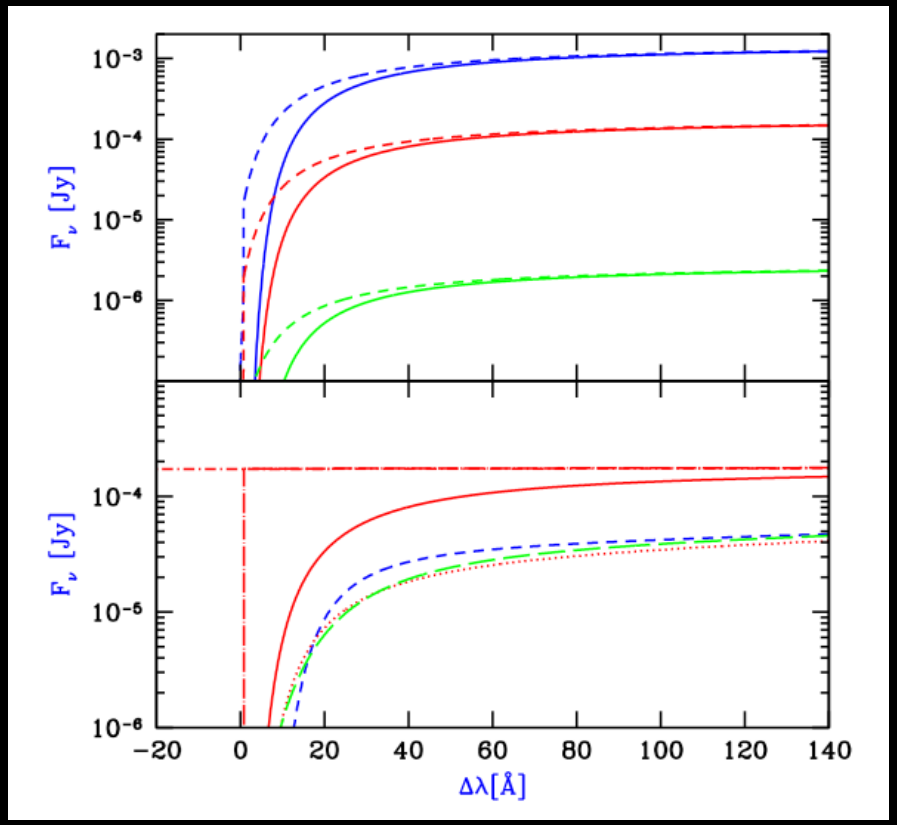
First z>6 GRB (Haislip et al. 2006; Kawai et al. 2006)



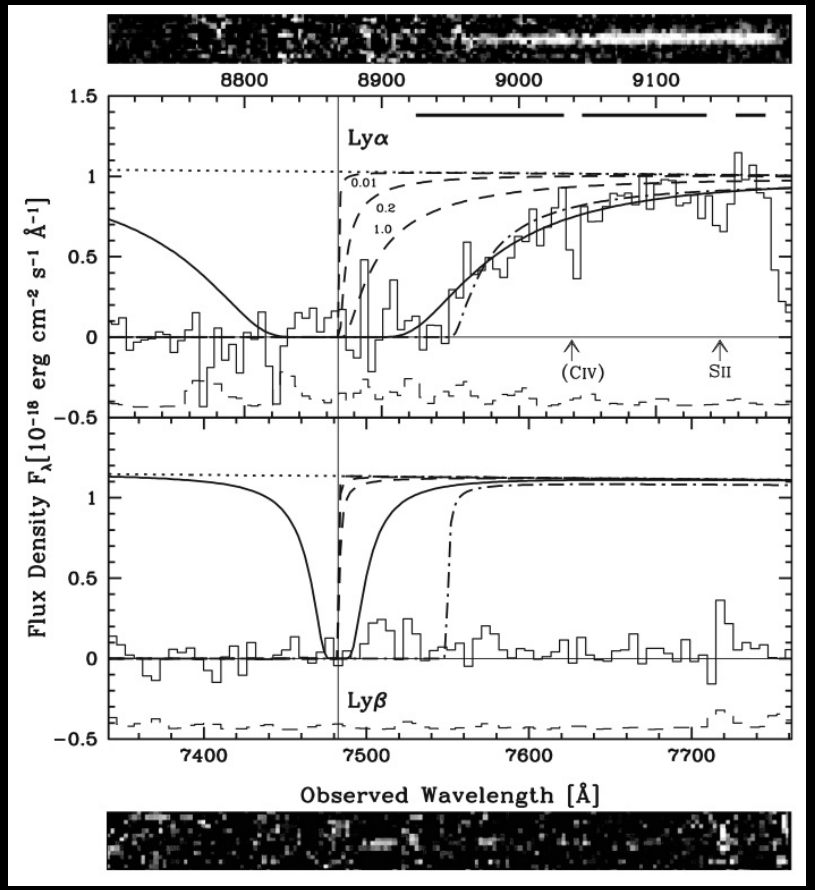


Mapping reionization

Small hosts have relatively little affect on their environments, providing a cleaner view of the Lyman-alpha damping wing (but harder if host itself is DLA).



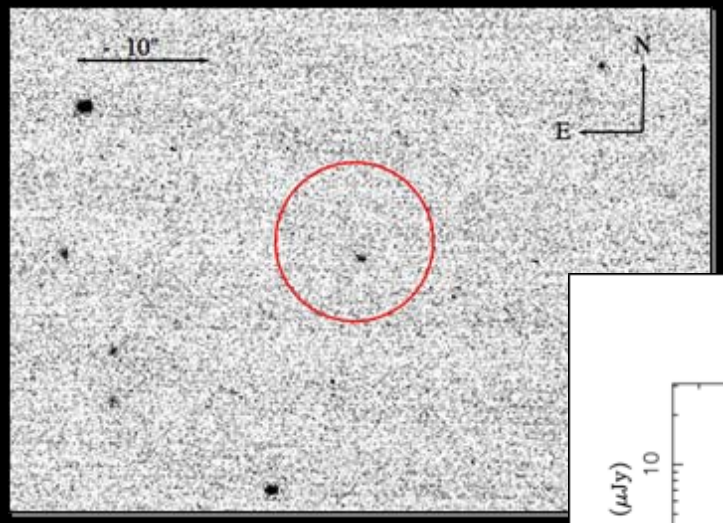
Barkana & Loeb 2004.



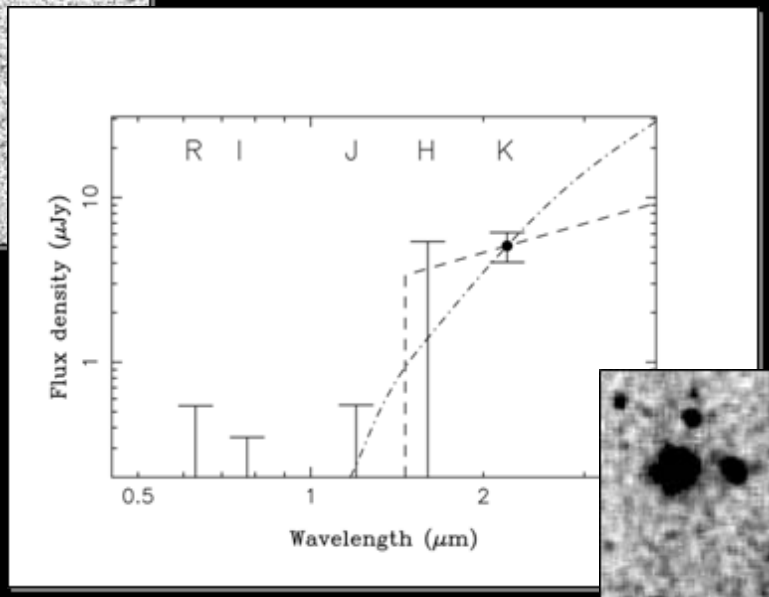
GRB050904 *Totani et al. 2006*

GRB 060923A

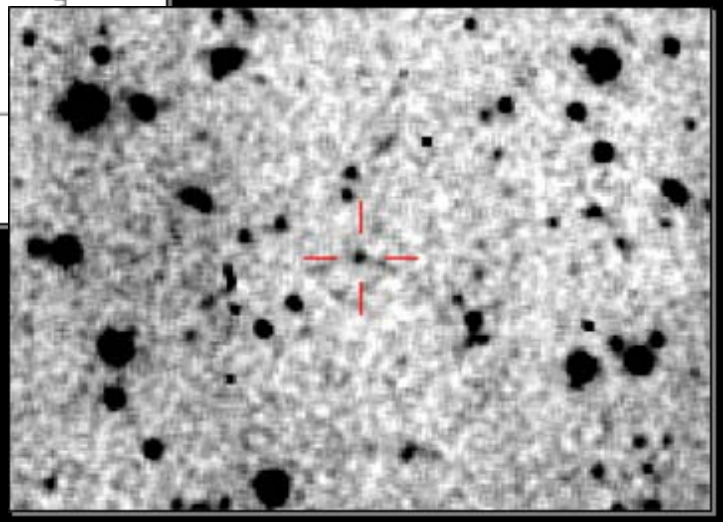
(The one that got away)



Only seen in K-band at UKIRT



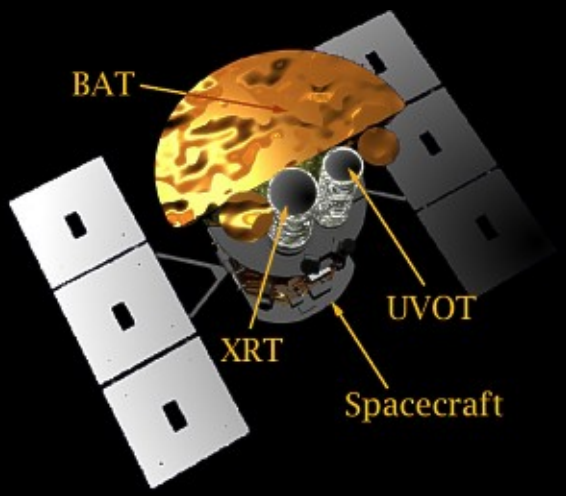
H-band dropout. Very high-z?

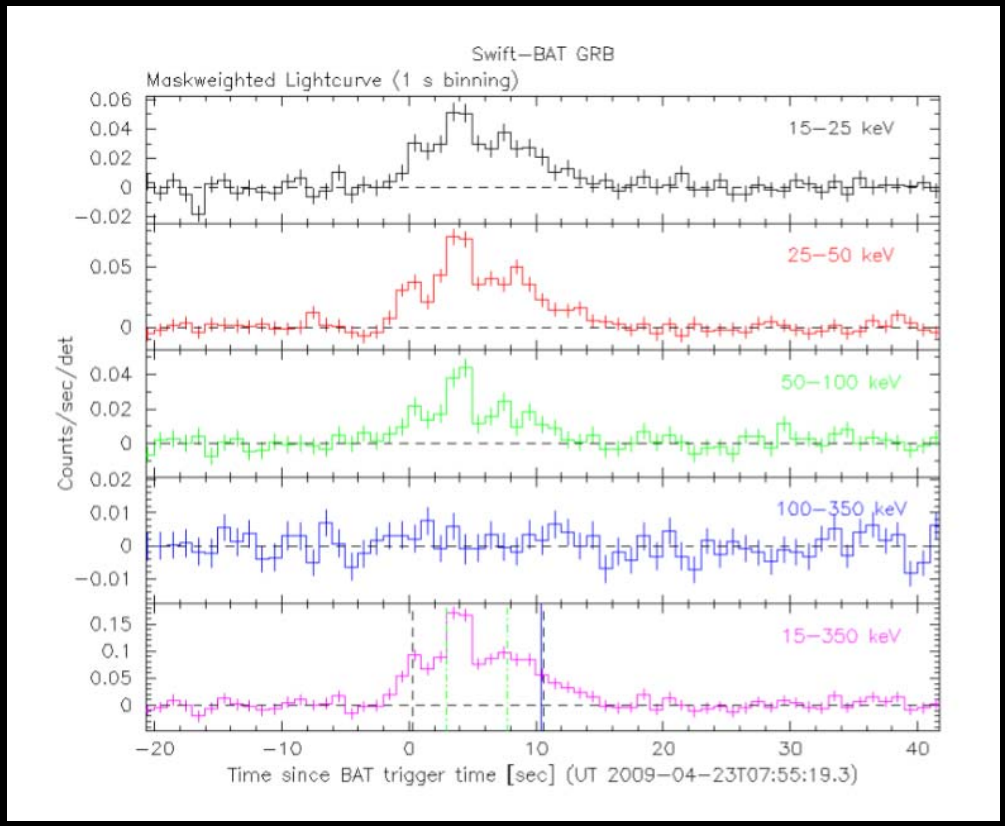


Host seen in deep R-band image

GRB 090423

(The far-out one)



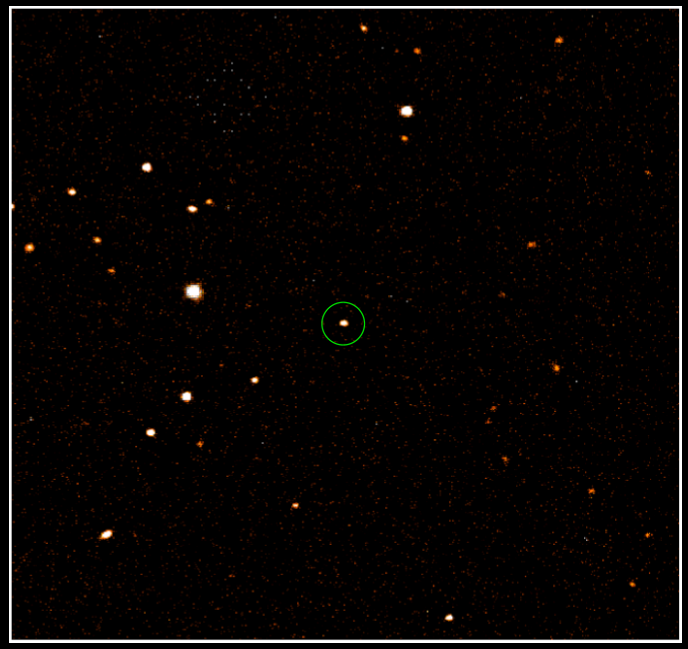


8.55 am: eSTAR submits (actually duplicate) MSBs for followup, but conditions are bad!

GRB 090423

Tom Kerr at the scope:

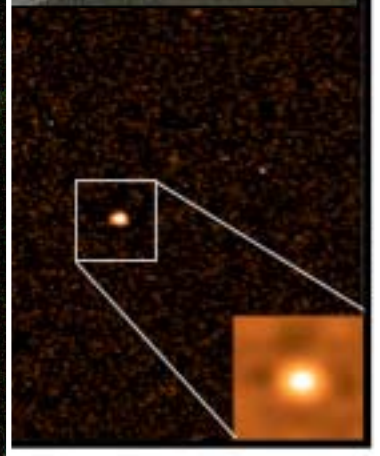
“We'll be lucky to complete the initial 25-min MSB. We're struggling with guiding right now and would normally have to move the windblind in a few minutes. However, doing that will mean it'll be impossible to guide due to wind, and there's no way we can try unguided, thetelescope will just blow away!”



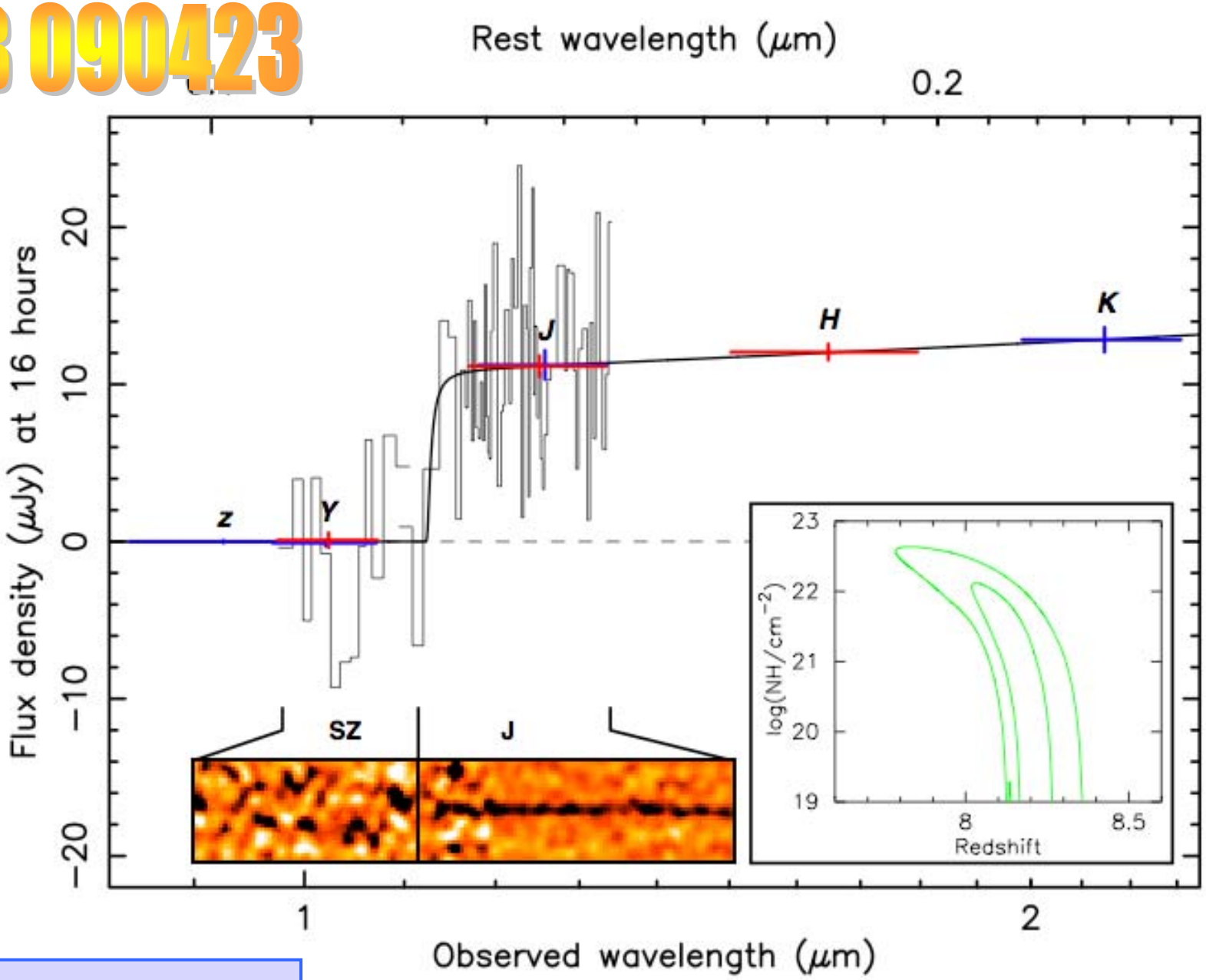
9:20 am: Observations start.

Faint K-band counterpart discovered, but early optical find nothing.

GRB 090423



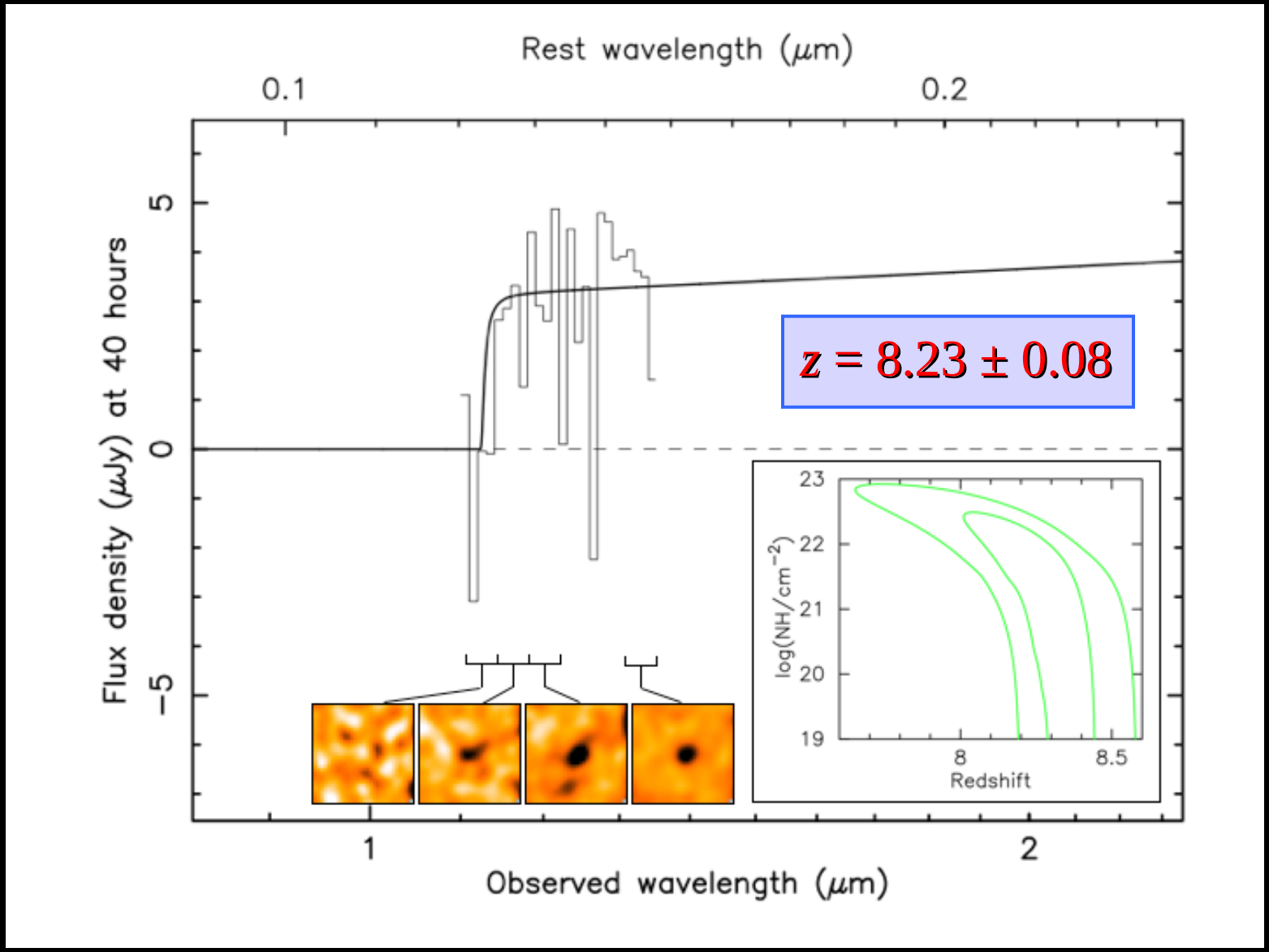
GRB 090423



Tanvir *et al.* (2009)

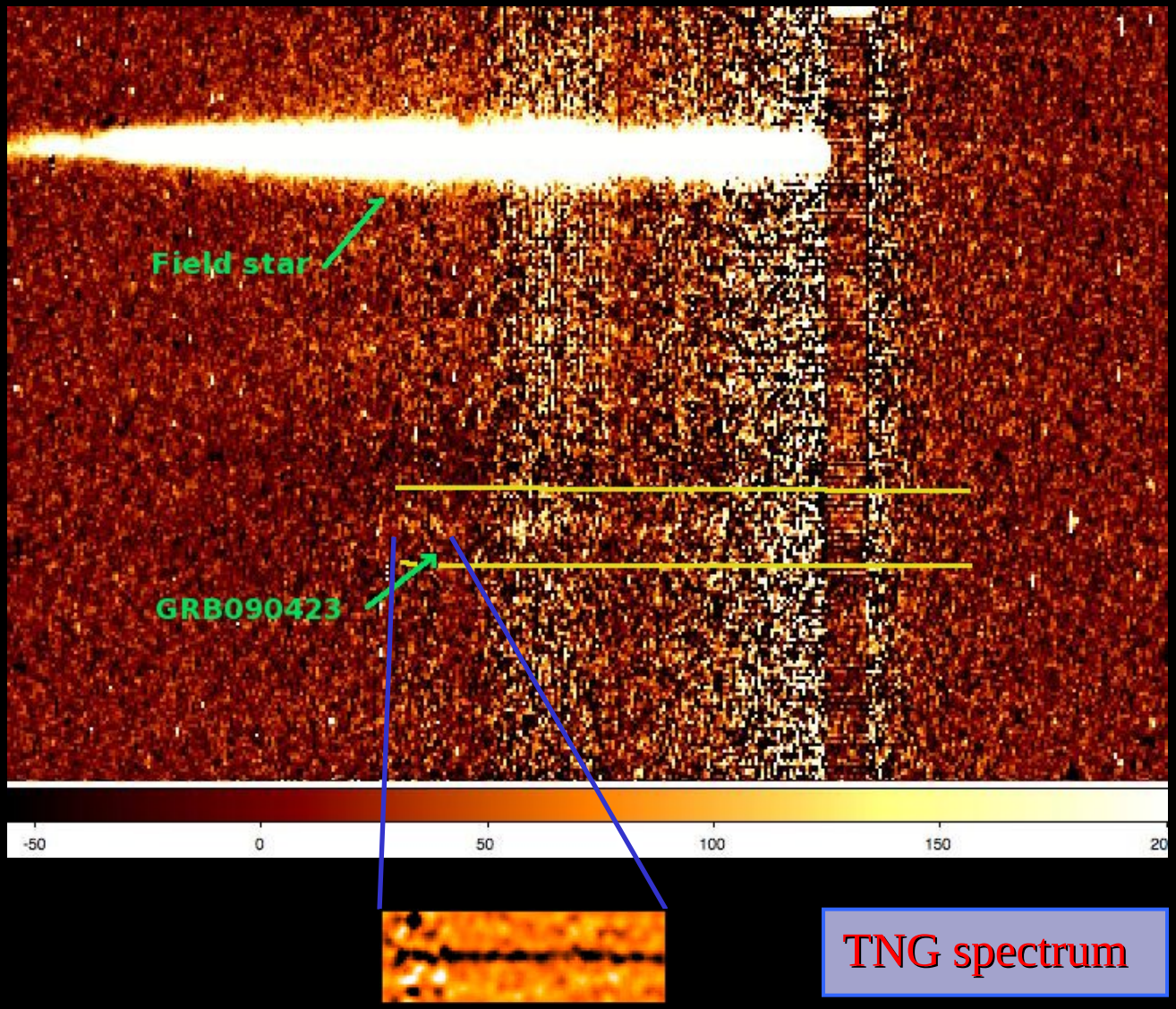
GRB 090423

SINFONI IFU spectrum



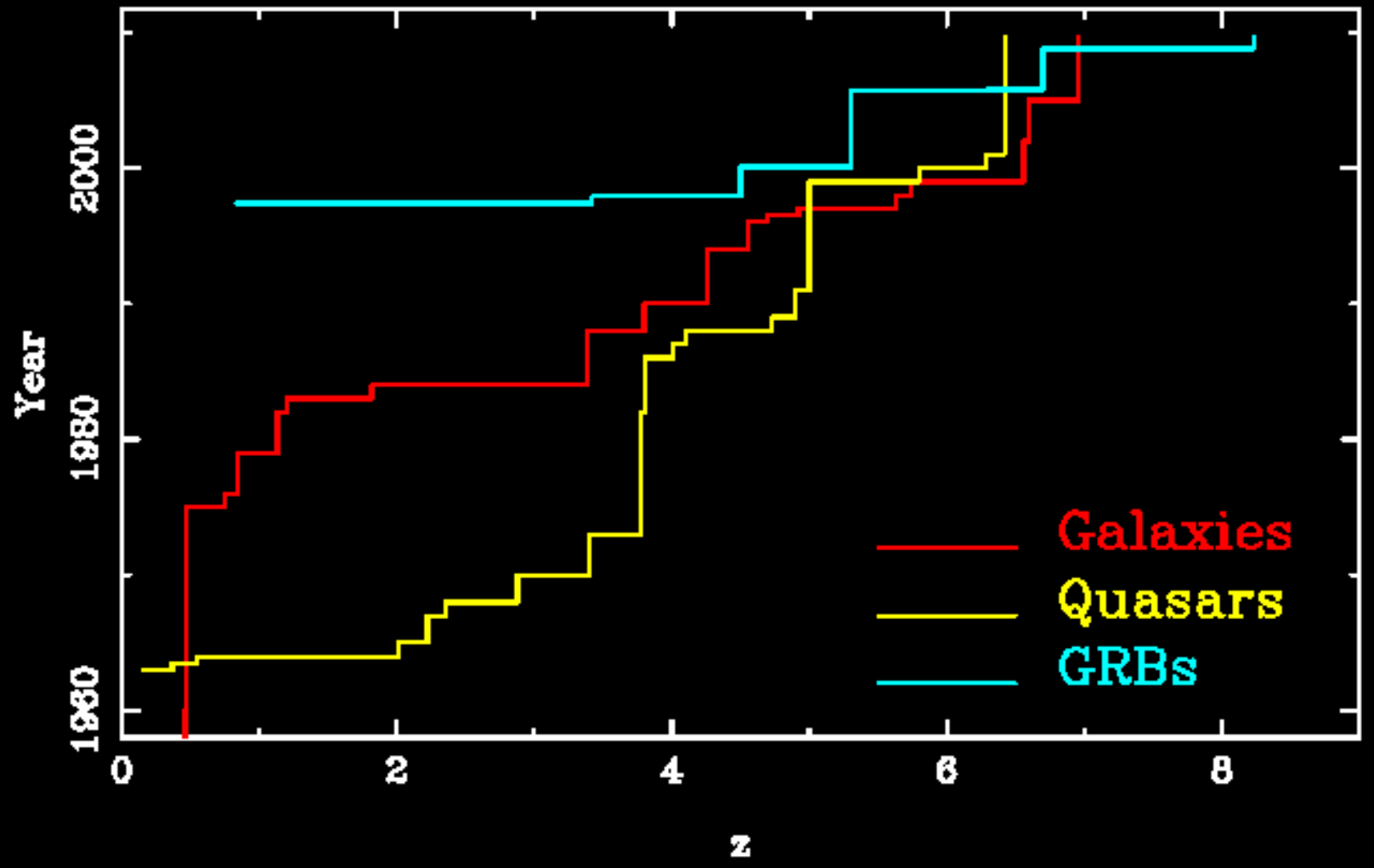
GRB 090423

Salvaterra et al. (2009)

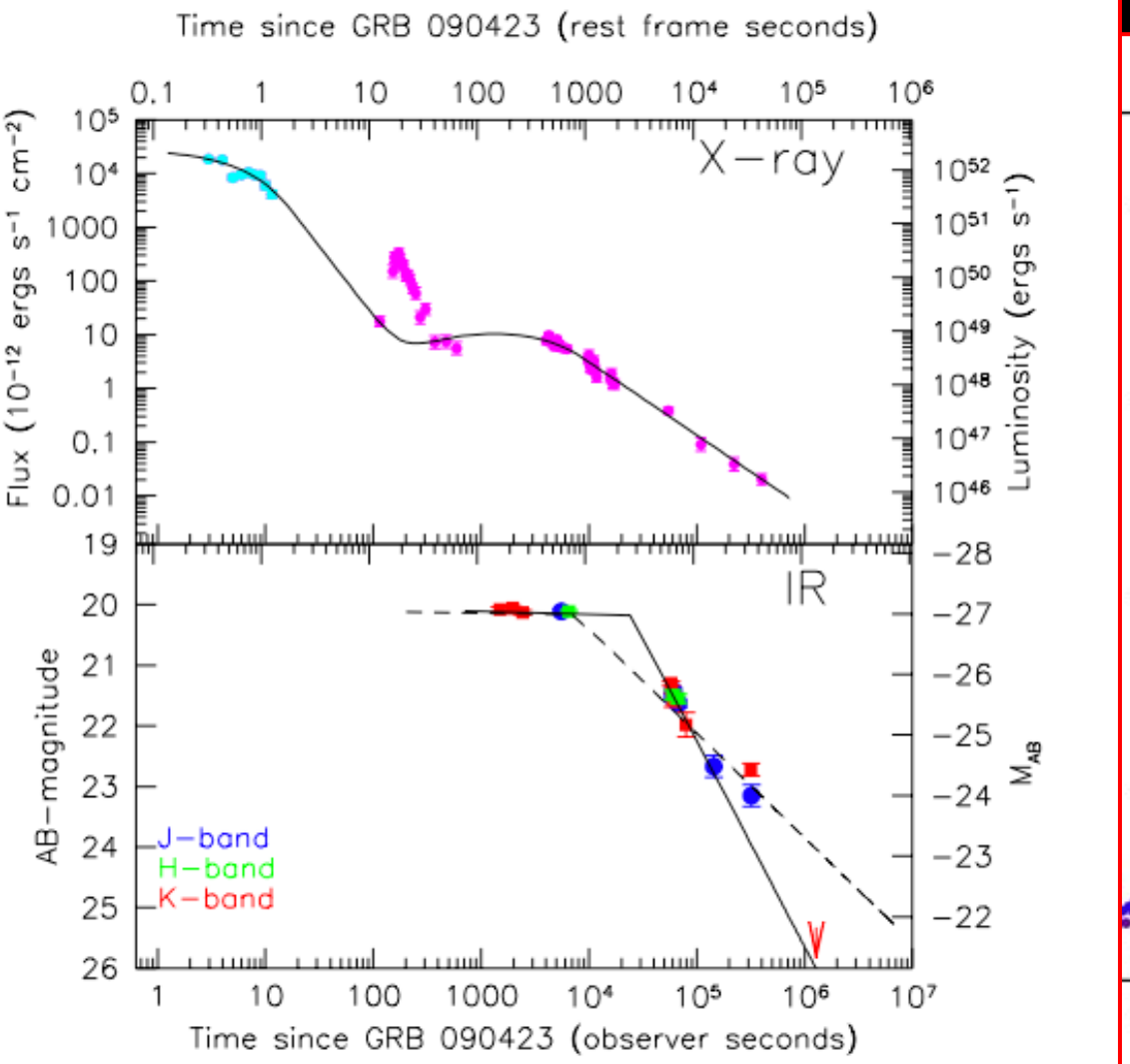


TNG spectrum

GRB 090423



GRB 090423


Time since GRB 090423 (rest frame seconds)
0.1
1
10
100
1000
10^4
10^5
10^6
X−ray
Flux (10^{-12} ergs s^{-1} cm^{-2})
Luminosity (ergs s^{-1})
10^5
10^4
1000
100
10
1
0.1
0.01
10^{52}
10^{51}
10^{50}
10^{49}
10^{48}
10^{47}
10^{46}
IR
AB−magnitude
M_{AB}
19
20
21
22
23
24
25
26
−28
−27
−26
−25
−24
−23
−22
J−band
H−band
K−band
1
10
100
1000
10^4
10^5
10^6
10^7
Time since GRB 090423 (observer seconds)

Summary

- A **BIG THANK-YOU** to all the observers and telescope operators who have taken, and continue to take, observations for the GRB followup campaign!

- UKIRT remains key part of the global effort to monitor GRBs and particularly in the identification and location of high redshift bursts - which provide a unique window on the early universe.

- Also shows the crucial requirement of having multiple 4+m telescopes available for followup and widely distributed around the planet!