New Results on the Gamma-Ray-Burst-Supernova Connection

David Alexander Kann
Max-Planck Institut für Extraterrestrische Physik

On behalf of the GROND-Team

Extreme Universe Laboratory, Lomonosov Moscow State University, Russia
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SN 1998bw in Spiral Galaxy ESO184-G82

ESO PR Photo 39a/98 (15 October 1998)

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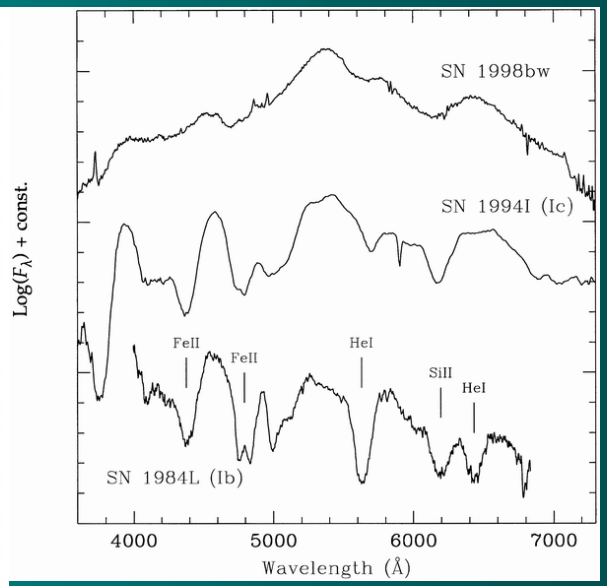

Galama et al. 1998

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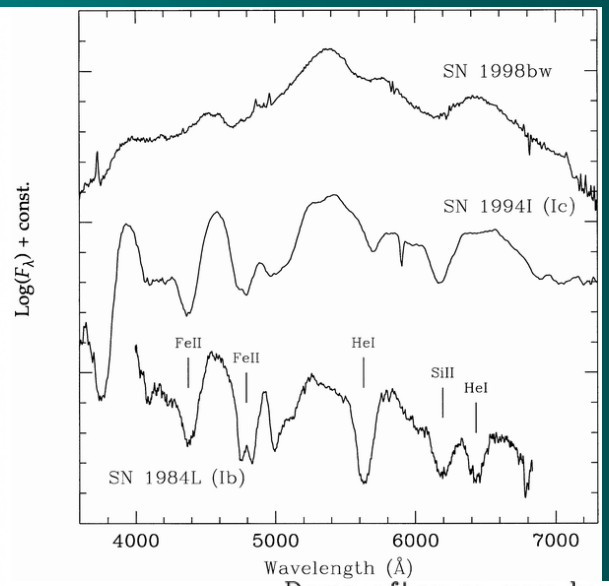
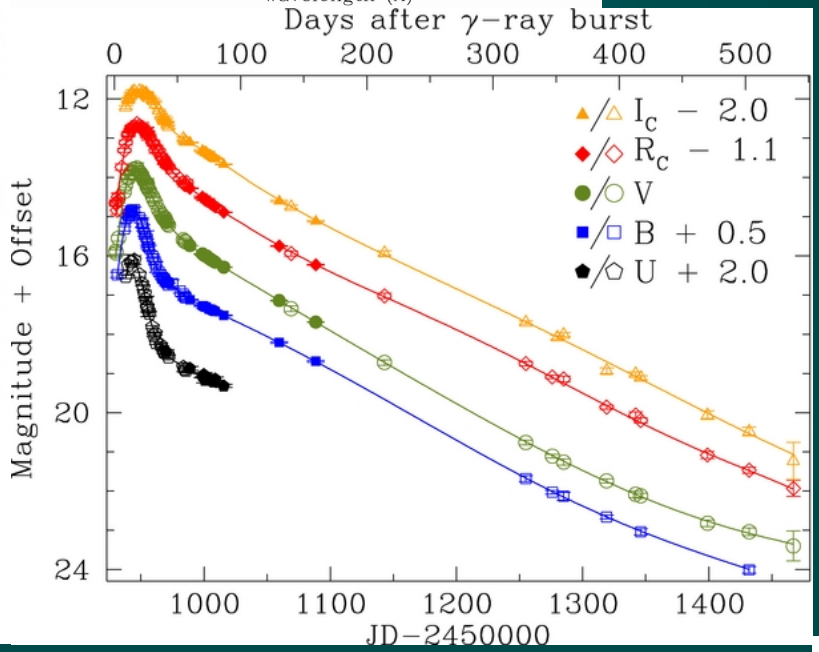


Galama et al. 1998

Clochiatti et al. 2011



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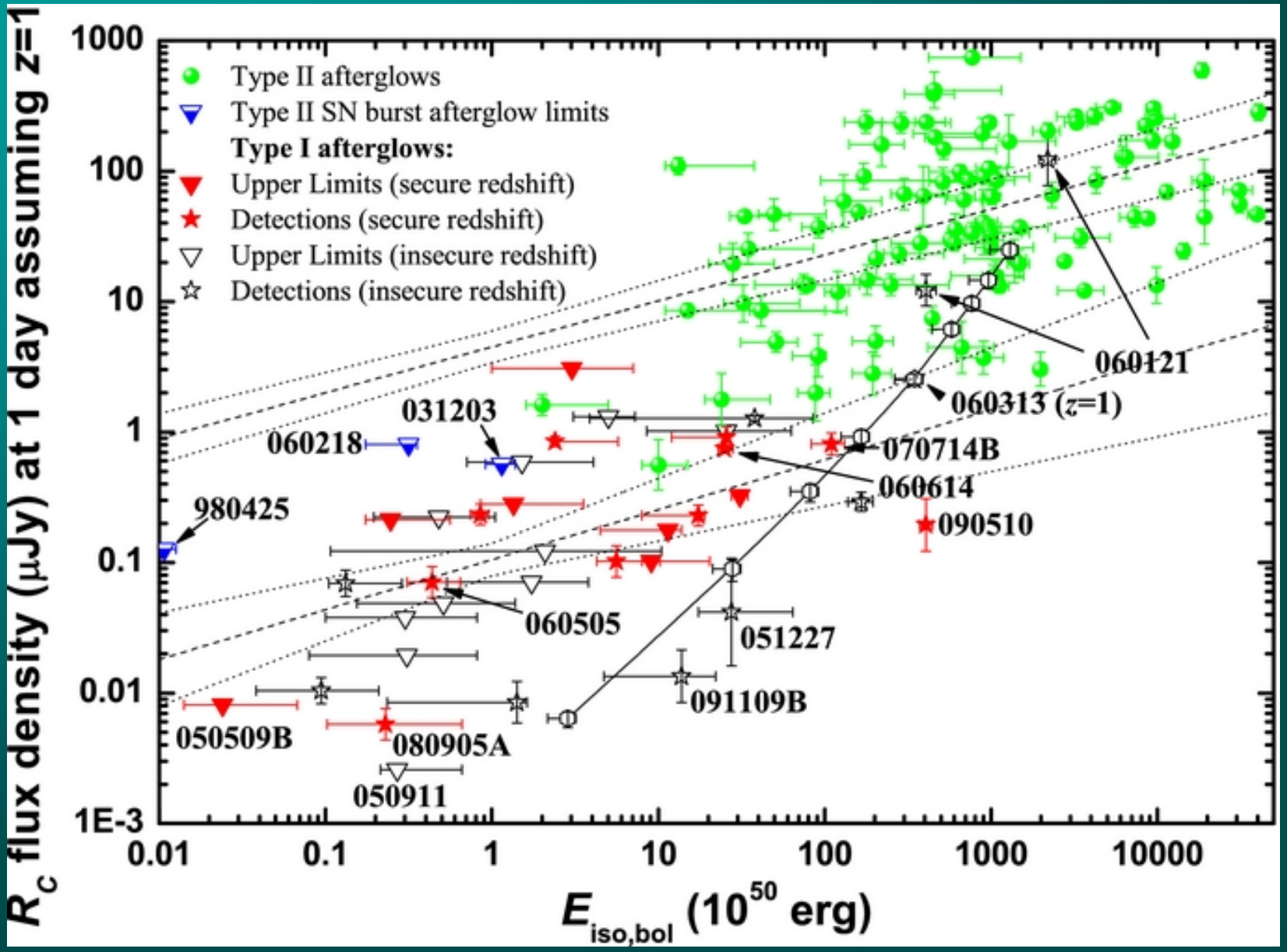

Kann et al. 2011

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  Instead of no SN, a „hypernova“ (broad-lined Type Ic SN)!
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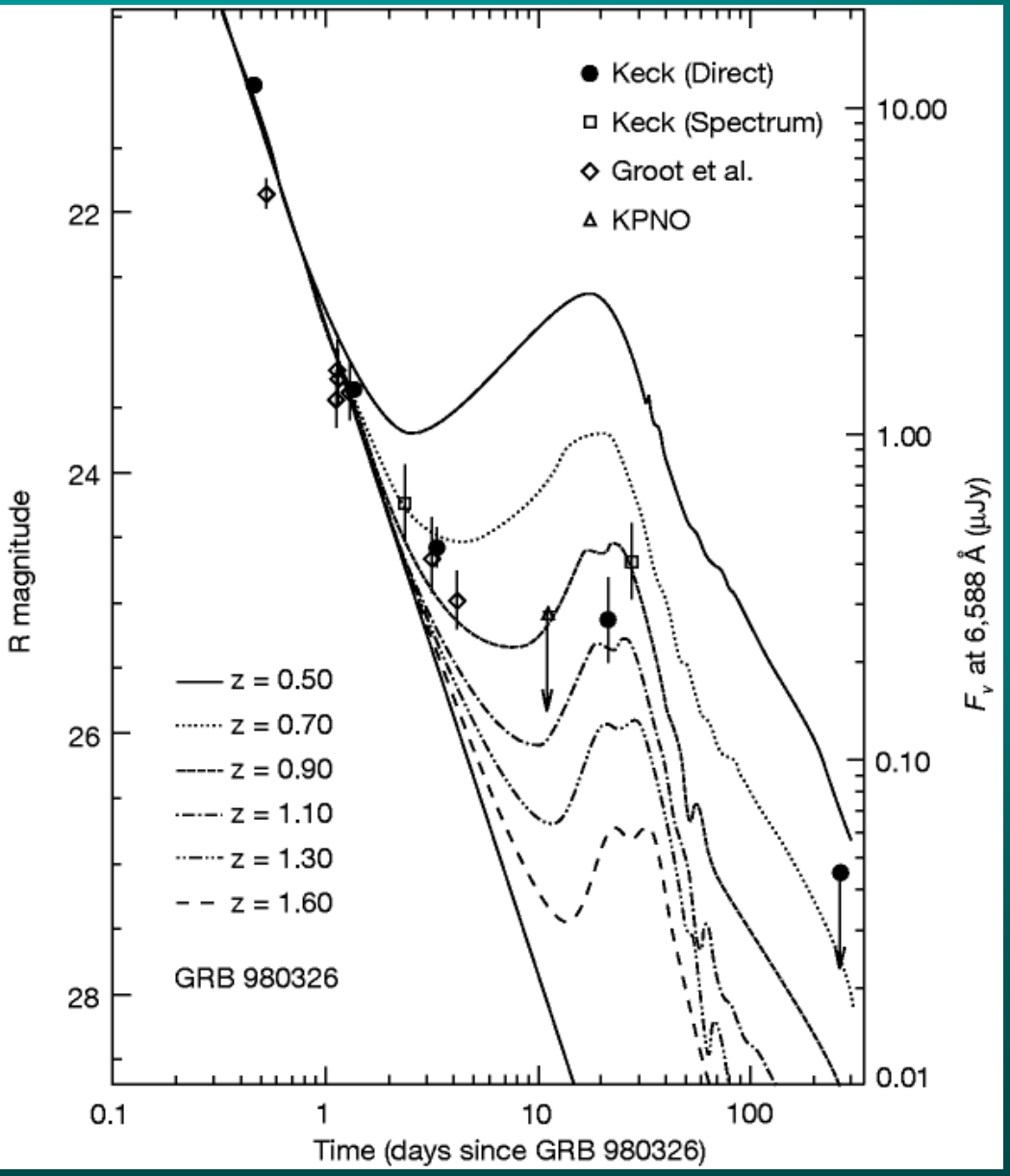

Bloom et al. 1999

But spectroscopy not successful, no redshift obtained (~ 1 from comparison with SN 1998bw)

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- GRB 021211 (Della Valle et al. 2003)
Low S/N, but at z = 1!

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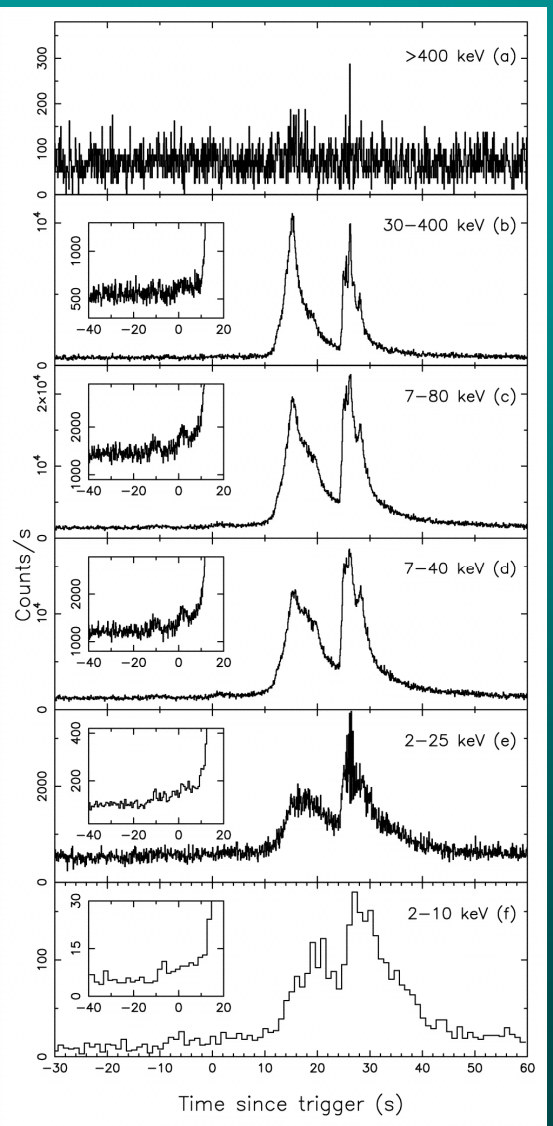

Vanderspek et al. 2004

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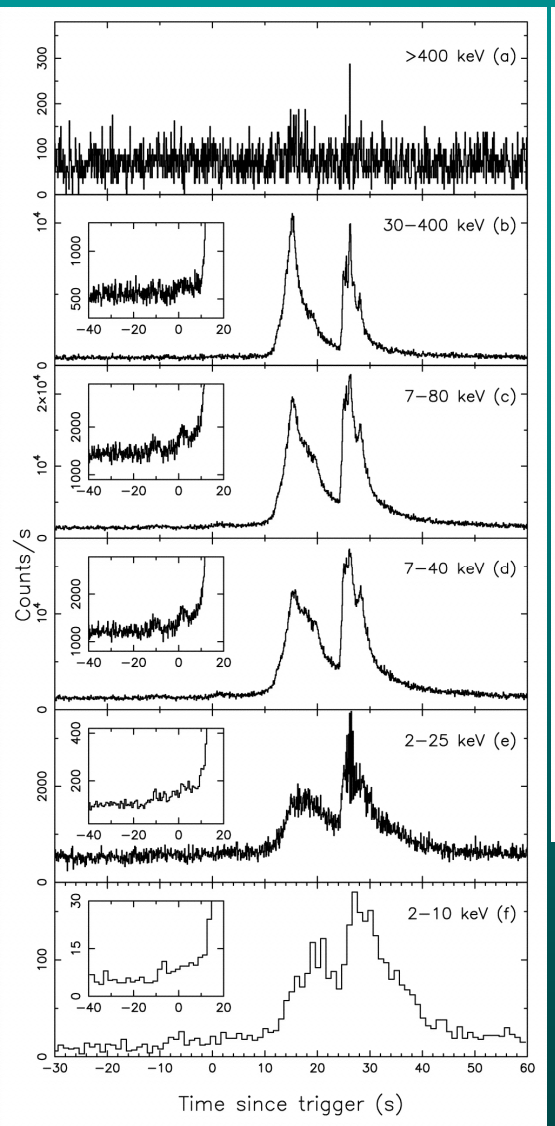

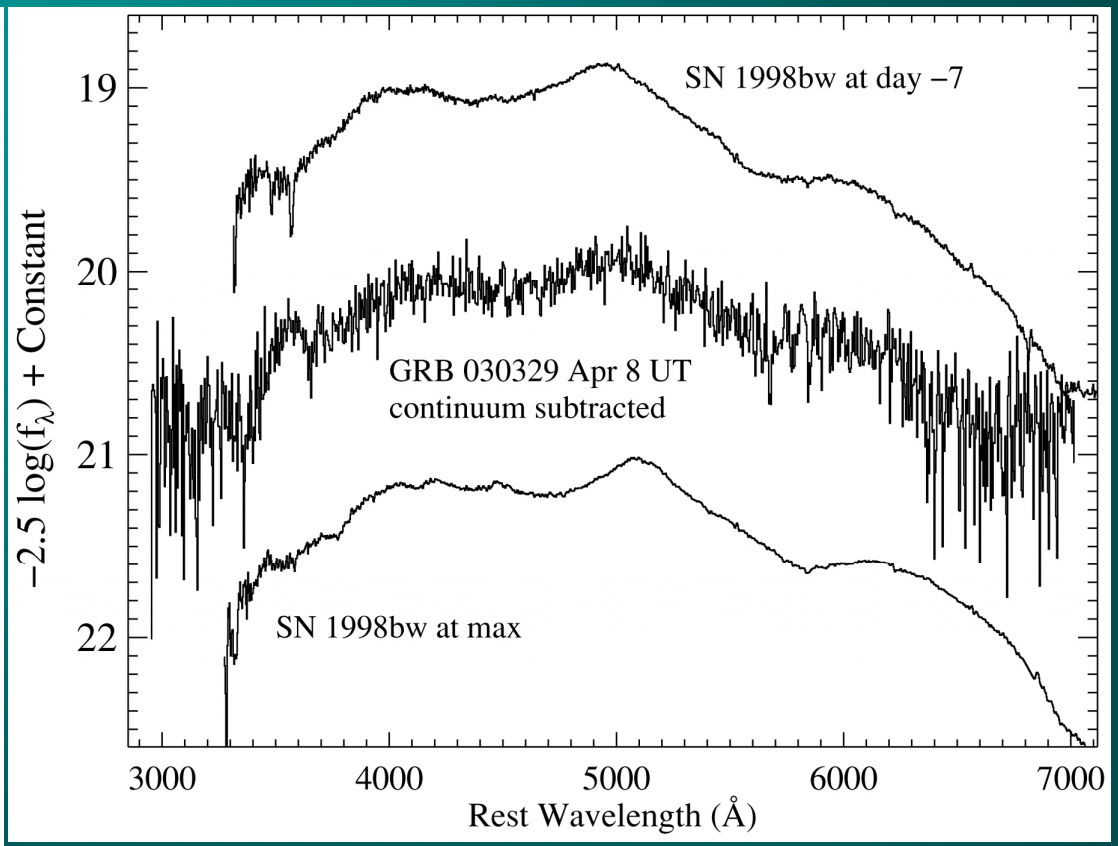

Stanek et al. 2003

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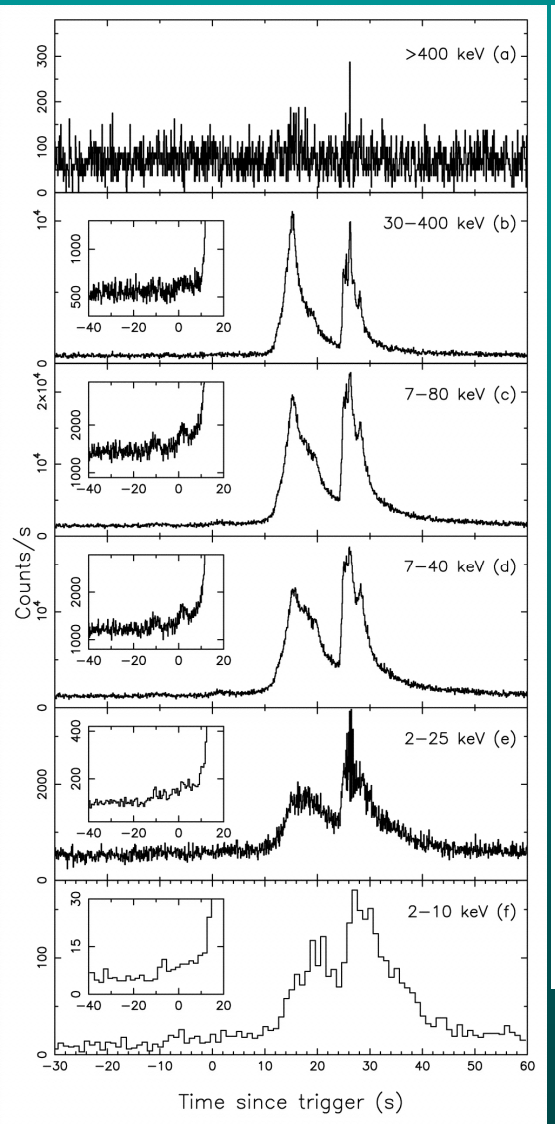

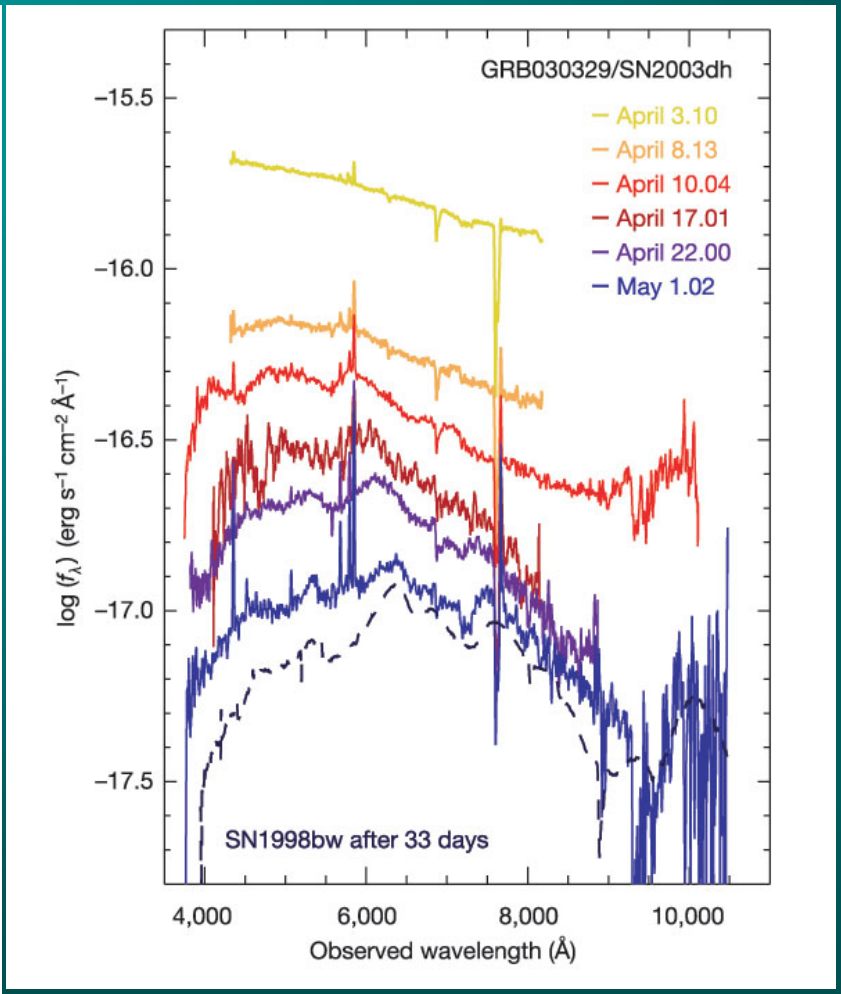

Hjorth et al. 2003

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  Zeh, … Kann, … et al. 2005 present first results on host-extinction-corrected SN light curves.

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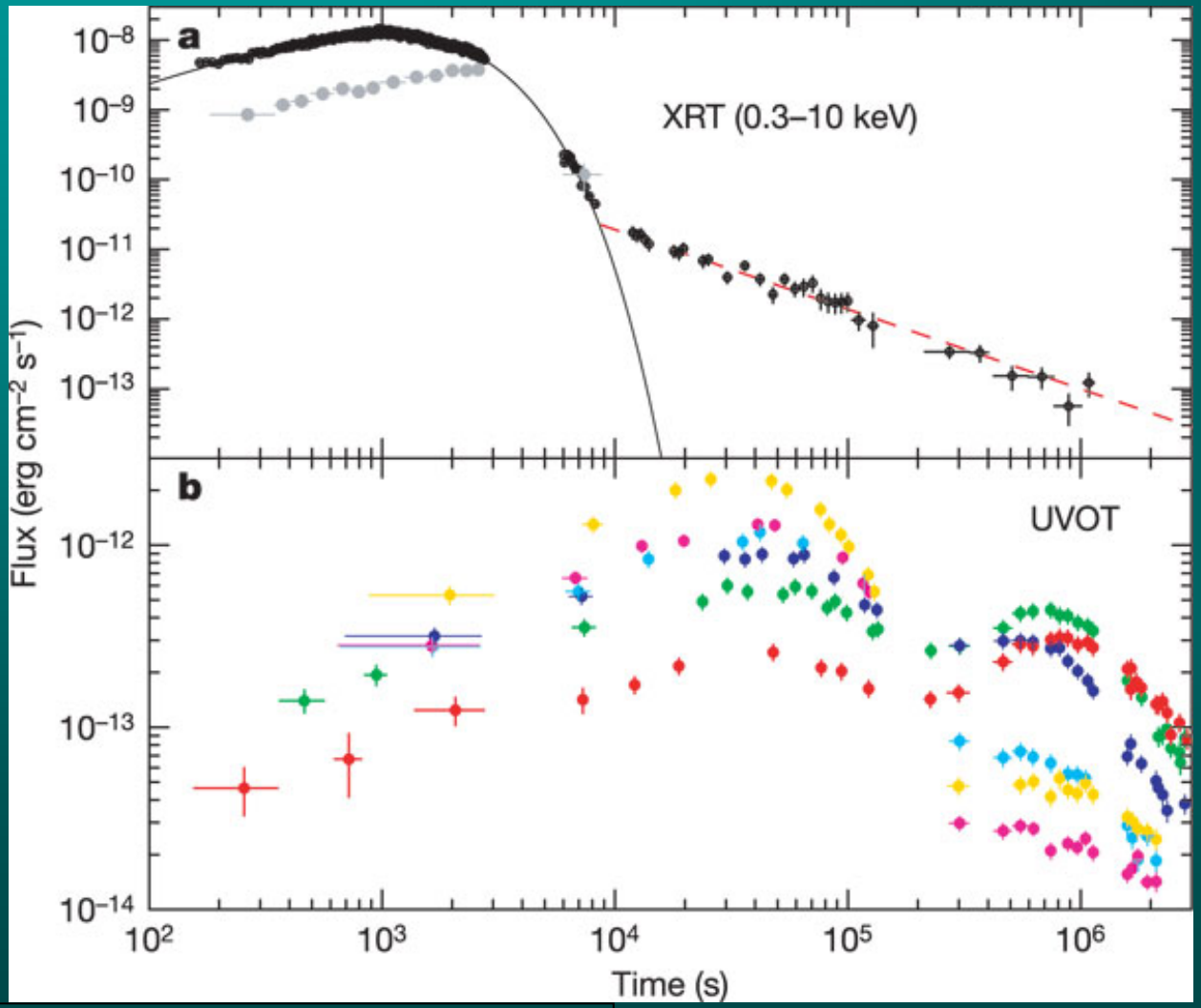

Campana et al. 2006

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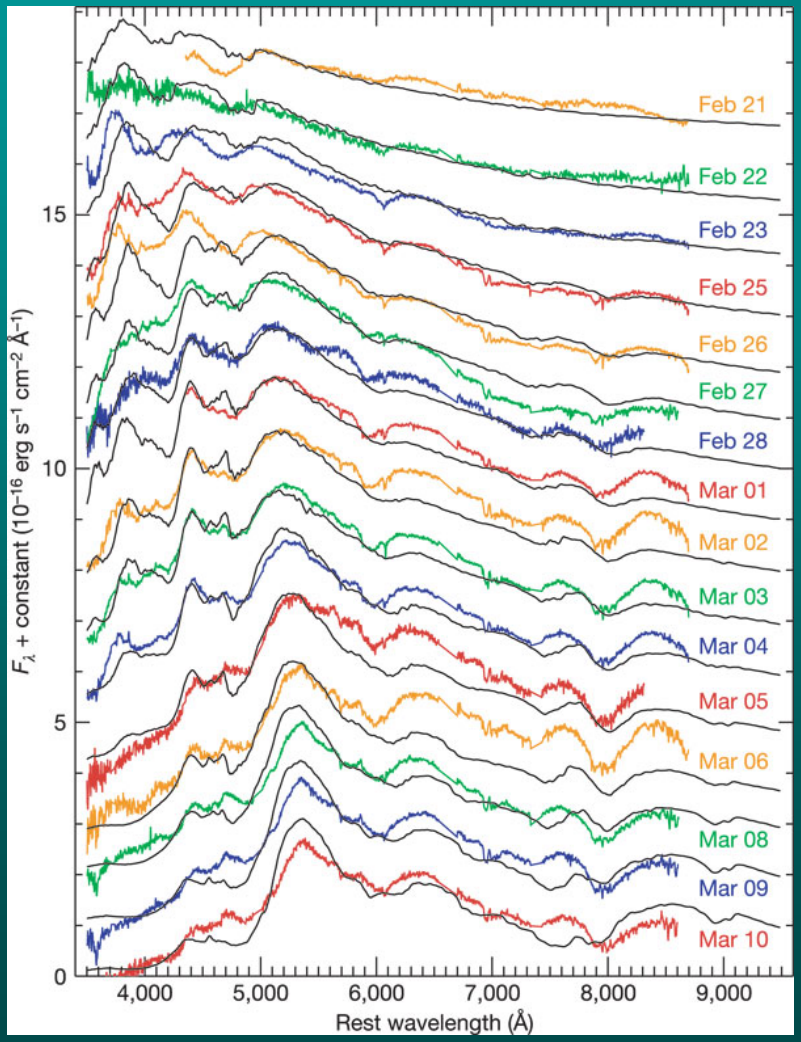

Pian et al. 2006, Mazzali et al. 2006

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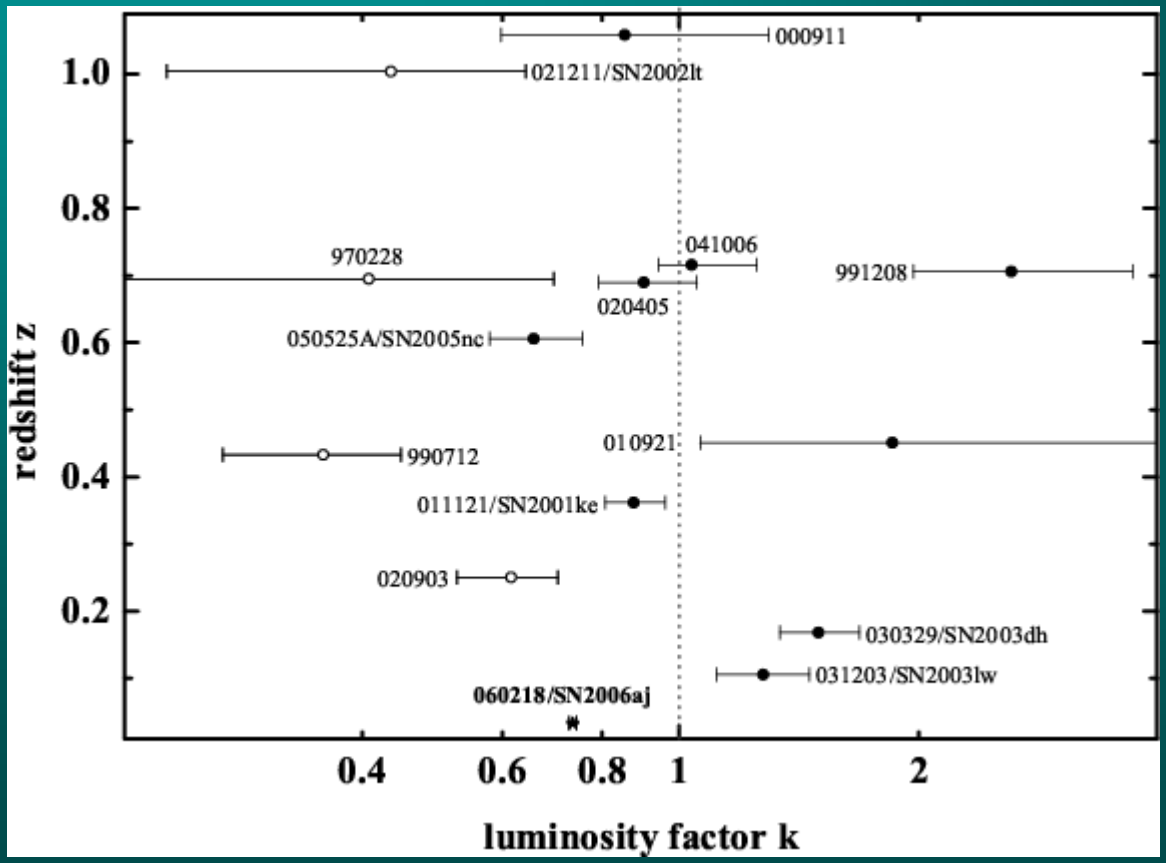

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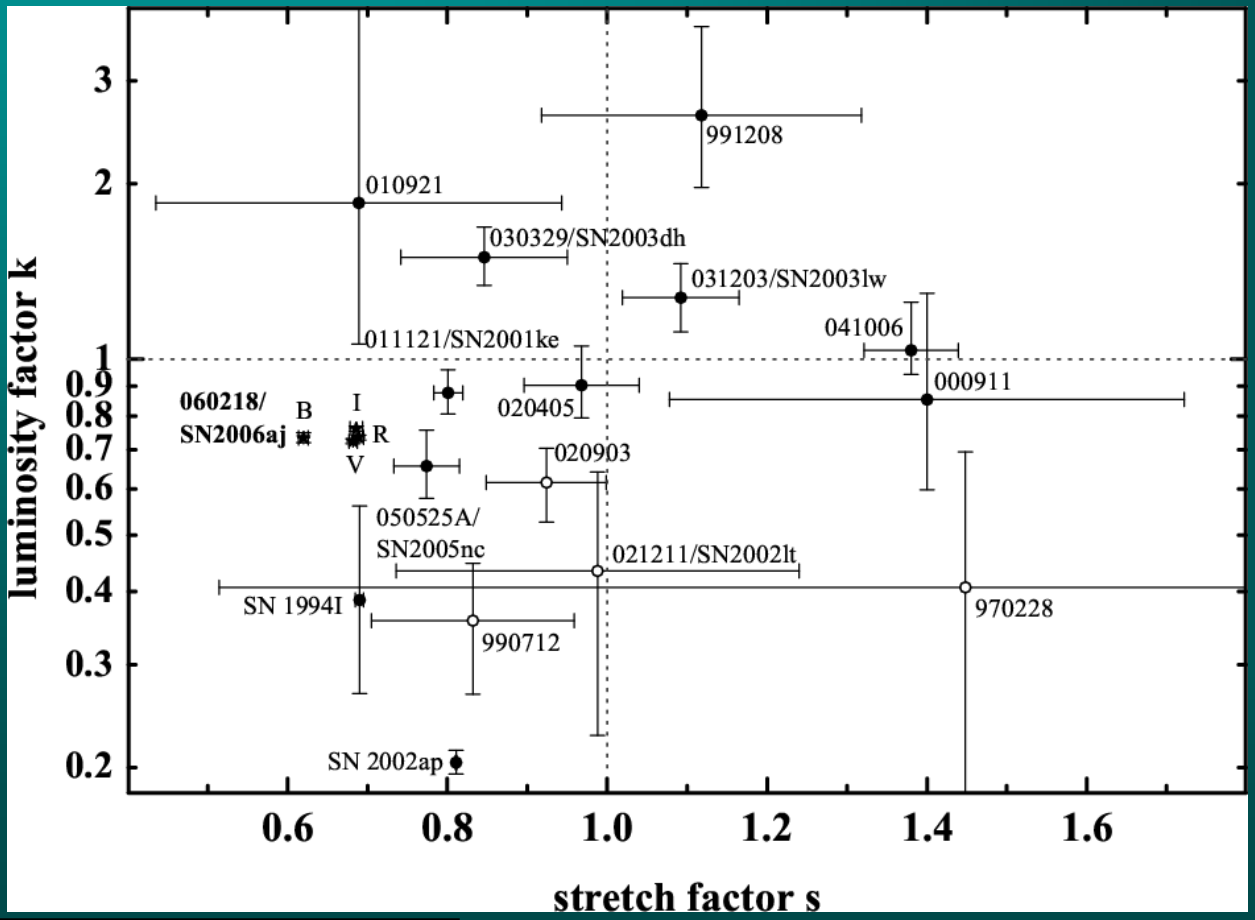

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  - GRB 091127/SN 2009nc: Spectroscopic SN of a GRB 030329-like GRB, including correct host-galaxy subtraction (Berger et al. 2011)
  - XRF 100316D/SN 2010dh: Another XRF 060218-like event! (Chornock et al. 2010, Starling et al. 2011, Olivares E., … Kann, … et al. 2012, Bufano et al. 2012)

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- Classical GRBs only have low-S/N spectroscopy
- GRB 030329 and GRB 091127 are X-ray rich, moderate luminosity GRBs

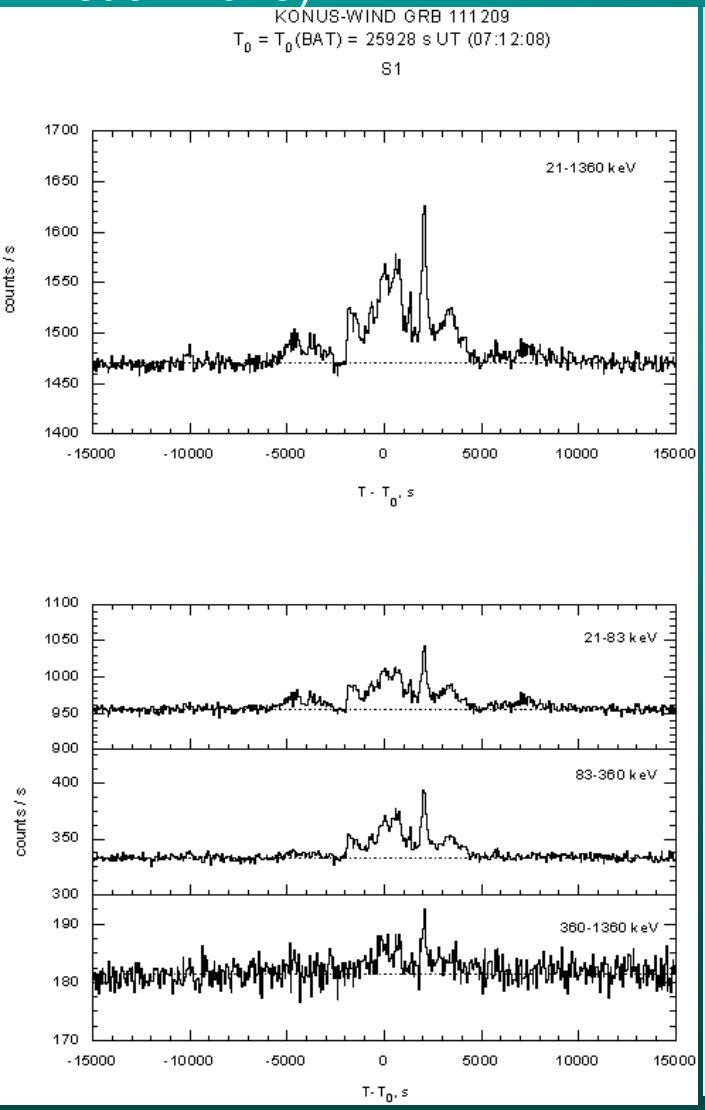
New Results:

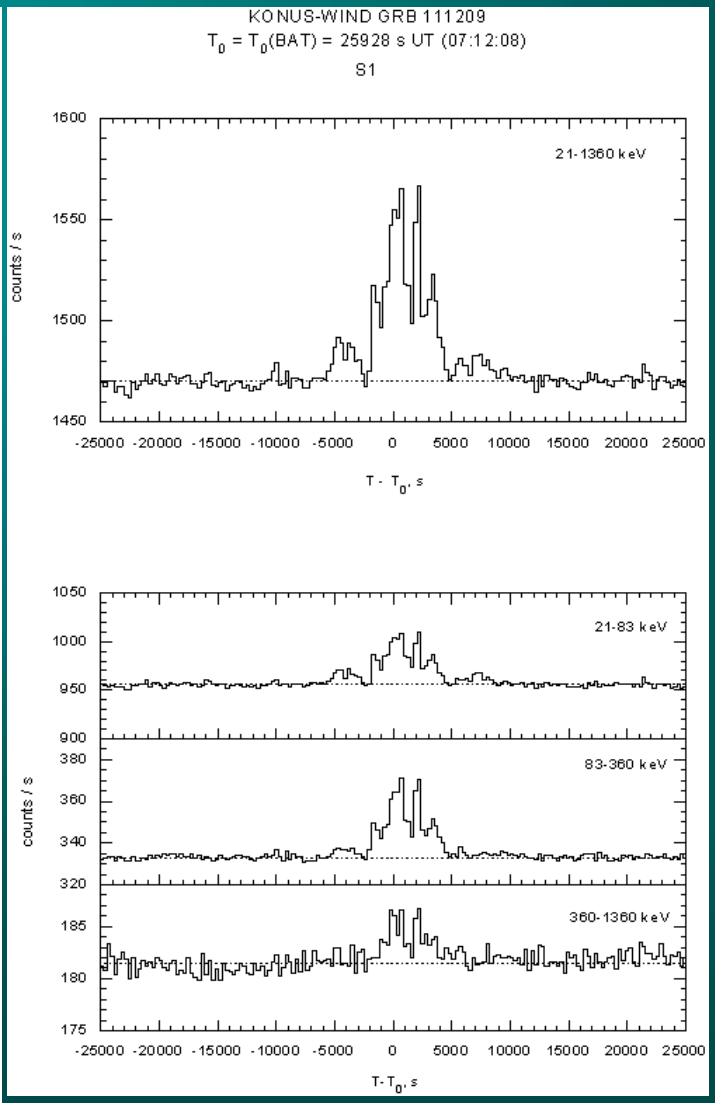
GRB 111209A

An UV-luminous SN for the longest GRB

GRB 111209A

GRB 111209A is the longest GRB ever observed (Golenetskii et al. 2011, Gendre et al. 2013)





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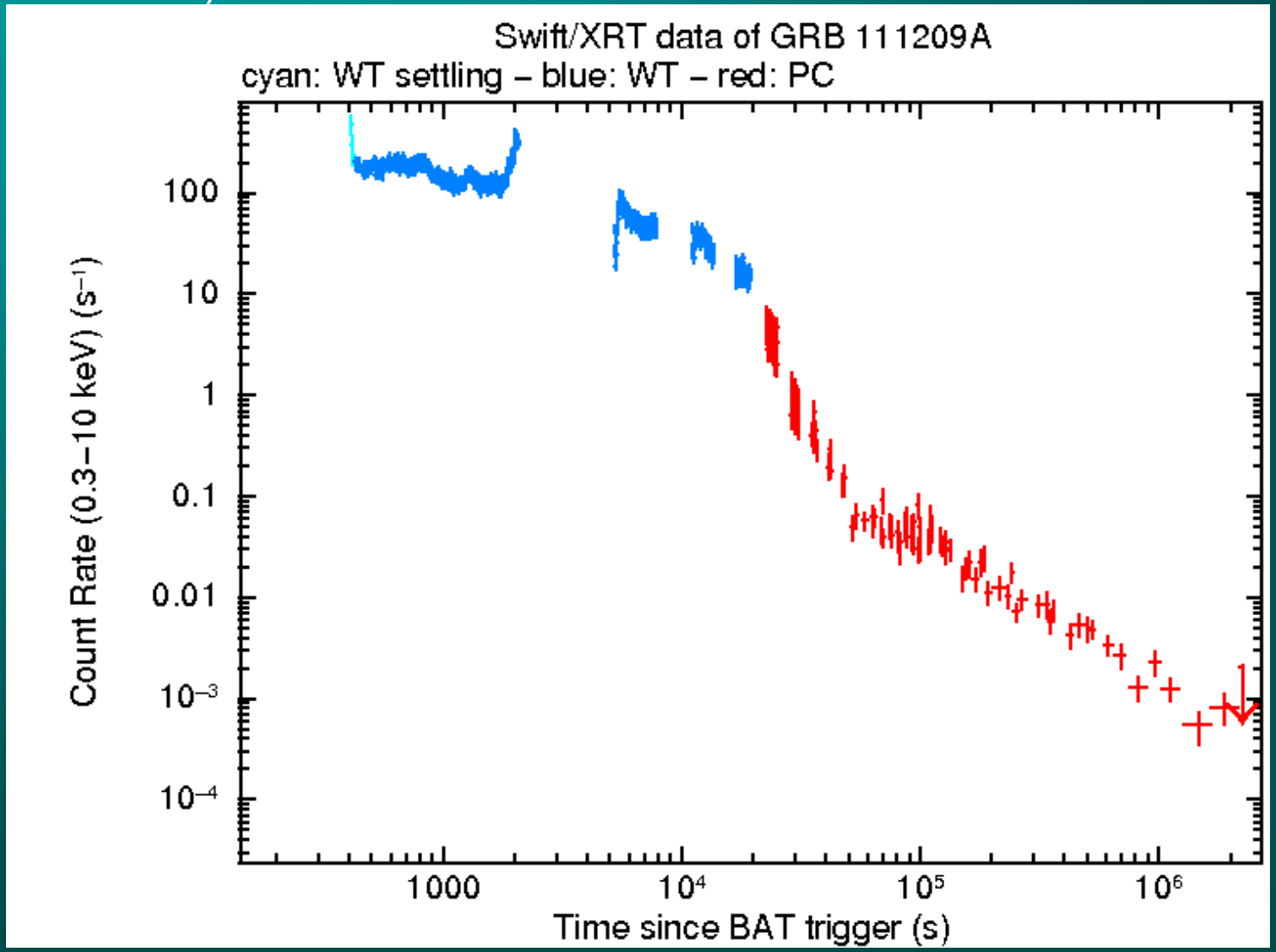
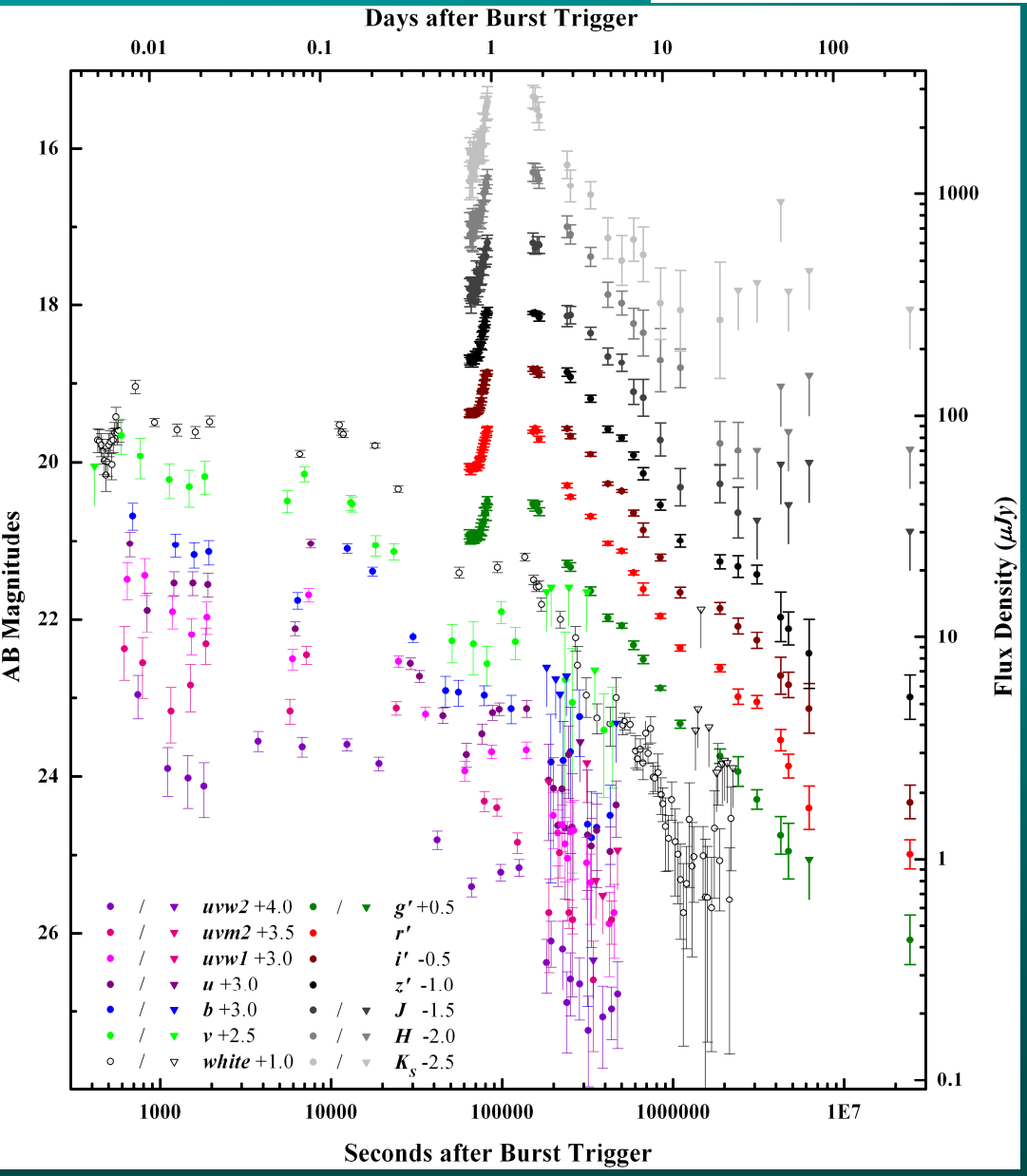


Evans et al. 2007, 2009

GRB 111209A



Optical observations reveal a highly structured light curve

UVOT + GROND data from Kann et al. in prep.

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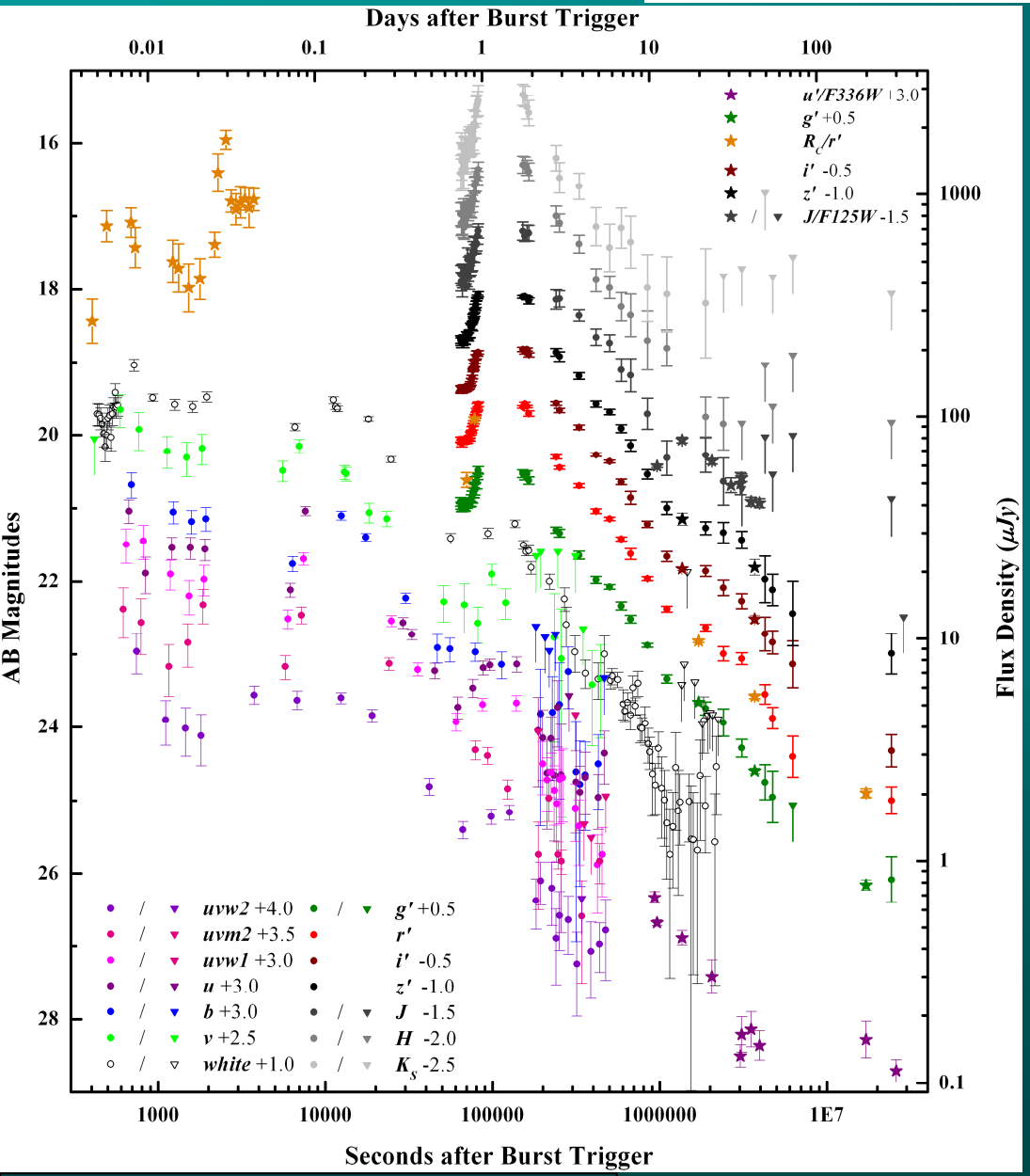

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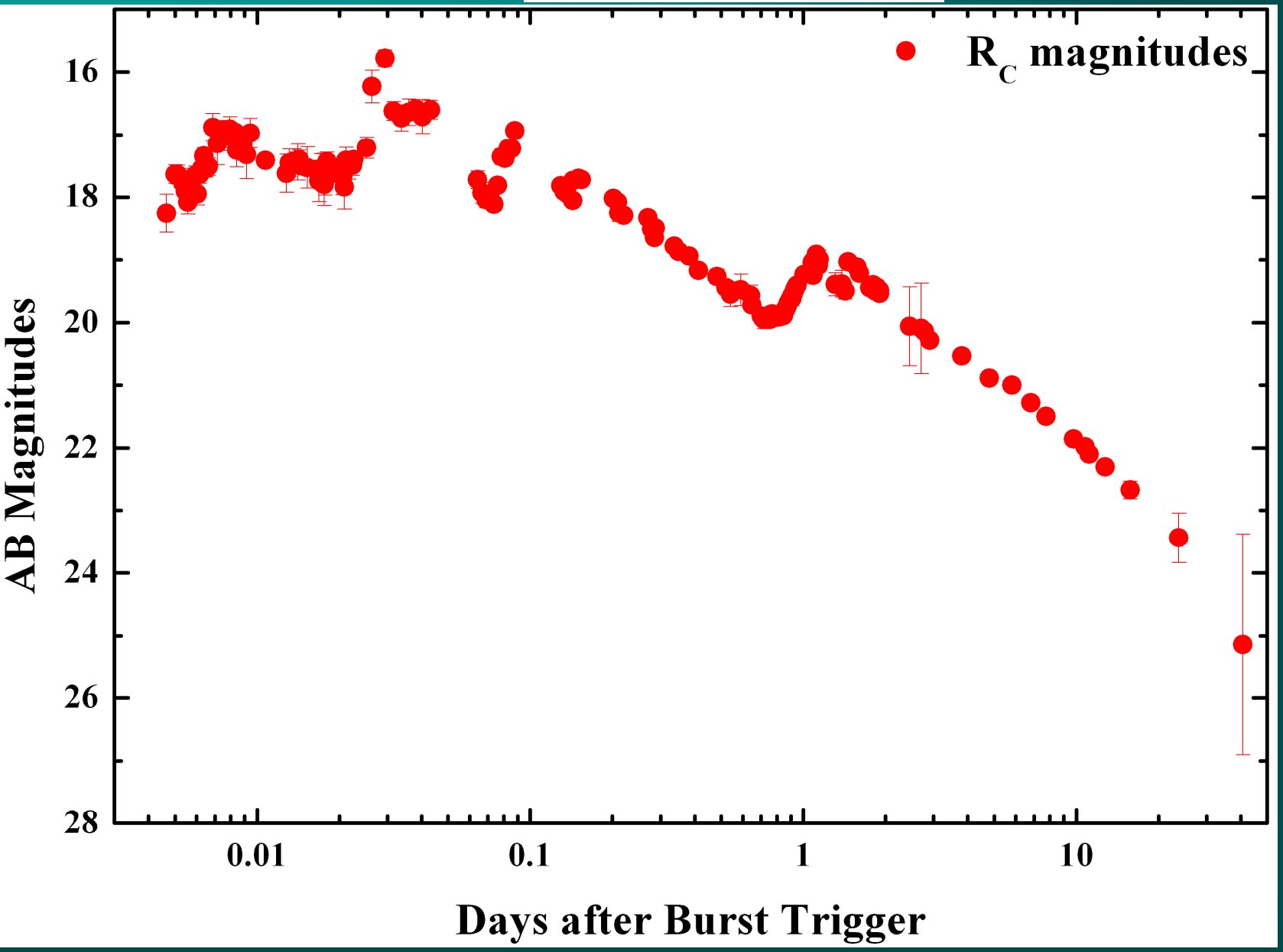
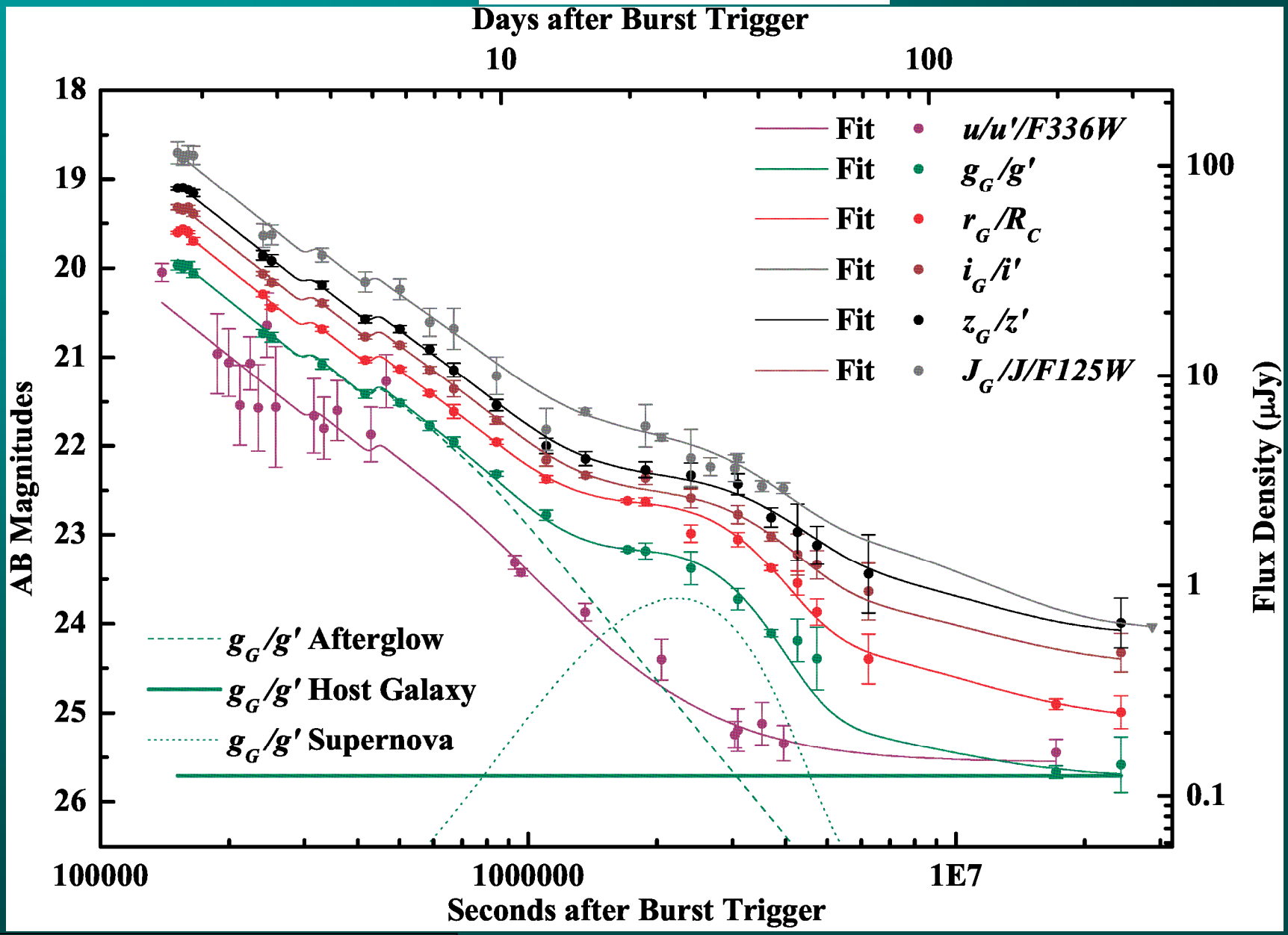
+ PROMPT (Nysewander et al. 2011), TAROT (Stratta et al. 2013), Gemini/HST (Levan et al. 2013)

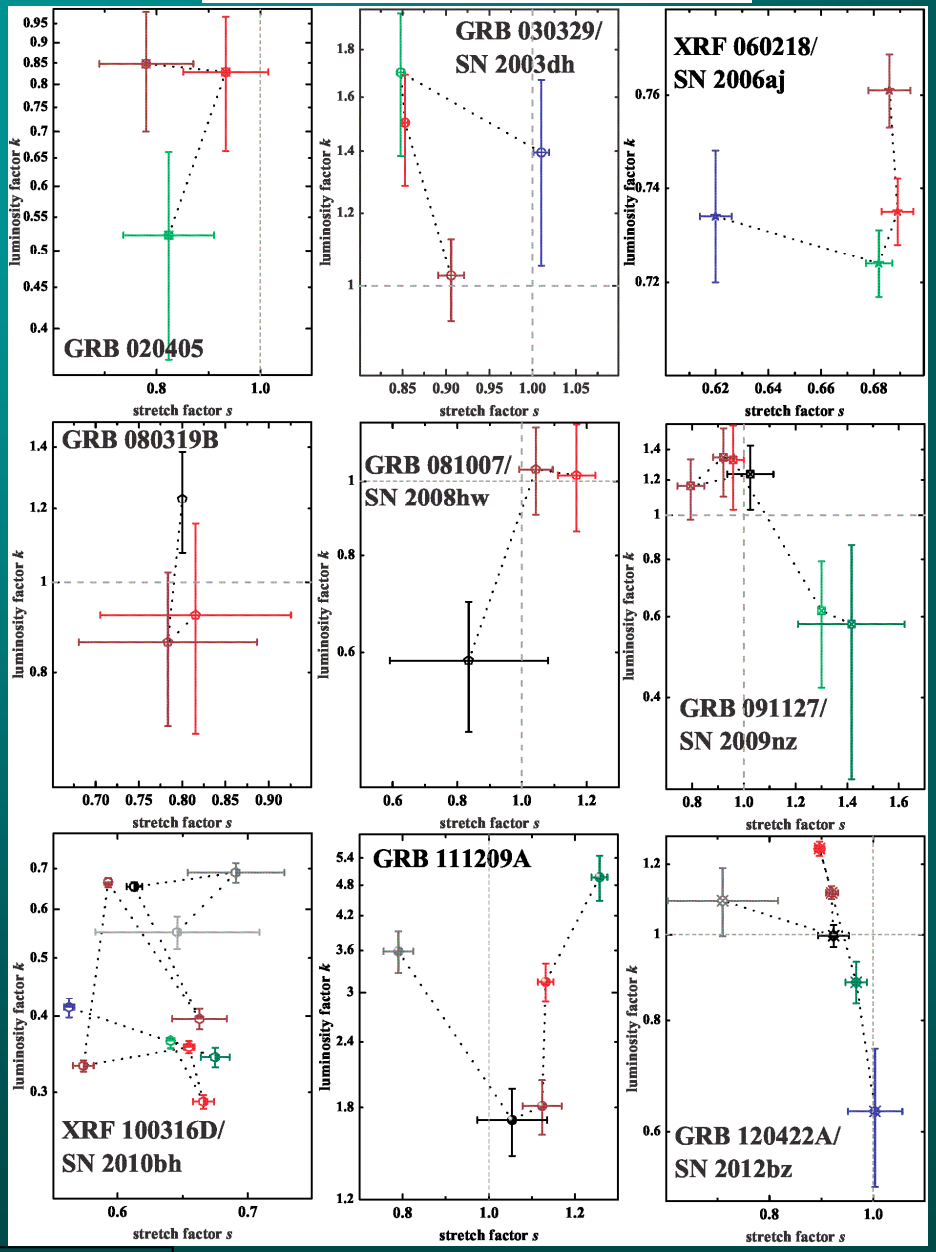
GRB 111209A


R_C magnitudes
AB Magnitudes
16
18
20
22
24
26
28
0.01
0.1
1
10
Days after Burst Trigger

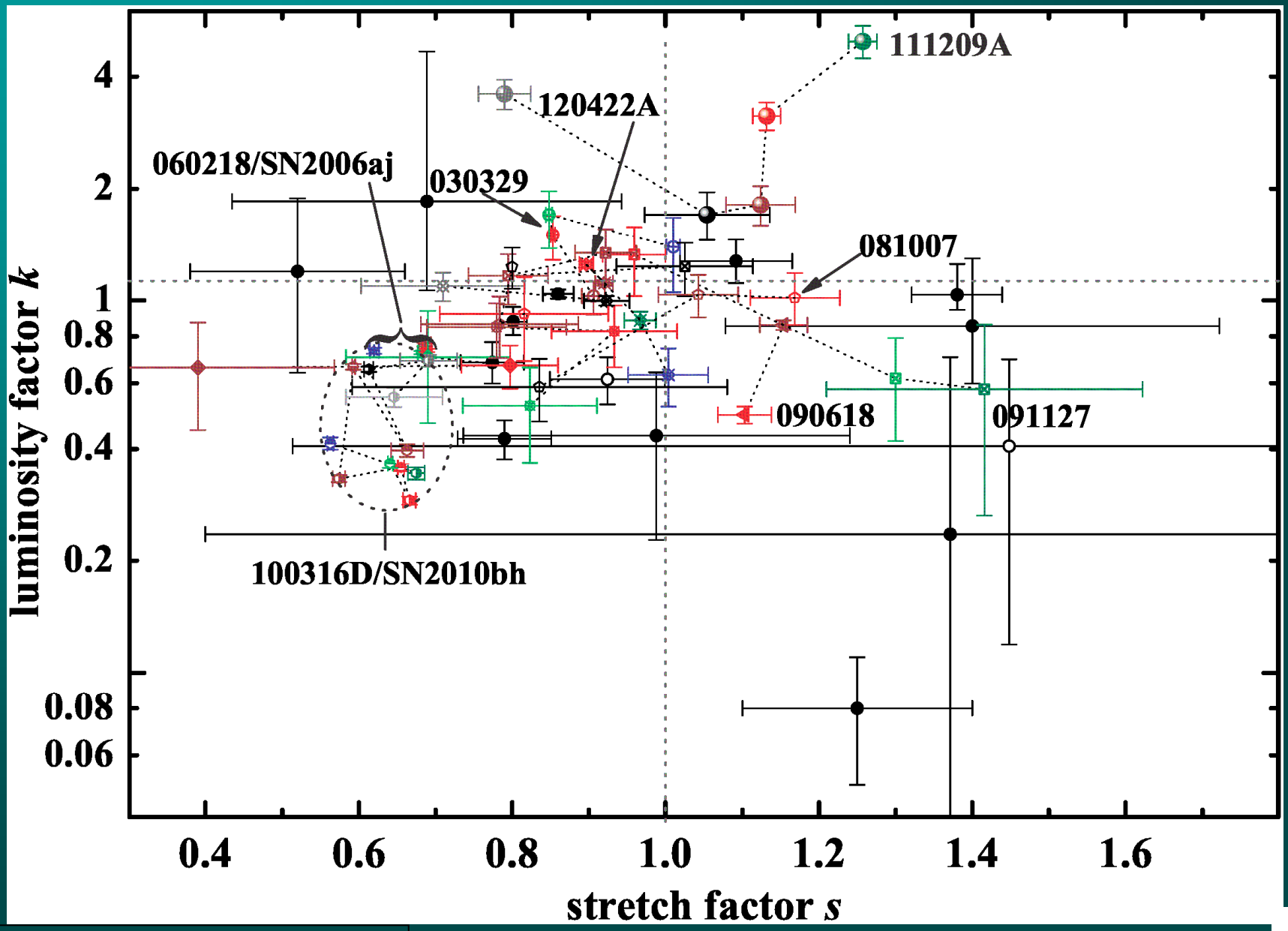
GRB 111209A


Days after Burst Trigger
10
100
18
19
20
21
22
23
24
25
26
AB Magnitudes
Fit u/u'/F336W
Fit g_G/g'
Fit r_G/R_C
Fit i_G/i'
Fit z_G/z'
Fit $J_G/J/F125W$
g_G/g' Afterglow
g_G/g' Host Galaxy
g_G/g' Supernova
100
10
1
0.1
Flux Density (μJy)
100000
1000000
1E7
Seconds after Burst Trigger

GRB 111209A


GRB 020405
GRB 030329/
SN 2003dh
XRF 060218/
SN 2006aj
GRB 080319B
GRB 081007/
SN 2008hw
GRB 091127/
SN 2009nz
XRF 100316D/
SN 2010bh
GRB 111209A
GRB 120422A/
SN 2012bz
luminosity factor k
stretch factor s

GRB 111209A


111209A
120422A
060218/SN2006aj
030329
081007
090618
091127
100316D/SN2010bh
luminosity factor k
stretch factor s
4
2
1
0.8
0.6
0.4
0.2
0.08
0.06
0.4
0.6
0.8
1.0
1.2
1.4
1.6

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CONCLUSION: GRB 111209A, despite ist extreme duration, is probably a „normal“ GRB spawned by a stripped-envelope progenitor.

New Results:

GRB 120422A

The missing link between LL-GRBs and classical GRBs?

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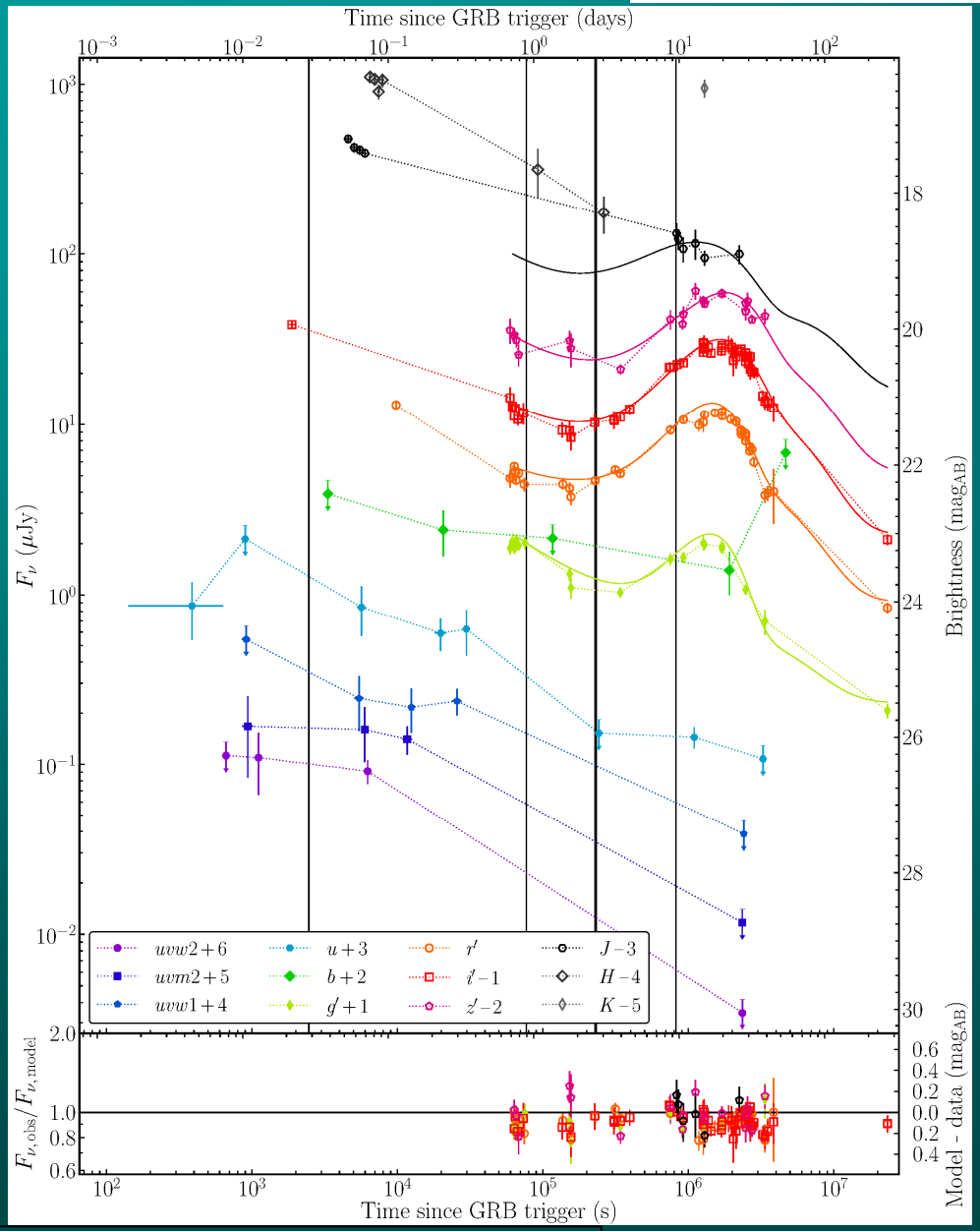
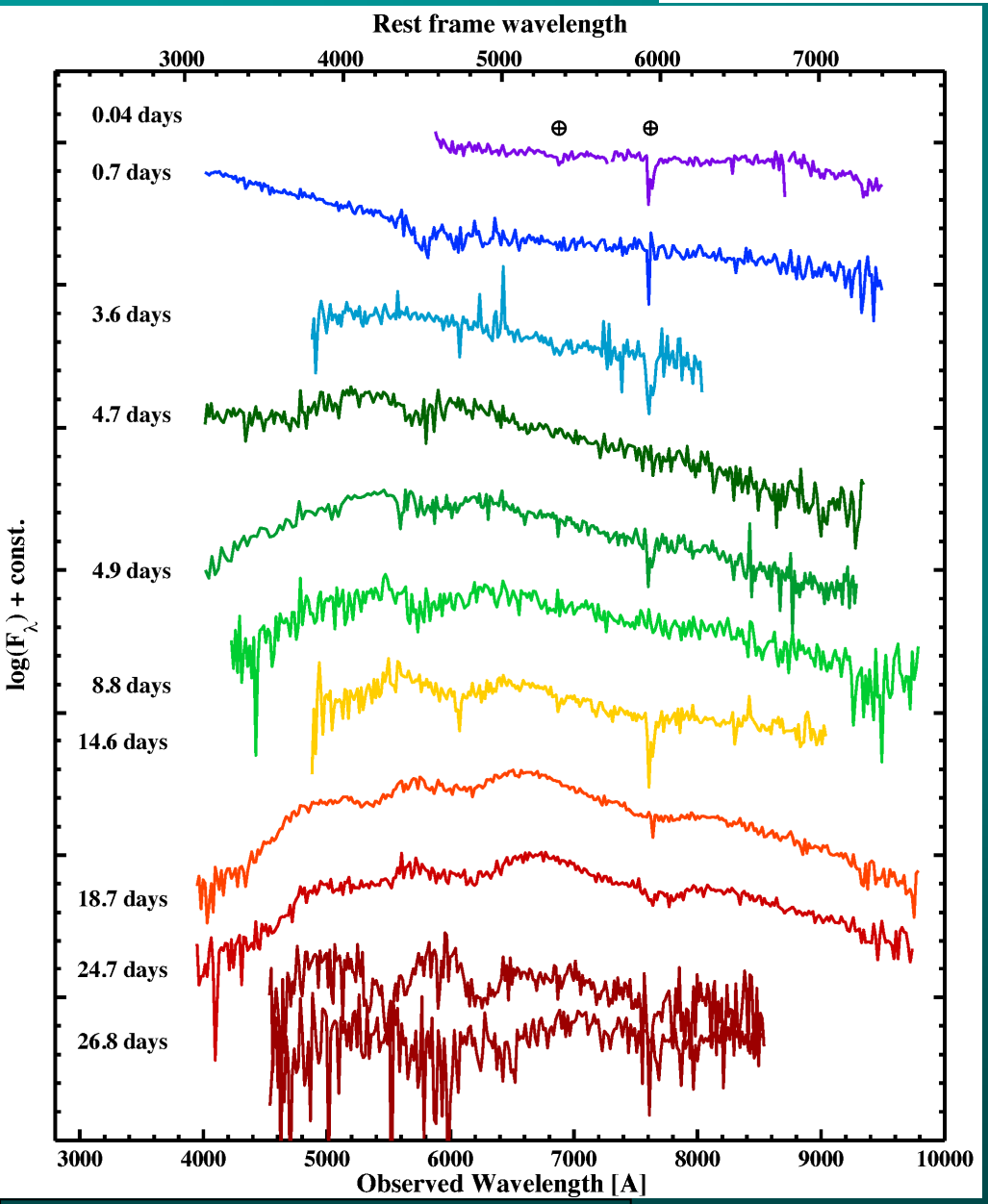
- A broadband (X-rays, optical/NIR photometry, spectroscopy, radio/sub-mm, host galaxy, surroundings, correlations…) study is in prep. by Schulze et al.

GRB 120422A



Schulze et al. 2013, in prep.

GRB 120422A



Schulze et al. 2013, in prep.

GRB 120422A

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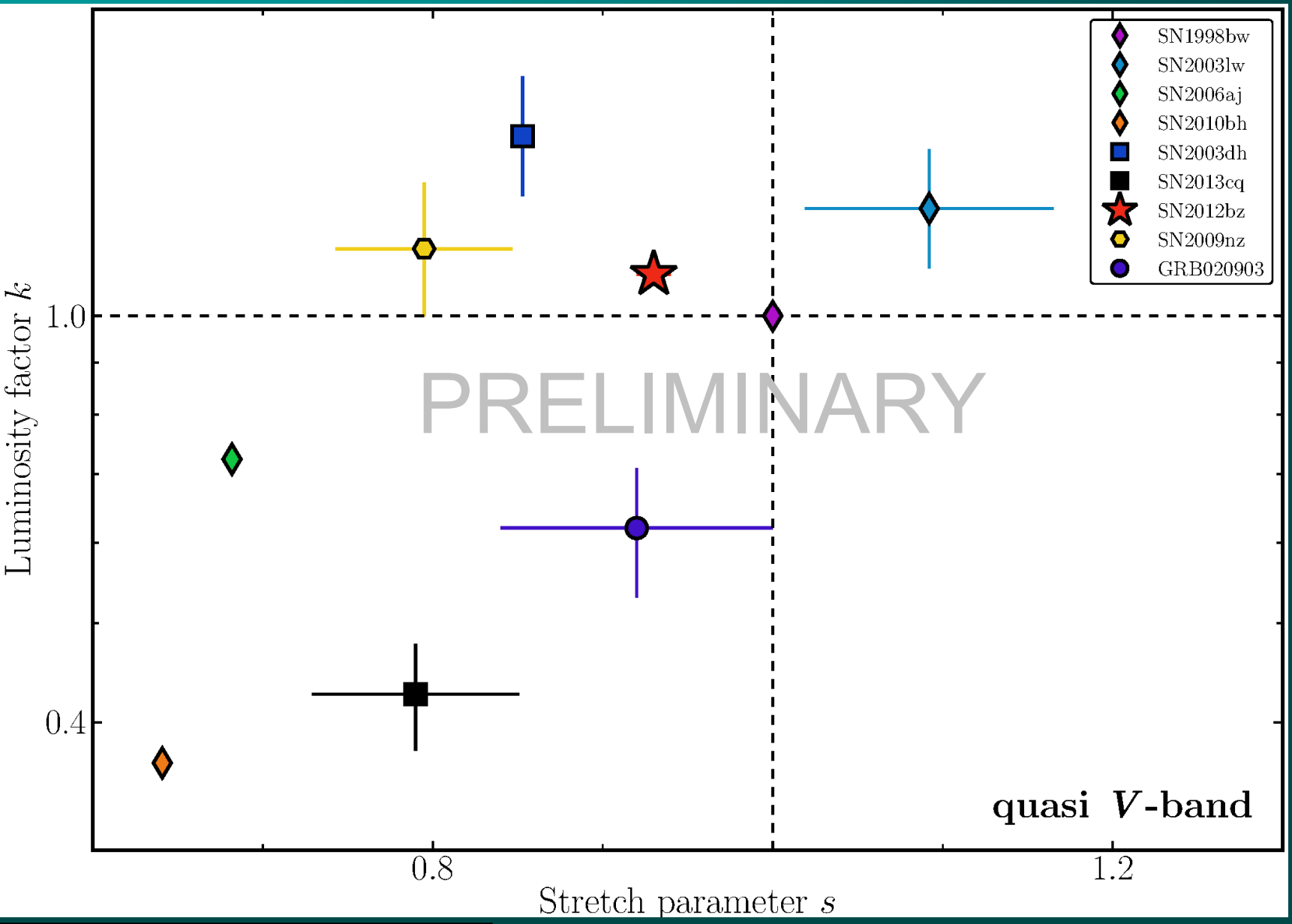


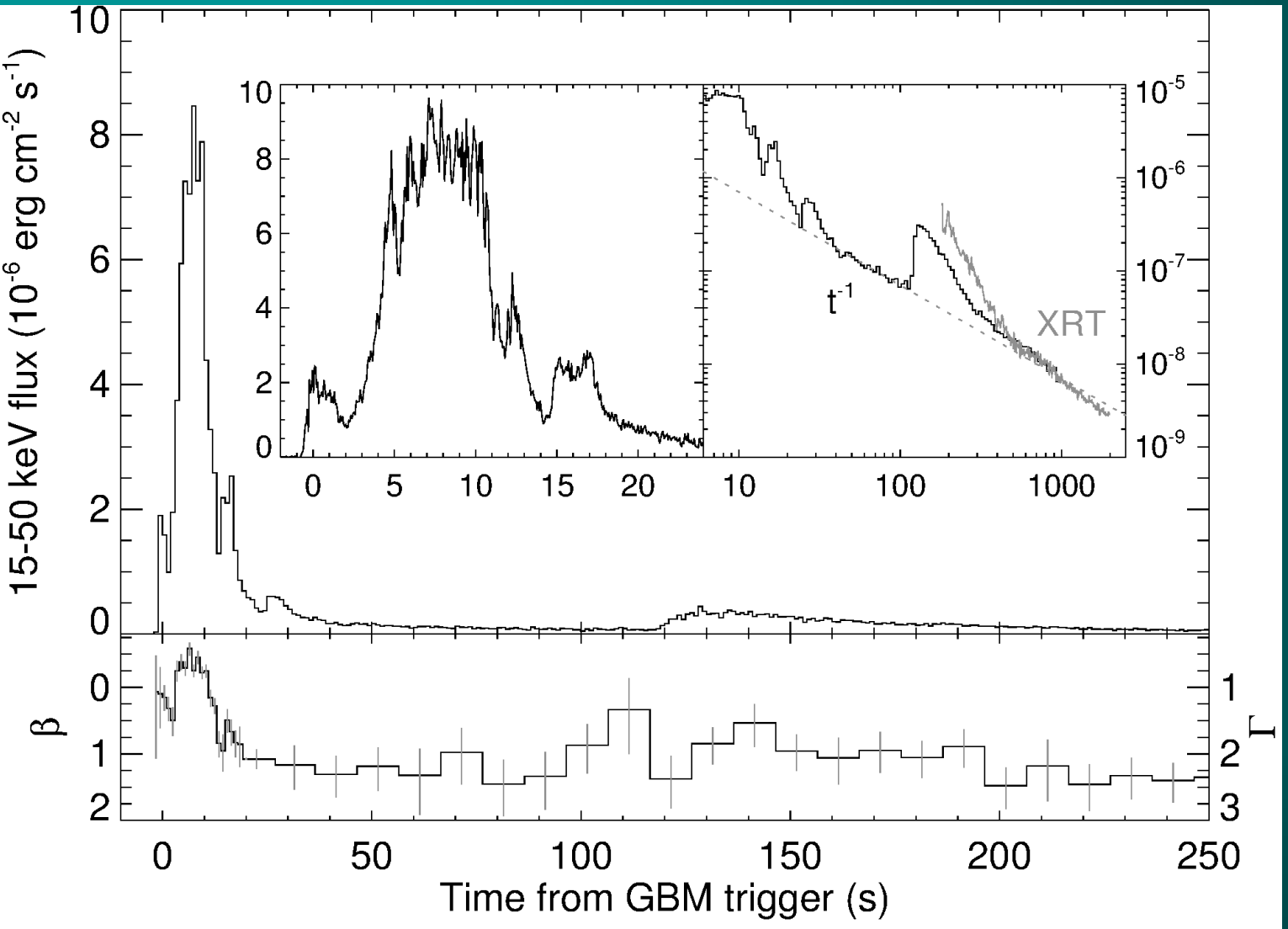
New Results:

GRB 130427A

Highly luminous cosmological GRBs are linked to Type Ic SNe

GRB 130427A

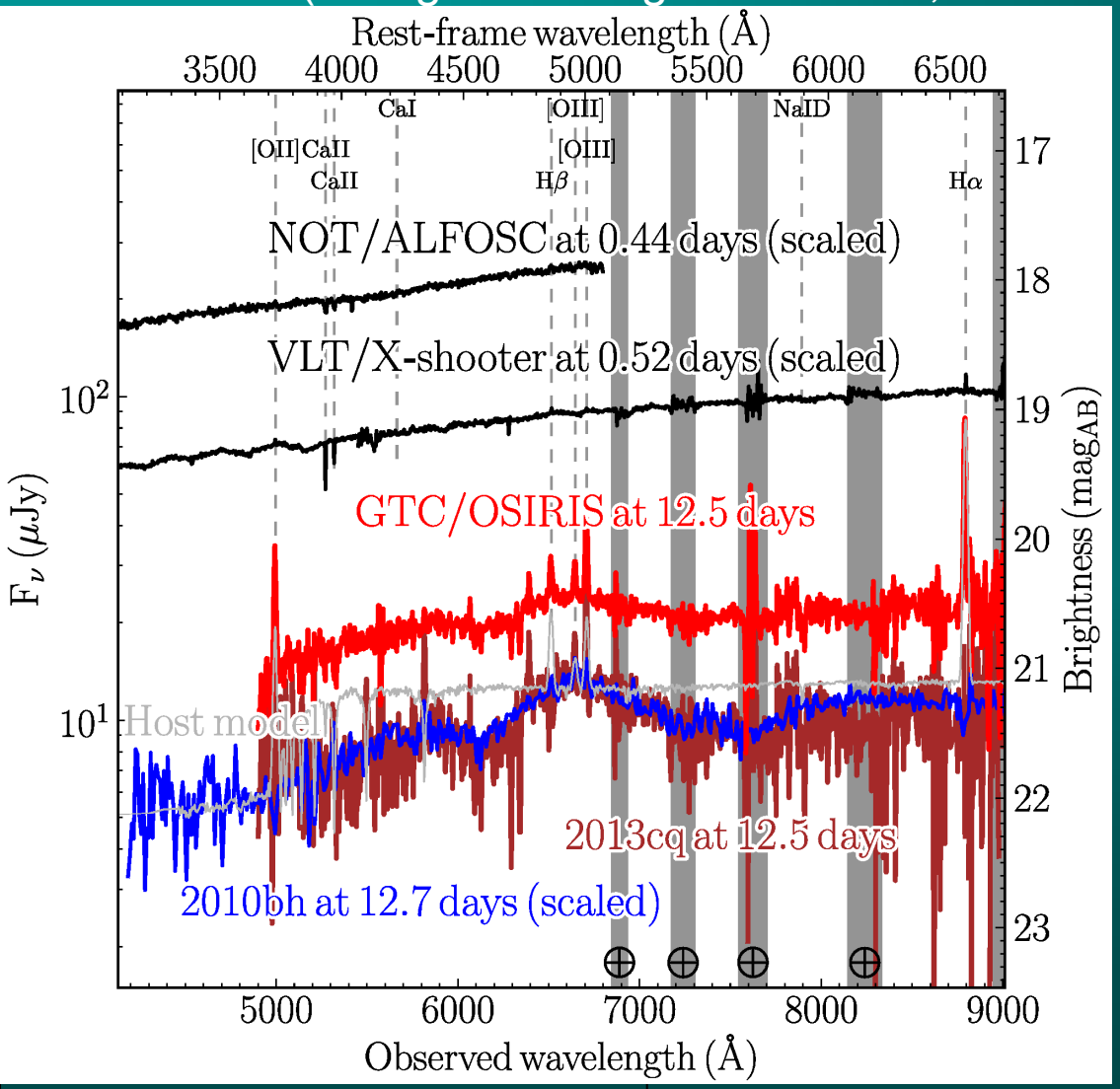
- GRB 130427A is the brightest GRB in 29 years, and the first low-redshift highly luminous GRB.



Perley, … Kann, … et al. 2013

GRB 130427A

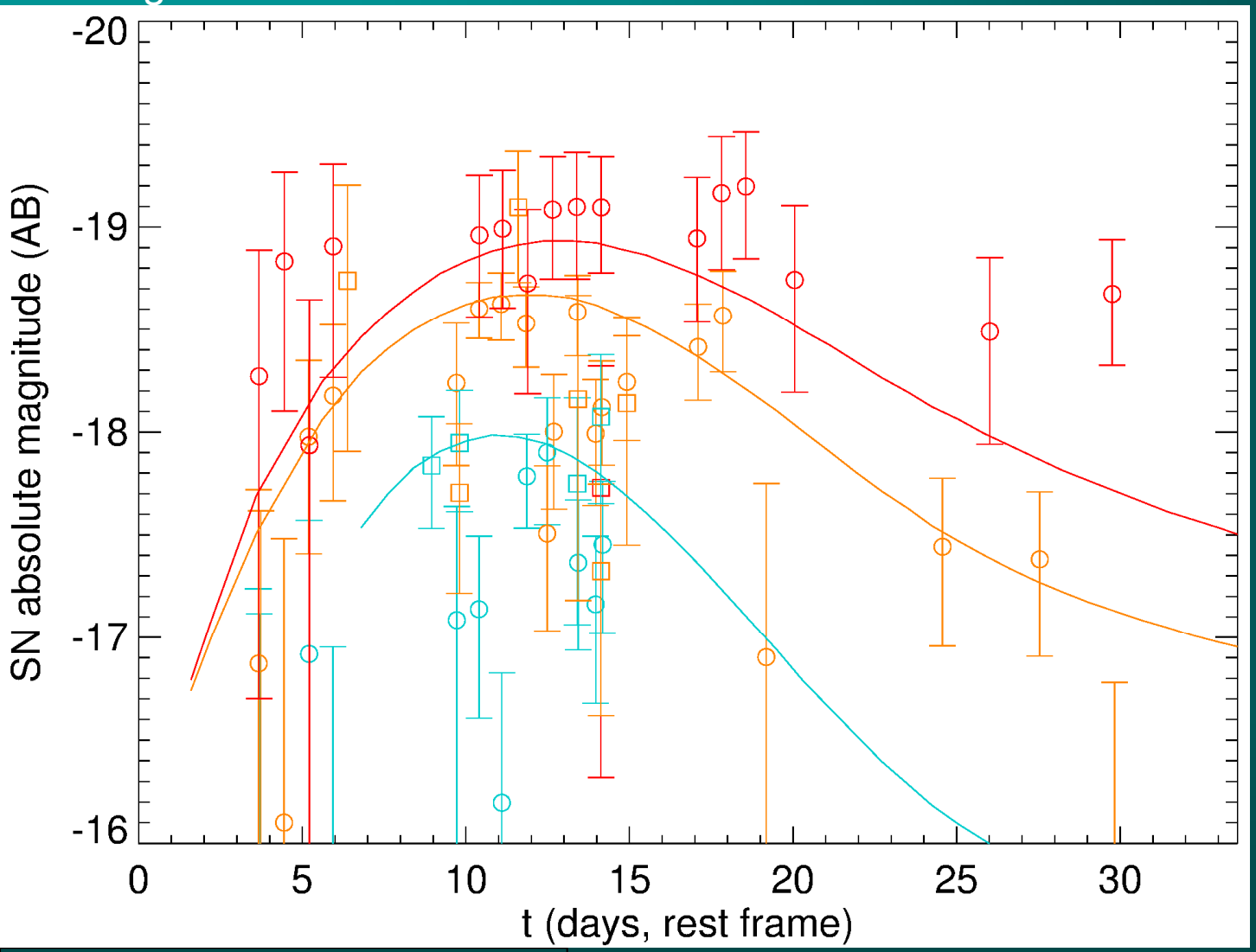
- The accompanying SN, SN 2013cq, was discovered with the Gran Telescopio Canarias (de Ugarte Postigo et al. 2013, Xu et al. 2013)



Xu et al. 2013

GRB 130427A

- Clear characterization of the SN in multiple colors awaits precise post-SN host magnitudes



Perley, … Kann, … et al. 2013

Upcoming Studies:

GRB 111211A

(Kann et al., in prep.)

First GRB-SN associated with an AGILE GRB (z = 0.478), SN spectroscopically discovered by the GTC, photometrically covered by GROND.

Upcoming Studies:

GRB 130215A

(Cano et al., in prep.)

Possibly transition event similar to GRB 120422A, SN spectroscopically discovered by the GTC.

Upcoming Studies:

GRB 120714A

(Klose et al., in prep.)

Another moderately luminous GRB at moderate redshift, SN spectroscopically discovered by the VLT, photometrically covered by GROND.

Upcoming Studies:

GRB 130831A

(??? et al., in prep.)

Interesting GRB with steep X-ray decay after plateau, SN photometrically discovered by Maidanak (Pozanenko et al. 2013). Spectroscopy???

Upcoming Studies:

GRB 130925A

(??? et al., in prep.)

Another ultra-long duration event at z = 0.347, afterglow extinguished by A_V ~ 4.5 mag in the rest-frame, unclear if SN-detection will be possible.

Honorable Mention:

GRB 130702A

(??? et al., in prep.)

Extremely nearby GRB (z = 0.145), GBM-only, discovered by iPTF (Singer et al. 2013), associated SN 2013dx discovered by NOT (Schulze et al. 2013), confirmed by TNG (d'Elia et al. 2013) and P200 (Cenko et al. 2013).

SUMMARY

- GRB 111209A is a whole new class of GRB (ULD-GRB, Levan et al. 2013), but also seems to be associated with collapsars. GRB 130925A is another ULD-GRB, follow-up is coming up.
- GRB 120422A and possibly GRB 130215A show that events between local low-luminosity GRBs and classical GRBs exist.
- GRB 130427A cements the link between „true cosmological“ GRBs and broad-lines Type Ic SNe.
- Spectroscopic confirmation of GRB-SNe is becoming more commonplace, thanks to dedicated follow-up with Big Glass (GTC, VLT X-shooter).

Спасибо за ваше внимание!