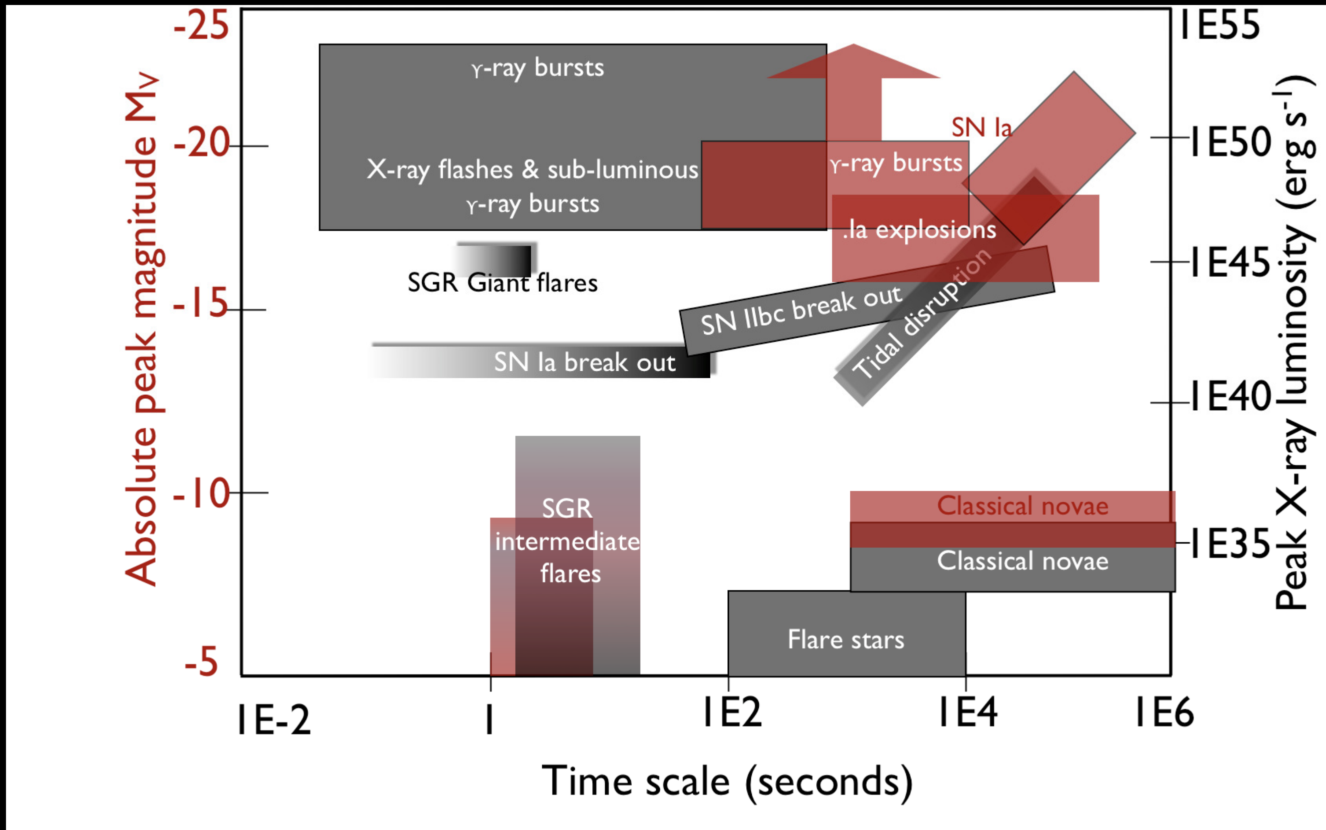
Luminous extragalactic transients

Paul O'Brien & Peter Jonker

(wiith thanks to Luigi Piro, Phil Evans, Kim Page, and James Reeves. On behalf of the Athena explosive transients working group)

Luminous extragalactic transients

Explosive transients

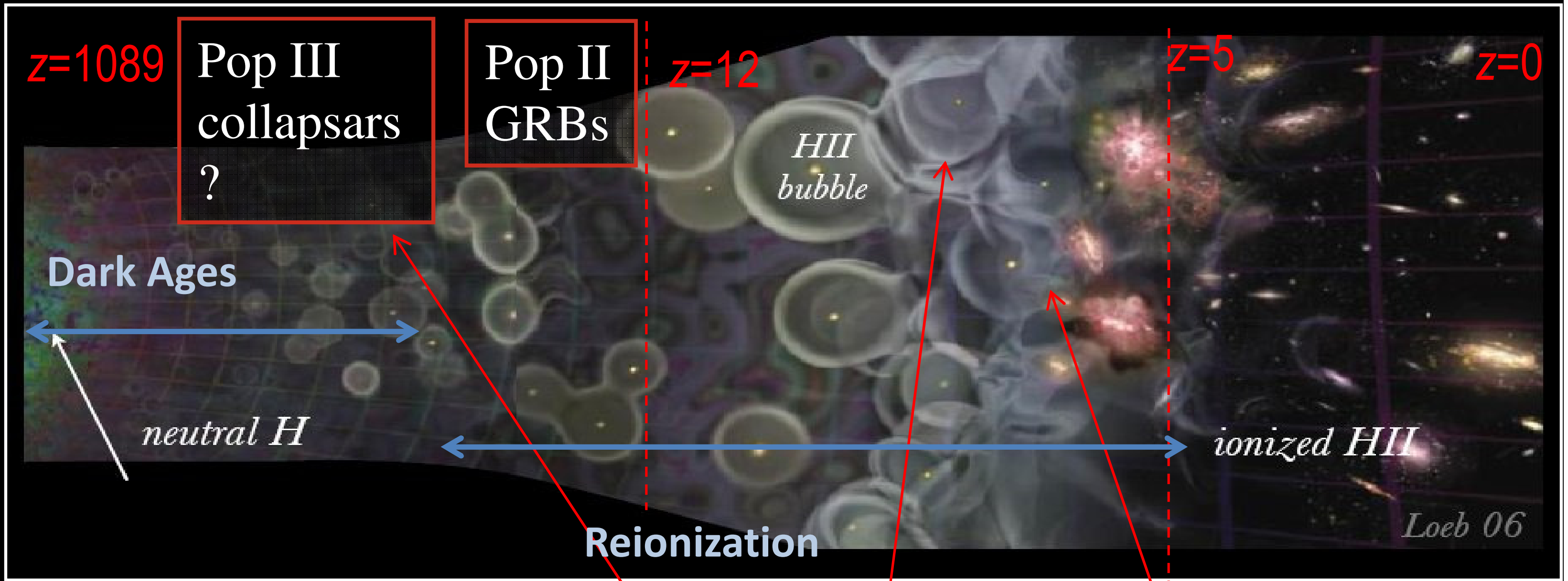


At high redshift, GRBs and TDEs are the most luminous (rare) transients

Jonker, O'Brien et al., 2013 arXiv1306.2336

Luminous extragalactic transients

The first stars, the first BH, the first metals

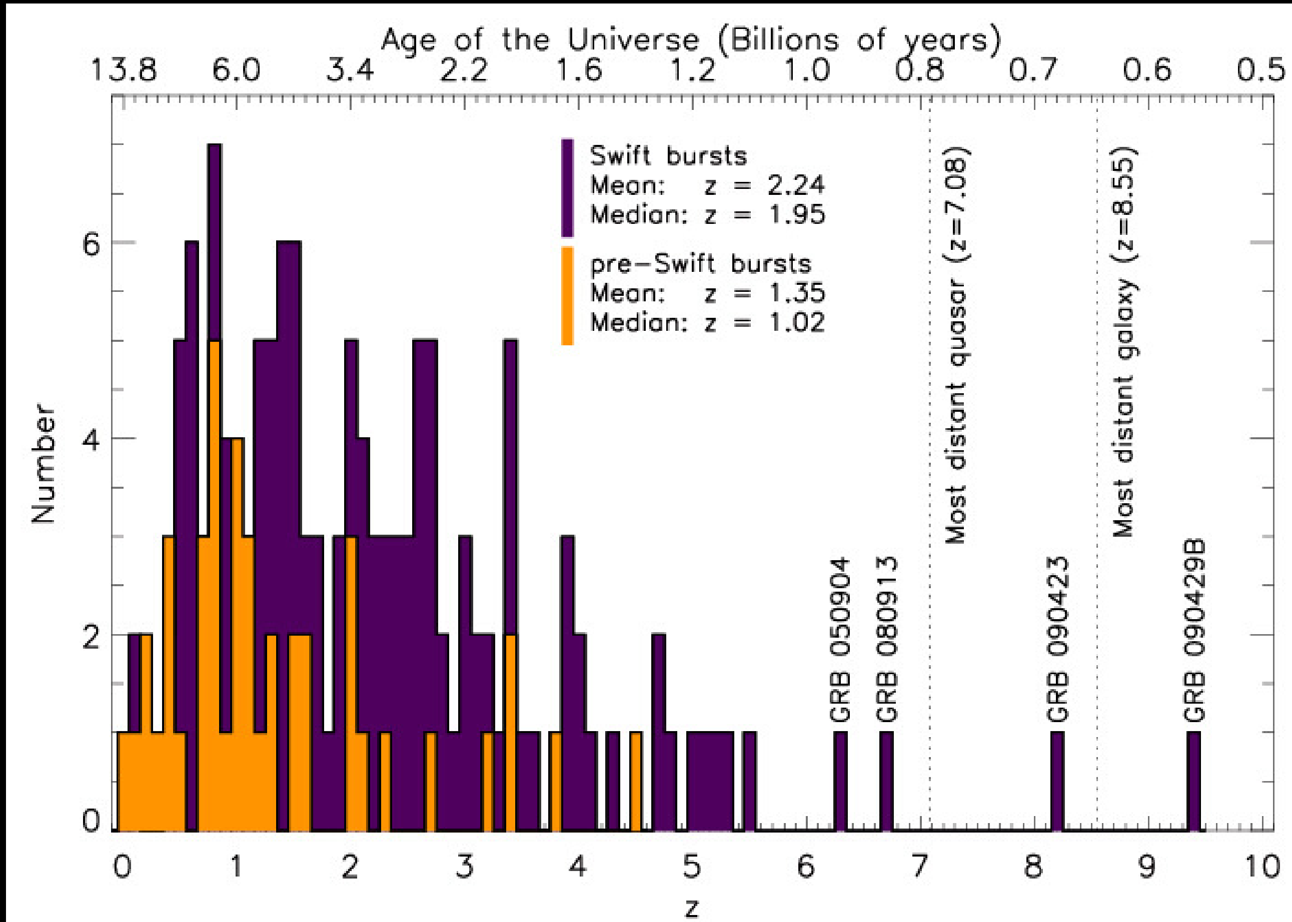


A dominant proportion of high-z star formation takes place in galaxies beyond the reach of JWST at $z > 8$; their nature will hardly be known, but **they will be GRB hosts**.

GRBs have to found to z>8-9 already, although this is non-trivial.

Luminous extragalactic transients

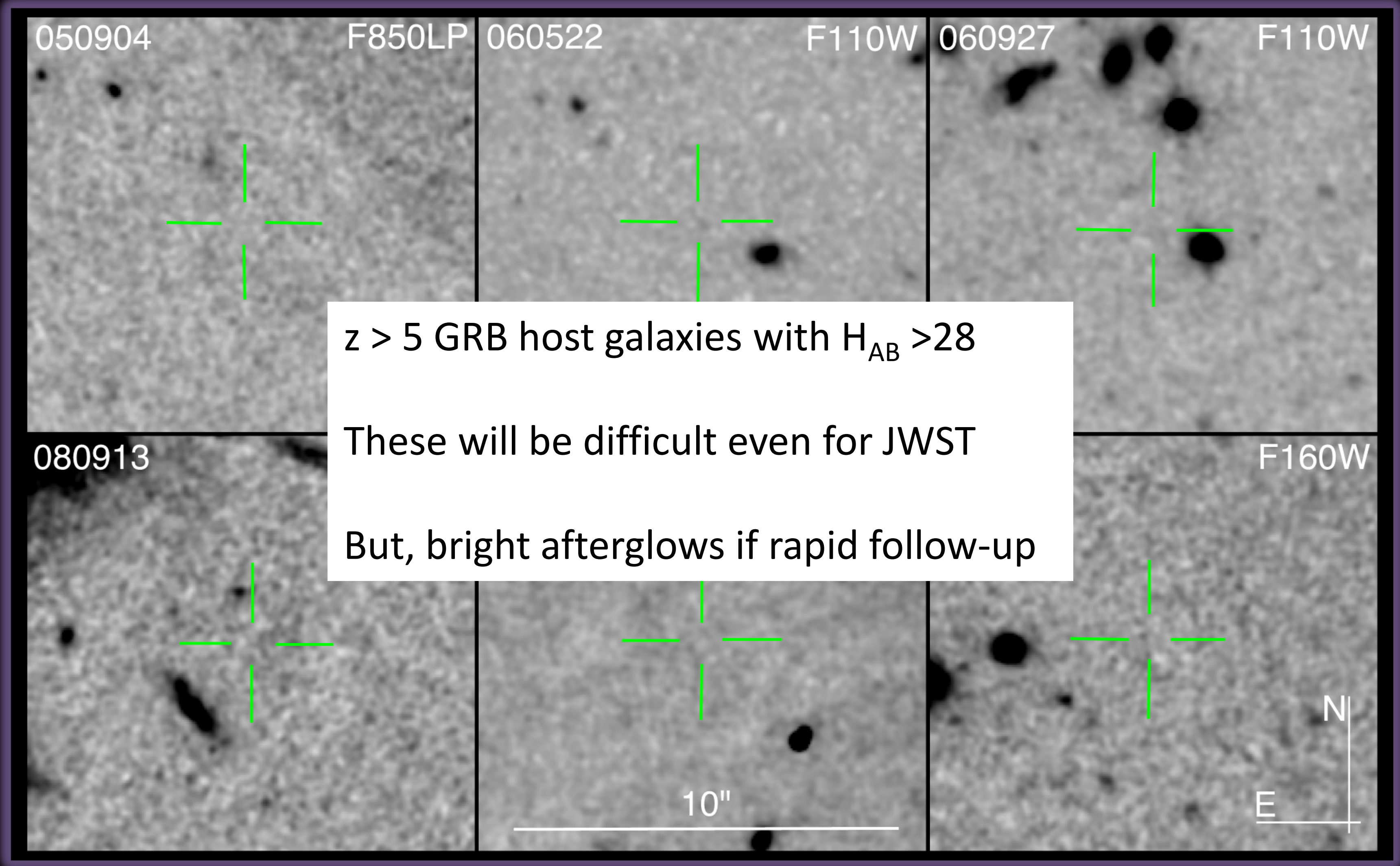
GRBs give you the highest-redshift Universe



Pali Jakobsson (2011)
http://raunvis.hi.is/~pja/GRBsample.html

Luminous extragalactic transients

GRBs: locate faint star-forming high-z galaxies



z > 5 GRB host galaxies with H_{AB} >28

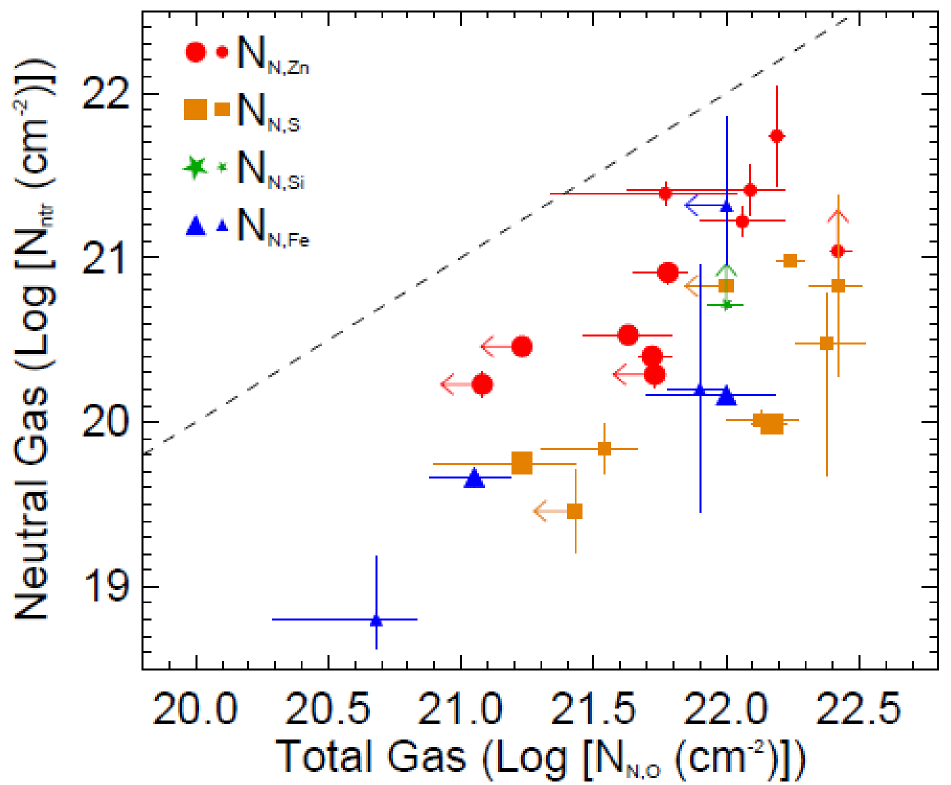
These will be difficult even for JWST

But, bright afterglows if rapid follow-up

Tanvir et al. 2012

Luminous extragalactic transients

is the environment near the GRB ionised?



Schady et al 2011

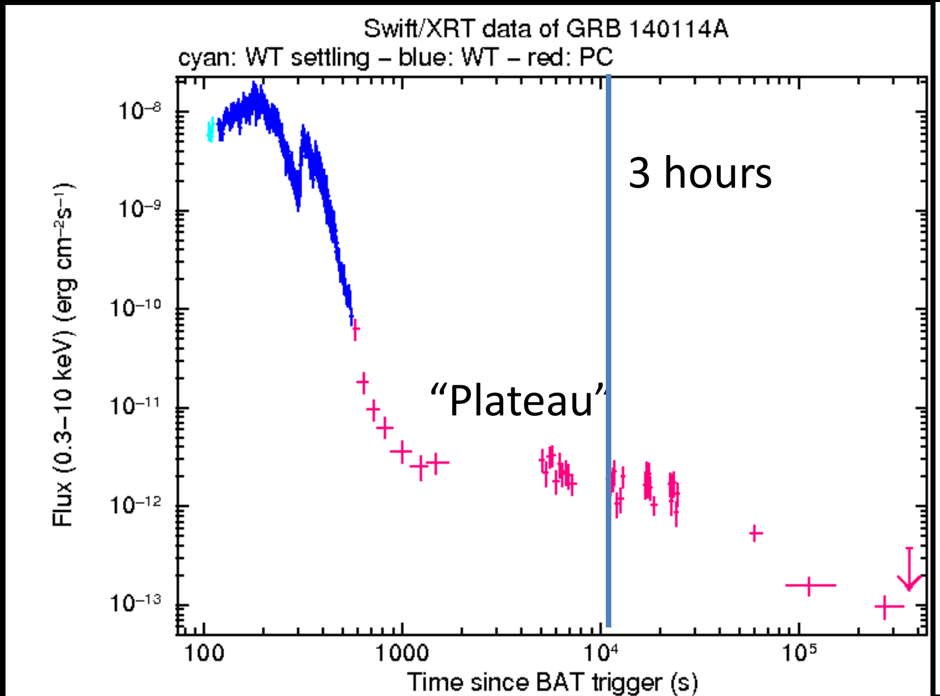
Excess column in X-rays – but is it intrinsic to the GRB host?

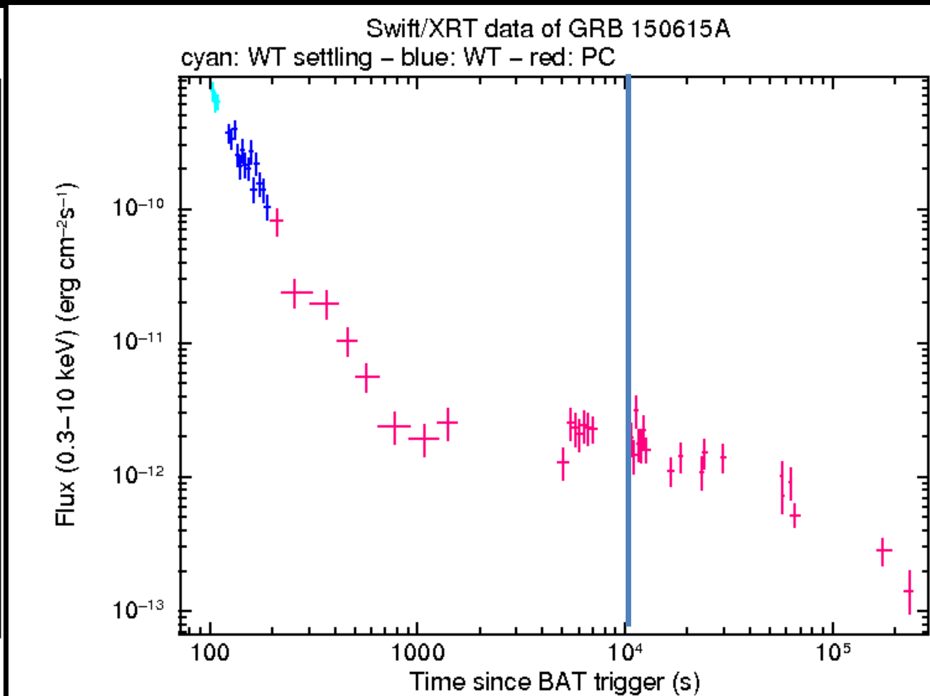
Don't know the local (few 10s of pc) abundance/ionisation

Need X-ray spectra to study the highly ionised gas in order to get the full picture

Luminous extragalactic transients

Example Swift GRB X-ray light curves





Usually see a slow early decay (slower than t^{-1}) from ~1ksec to ~0.5 day

Provides a high photon yield, if Athena responds fast enough (a few hours)

GRBs with Athena

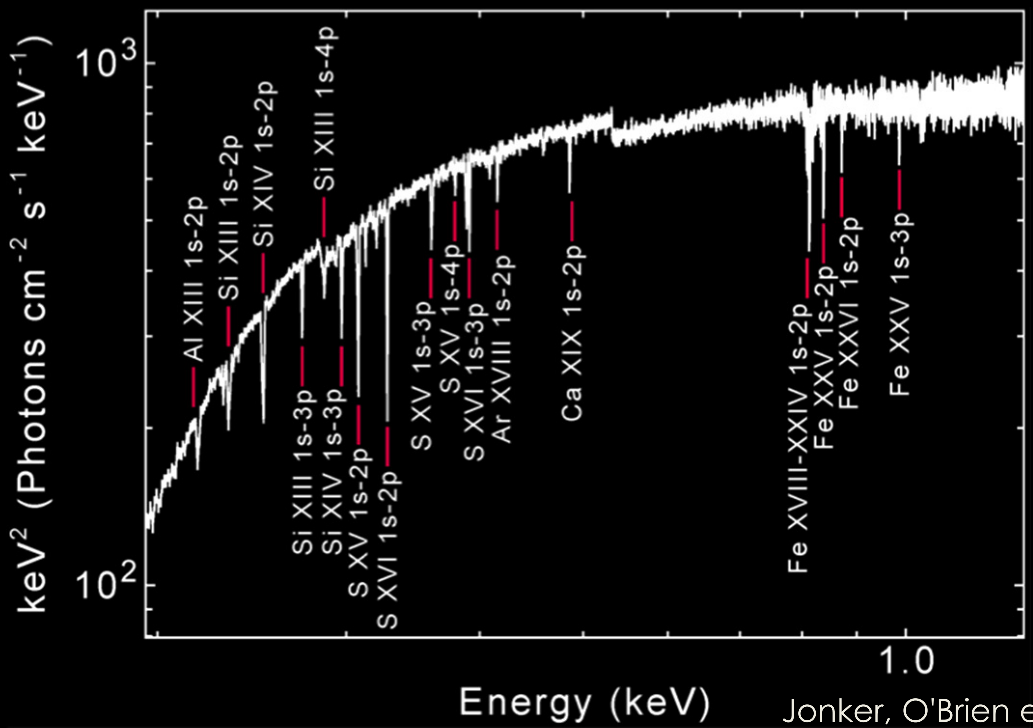
Find the missing baryons in the WHIM:

✓ Select targets based on prompt brightness

Find star forming sites in the high-z Universe:

✓ Select targets based on brightness and redshift indicator

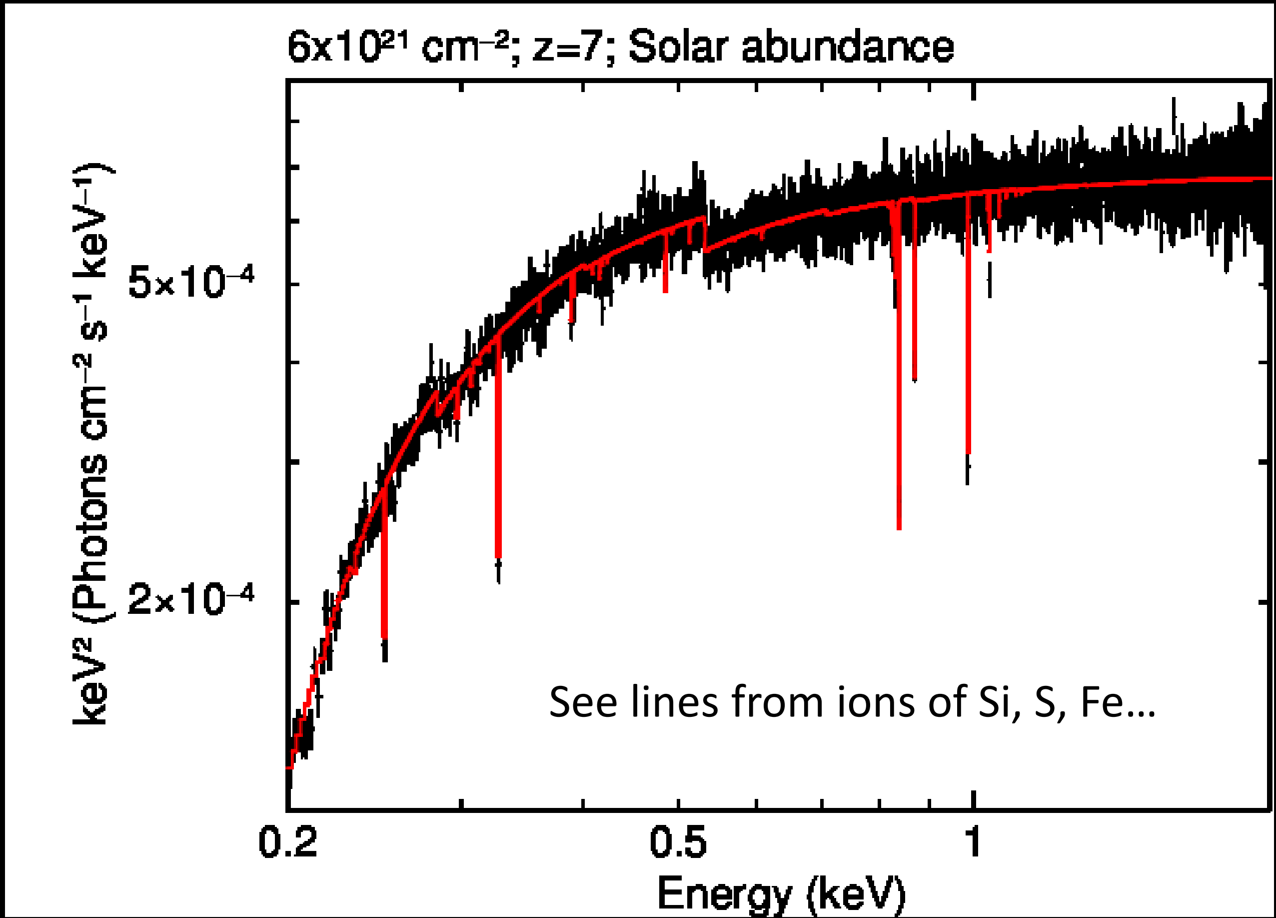
Mission requirement: TOO response in 4hrs (2hrs goal) for 50% of sky



Jonker, O'Brien et al., 2013 arXiv1306.2336

Luminous extragalactic transients

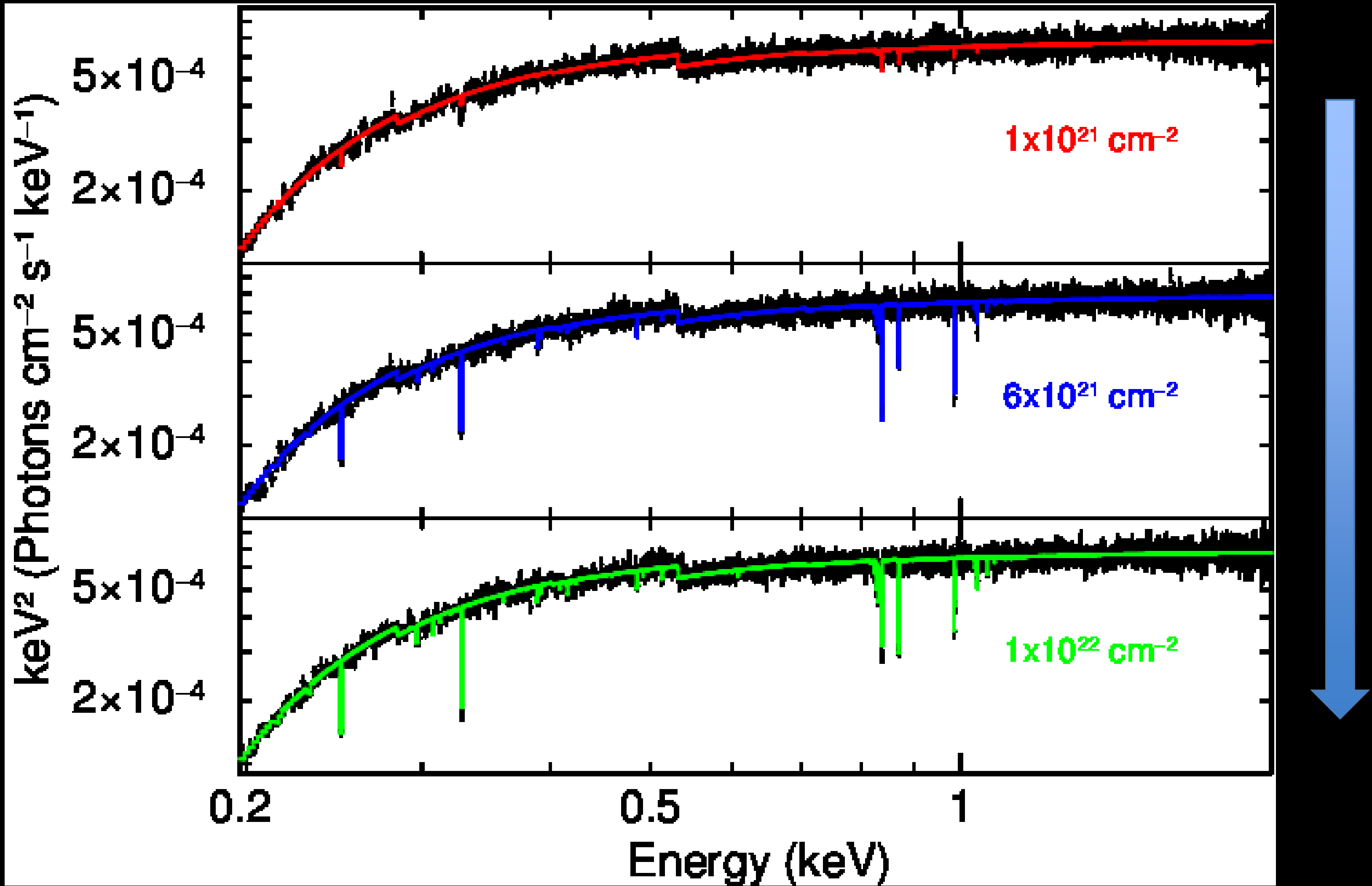
Simulated spectrum of a bright GRB at z=7
(fluence=$1x10^{-7}$ erg cm^{-2}, log Xi=3, Nh=$6x10^{21}$ cm^{-2})



(using baseline response files and XSTAR model grid)

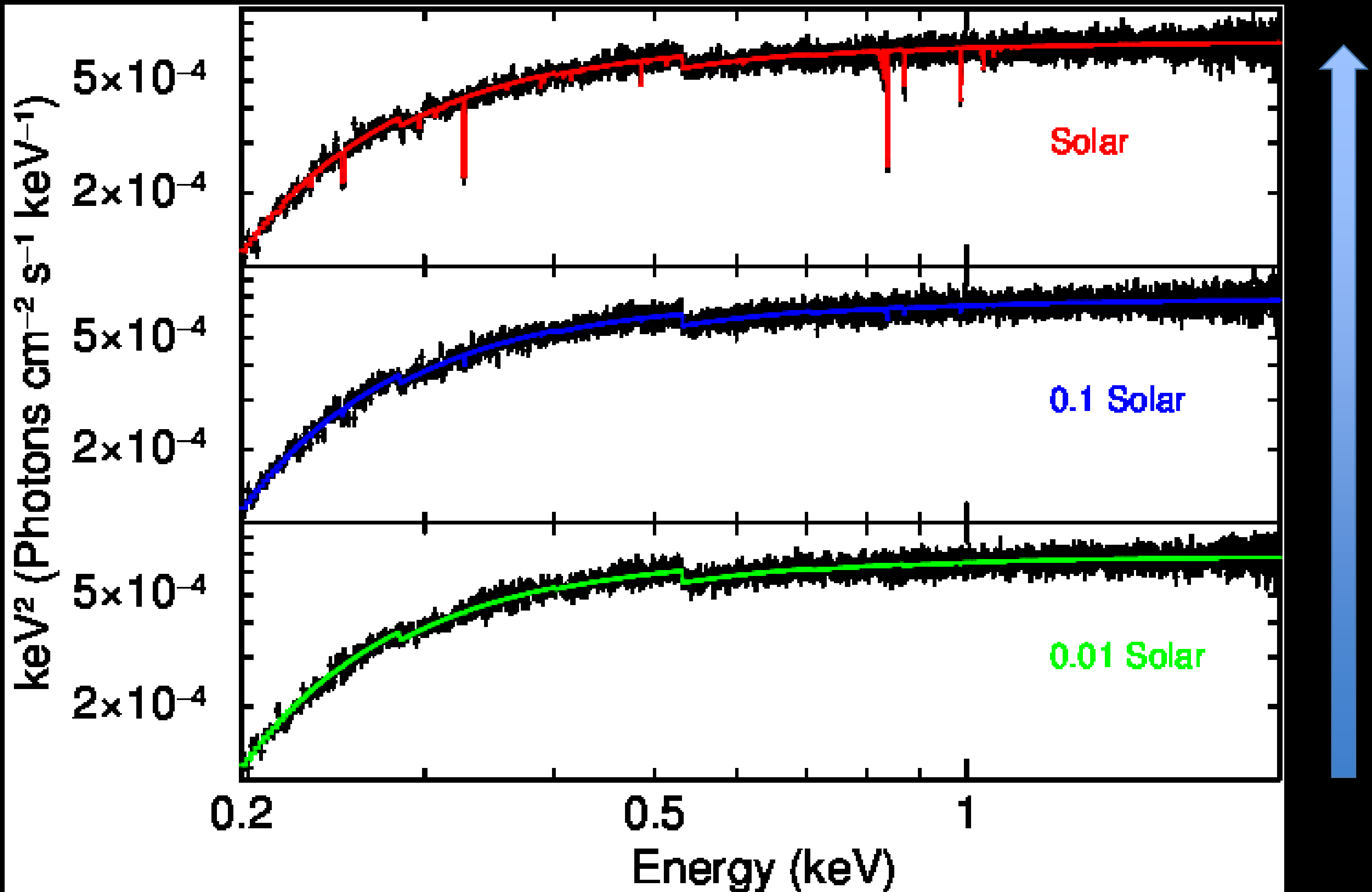
Luminous extragalactic transients

Effect of column density



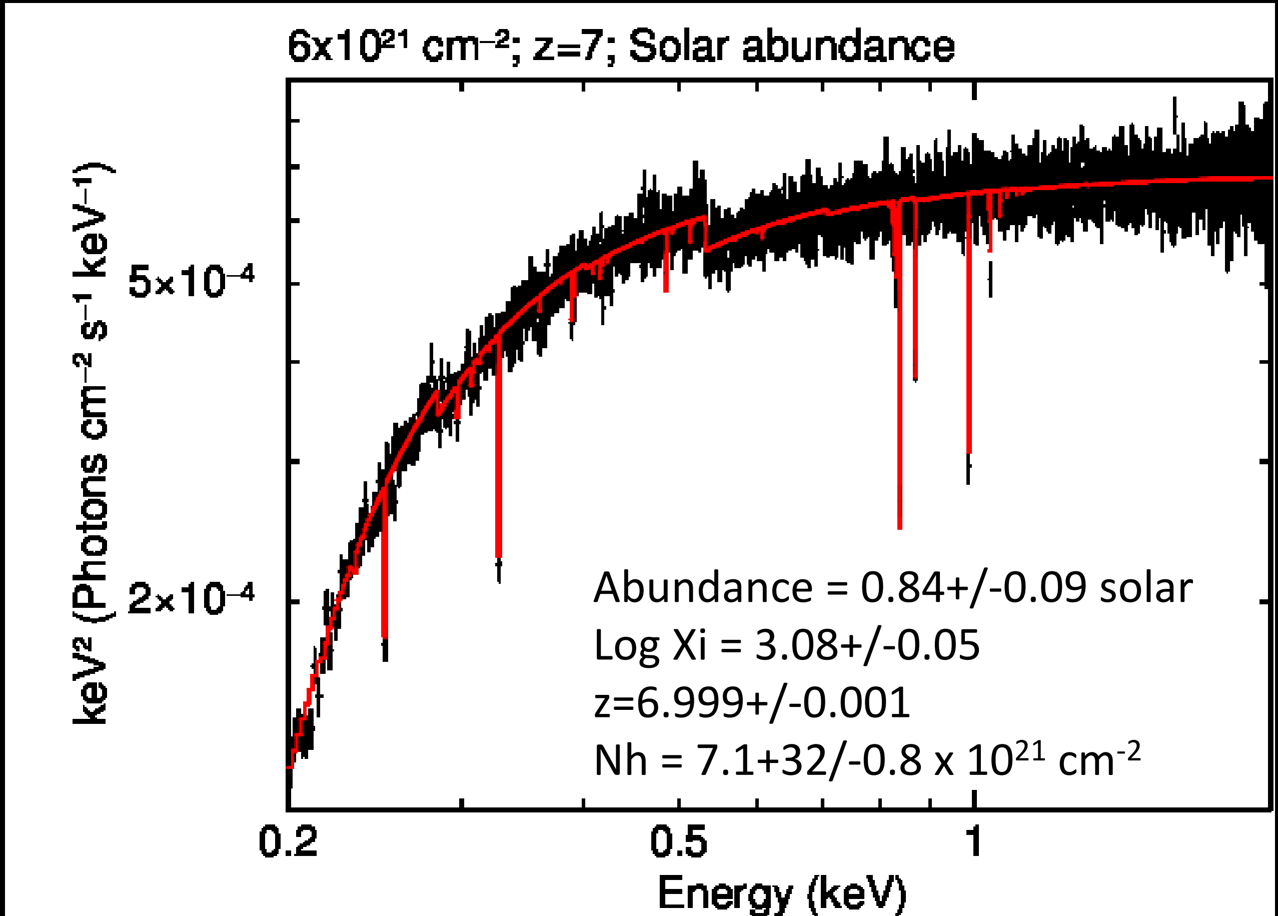
Luminous extragalactic transients

Effect of abundance



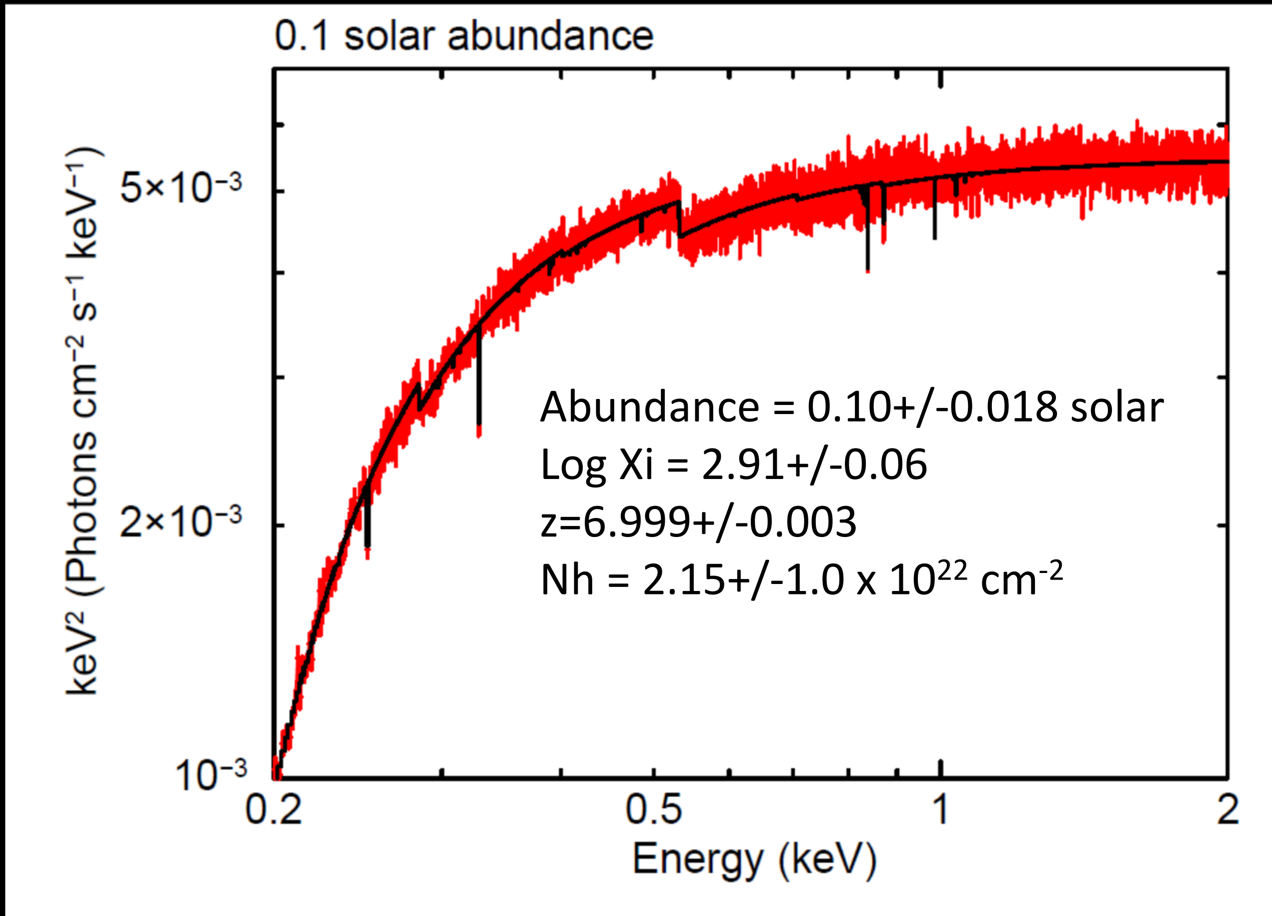
Luminous extragalactic transients

How well can we recover parameters?



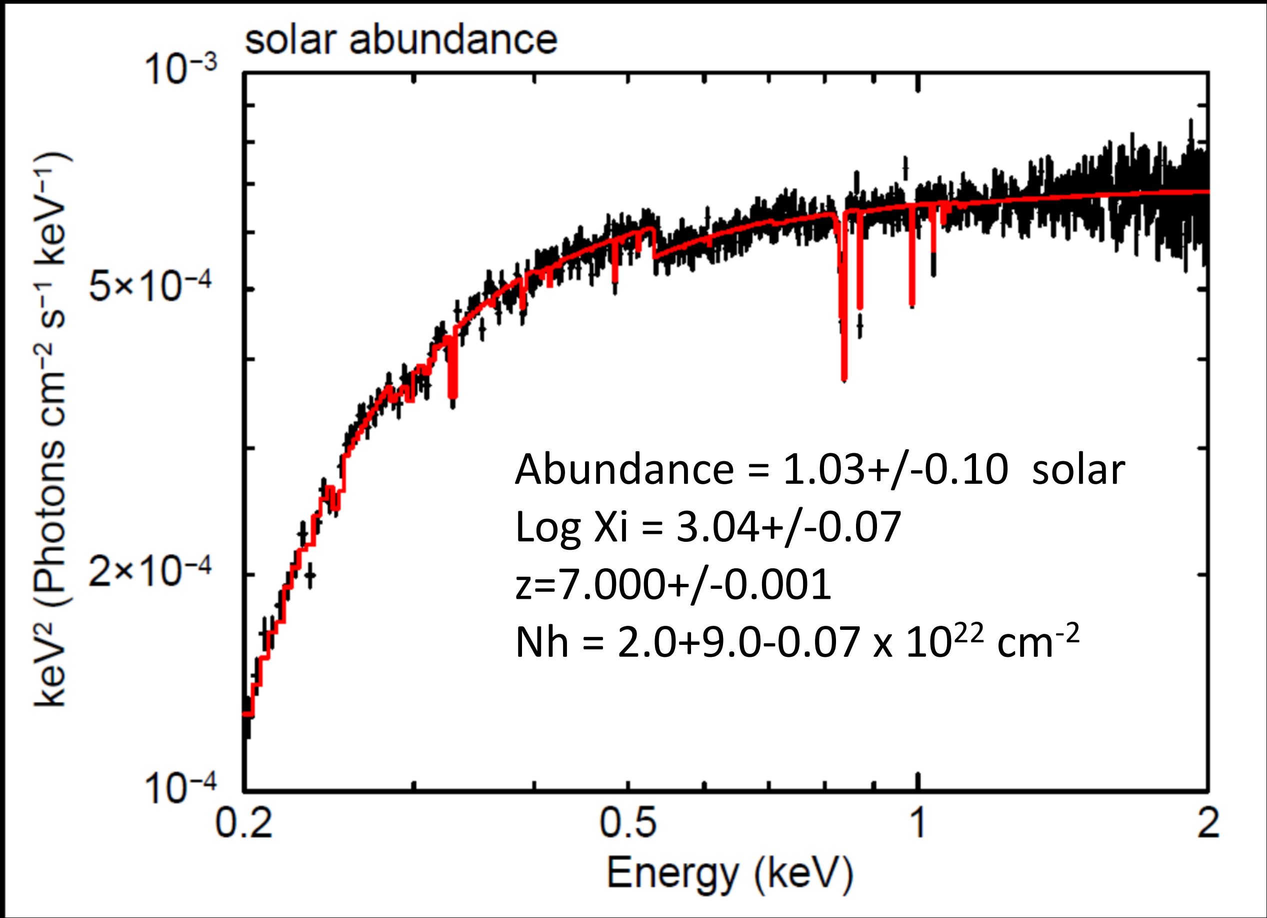
In practice will also have additional features: intervening systems, Galaxy…

Simulated spectrum of a very bright GRB at z=7 (fluence=4x10^{-7} erg cm^{-2}, log Xi=3, Nh=2x10^{22} cm^{-2})



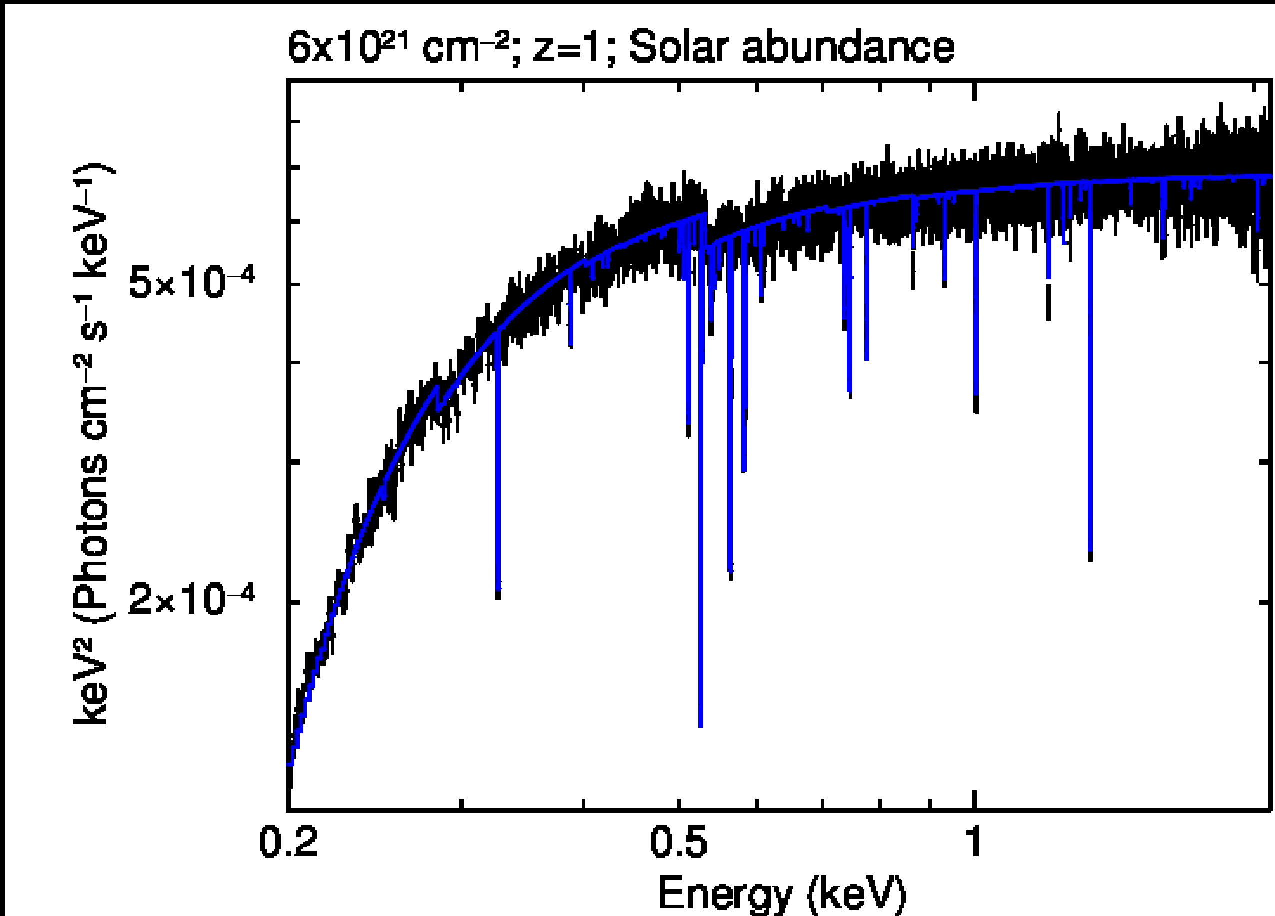
Luminous extragalactic transients

Simulated spectrum of a fainter GRB at z=7 (fluence=5×10^{-8} erg cm^{-2}, log Xi=3, Nh=2×10^{22} cm^{-2})



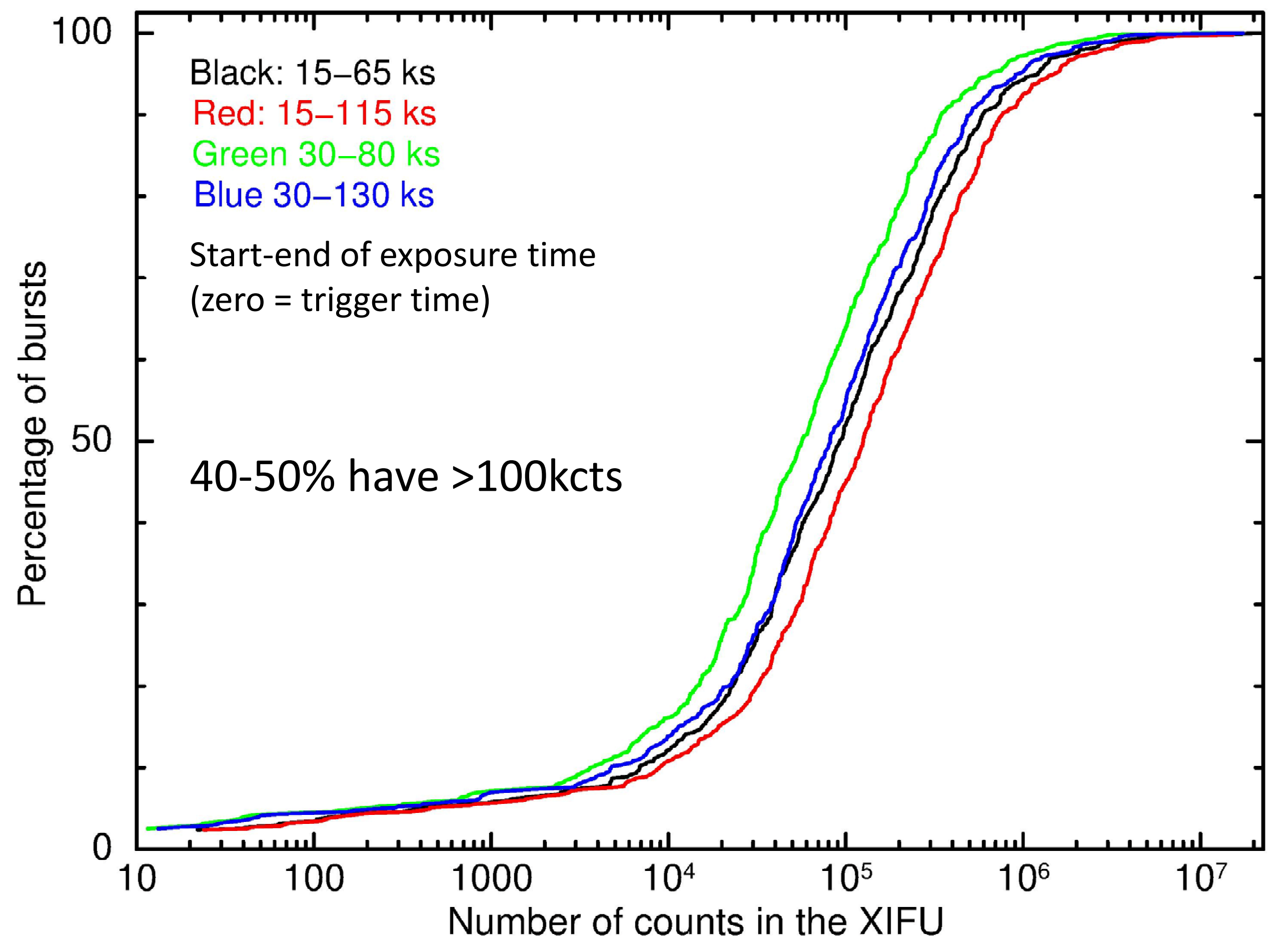
Luminous extragalactic transients

Simulated spectrum of a bright GRB at z=1
(fluence=1×10^{-7} erg cm^{-2}, log Xi=3, Nh=6×10^{21} cm^{-2})



Luminous extragalactic transients

Swift sample with Athena X-IFU



Conclusions and issues

- Utilise GRBs to study sites where first stars form and ID locations of galaxies otherwise too faint to study
- Athena is powerful enough to see ionised gas in GRBs across wide range of comic time using GRBs as a backlight (using X-IFU)
- Independent and complementary access to gas parameters from rest-frame UV/optical

- Accuracy depends on the GRB and (crucially) TOO speed – cannot win by longer exposures later. Also need to be able to observe easily from the ground – e.g. L1 vs. L2 implications TBD

- We do need something to find transients (optimistic note - this has been true for last 50 years, and SVOM will extend that to ~60 years)