Highly luminous supernovae associated with Gamma-Ray Bursts: News on the GRB-SN connection

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Ioffe Workshop on GRBs and other transient sources: 25 Years of Konus-Wind Experiment

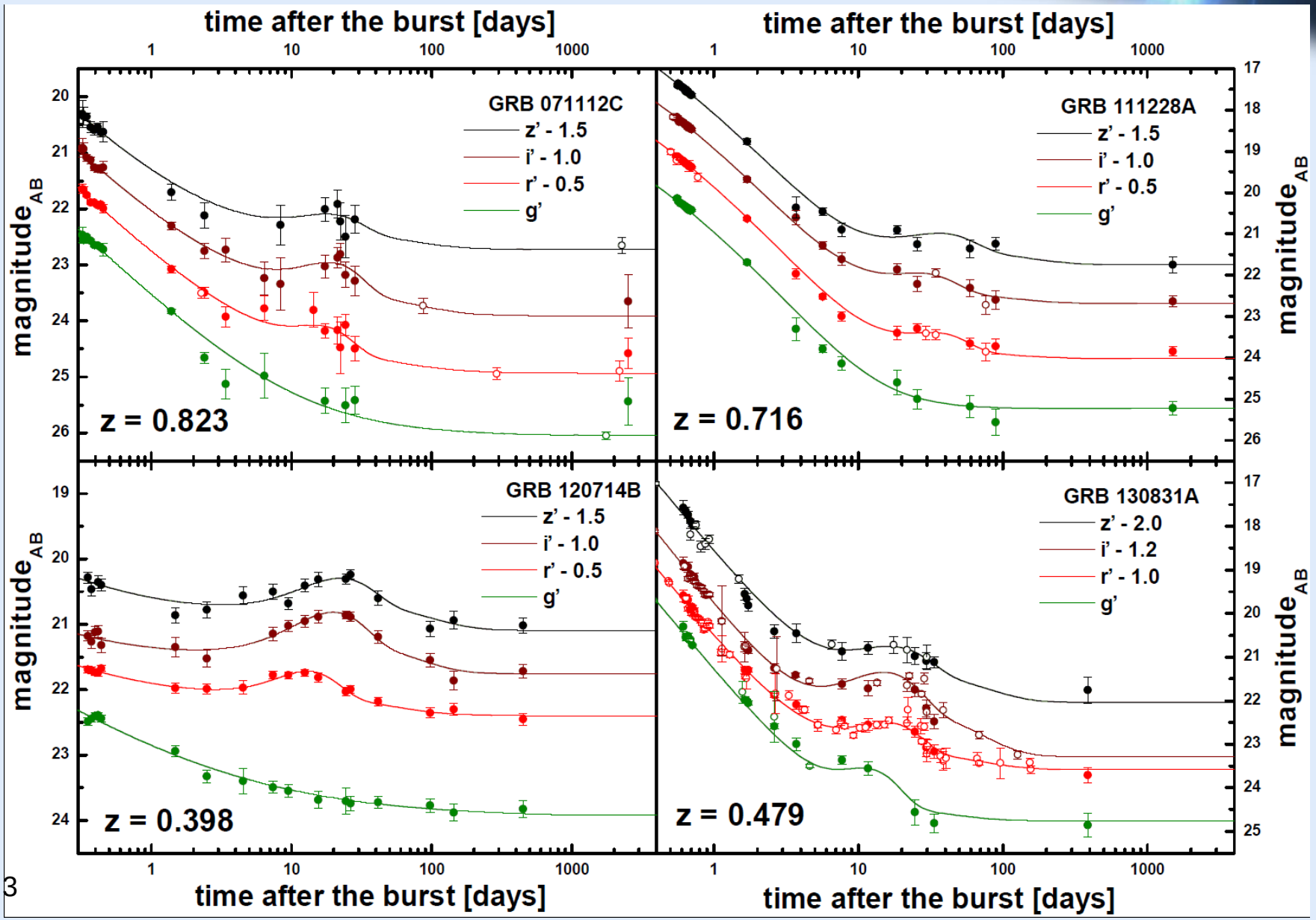
St. Petersburg, Russian Federation

190912.47917

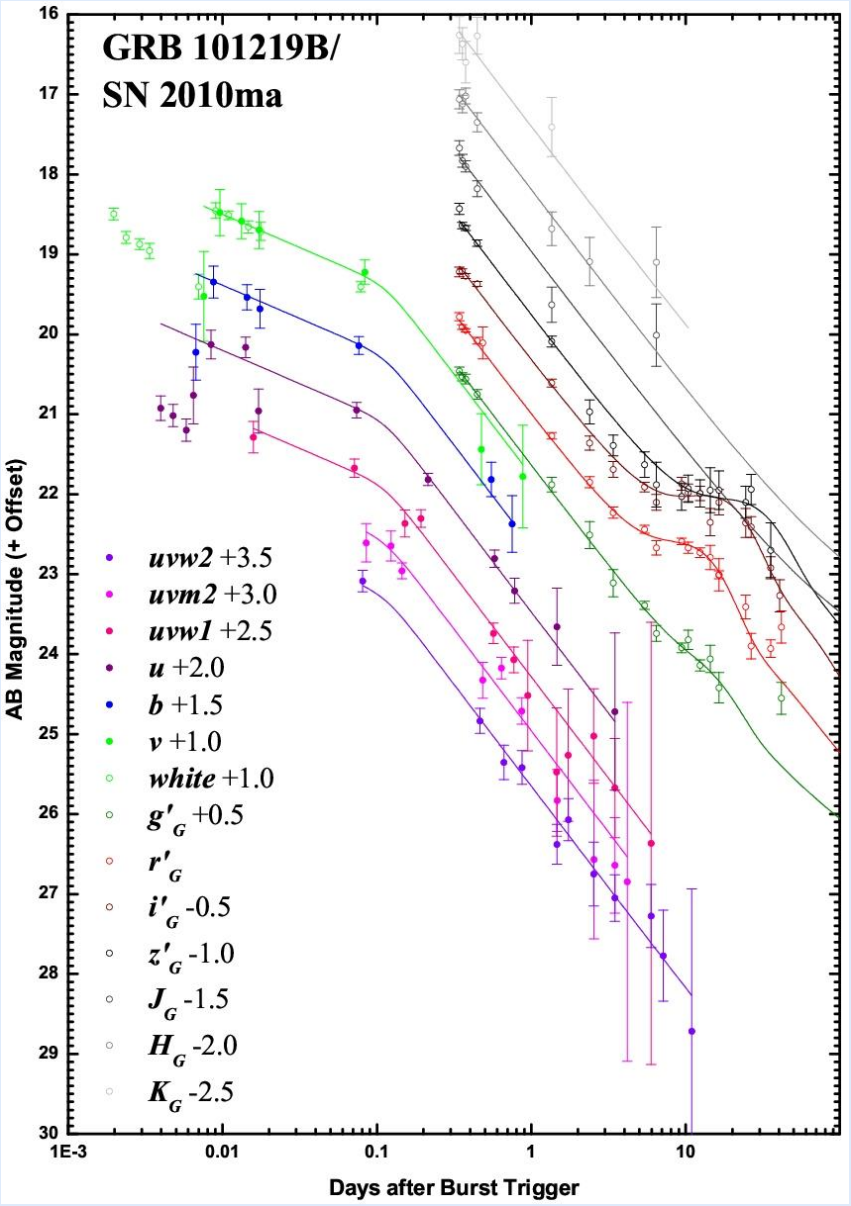
As has been mentioned before...

- 1968: Colgate proposes gamma flash with SN
- 1993: Woosley proposes collapsar model, *failed* SN
- 1998A: Paczynski proposes association with star-forming regions
- 1998B: GRB 980425/SN 1998bw establishes GRB-SN connection, Type Ic-BL
- 2003: GRB 030329/SN 2003dh links cosmological GRBs to SNe
- 2004: Zeh et al.: Systematic study and *k*, *s* context
- 2006: XRF 060218/SN 2006aj: Shock-breakout flash
- 2011: see below...
- 2013: GRB 130427A/SN 2013cq links *real* cosmological GRBs to SNe
- 2017: GRB 171205A/SN 2017iuk: Discovery of cocoon emission
- 2019: GRBs 190114C/190829A: GRB-SNe and VHE afterglow emission

GRB-SNe with GROND (Klose+19)



GRB-SNe in Multicolor (Kann+ in prep.)



Systematic reanalysis of all available GRB-SNe with multicolor detections using a maximized dataset (including 1000+ as yet unpublished data points!)

Derivation of afterglow- and host-subtracted SN light curves.

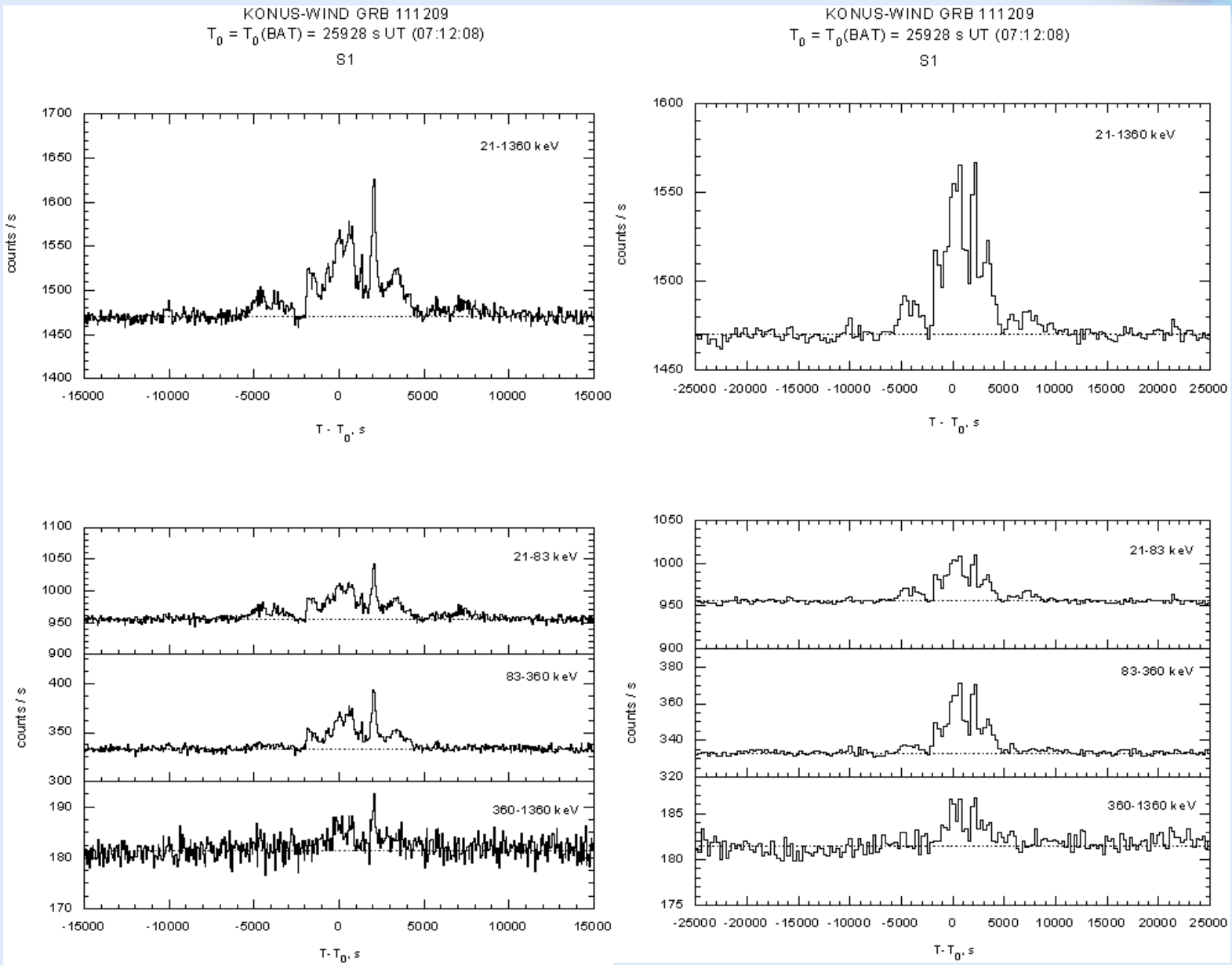
Derivation of bolometric light curves.

Derivation of standard-filter *k*-values and sample statistics.

Study of GRB-SNe as cosmological standard candles.

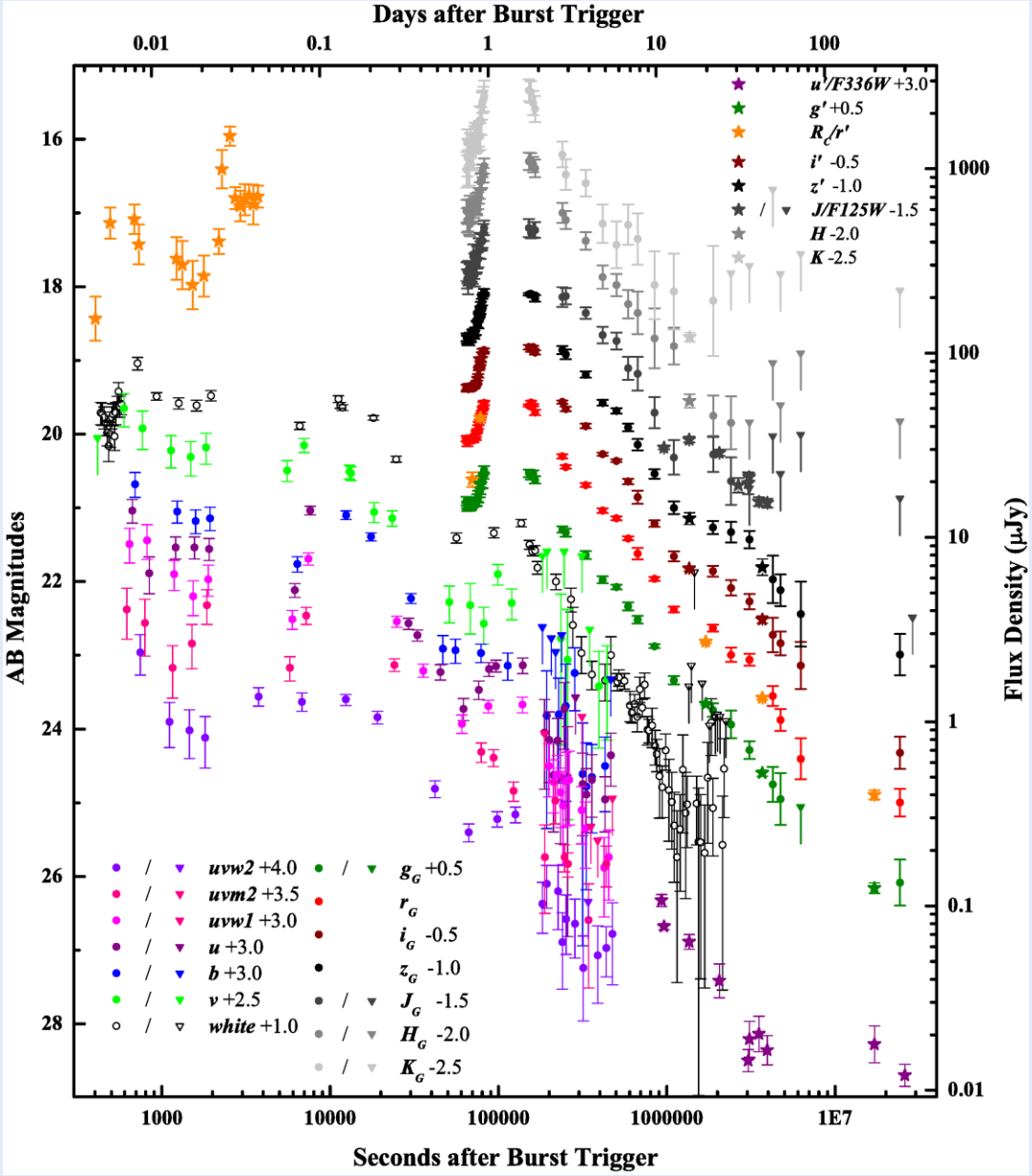
Part of the GRBPhot project.

GRB 111209A, where have I seen you before...



Golenetskii+11

GRB 111209A Optical Follow-Up (Kann+18)



„Complex but not unprecedented“

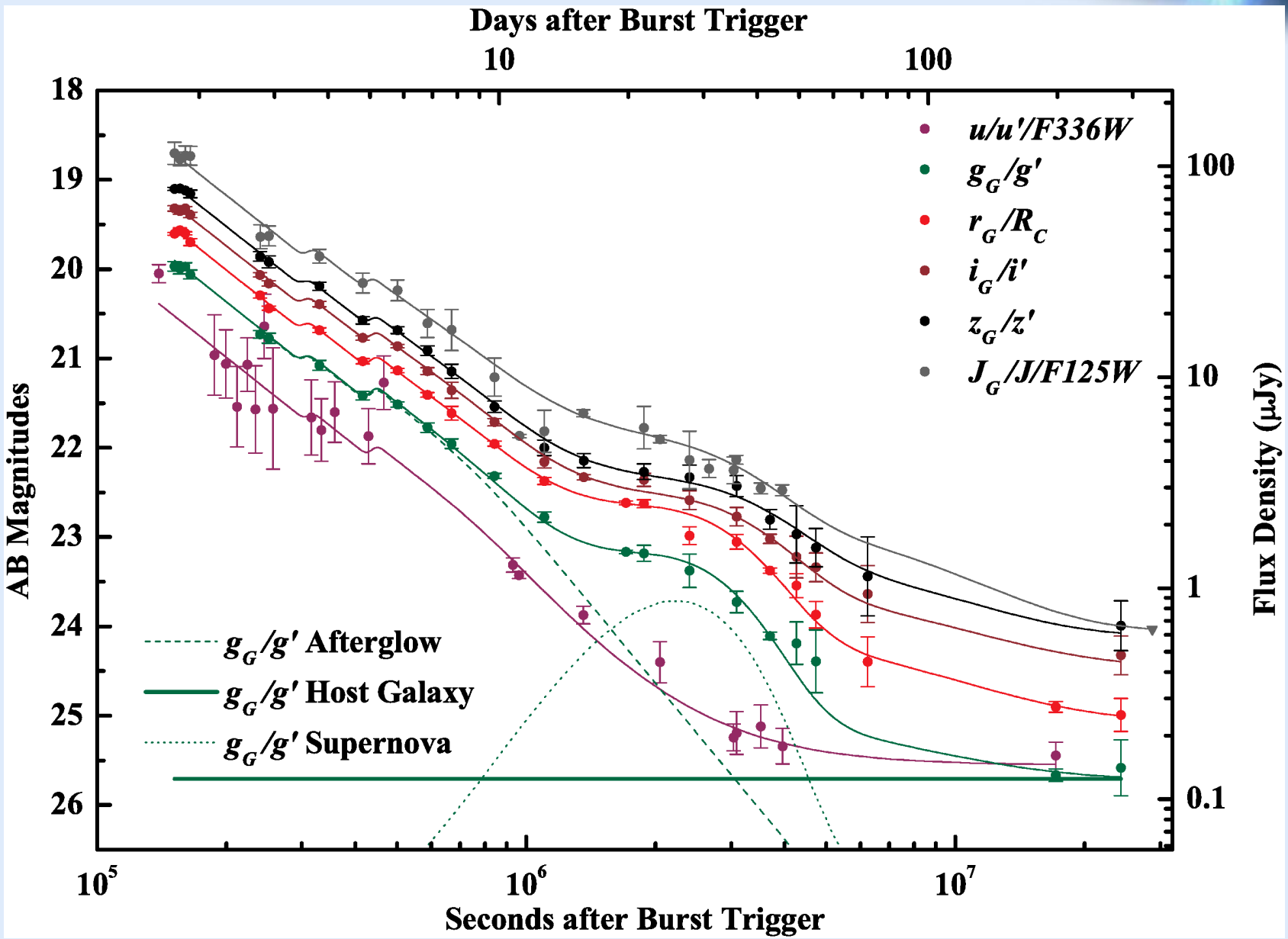
Strong variability during the prompt phase (Stratta+14)

Strong rebrightening plus spectral change around 1 day: two-jet model

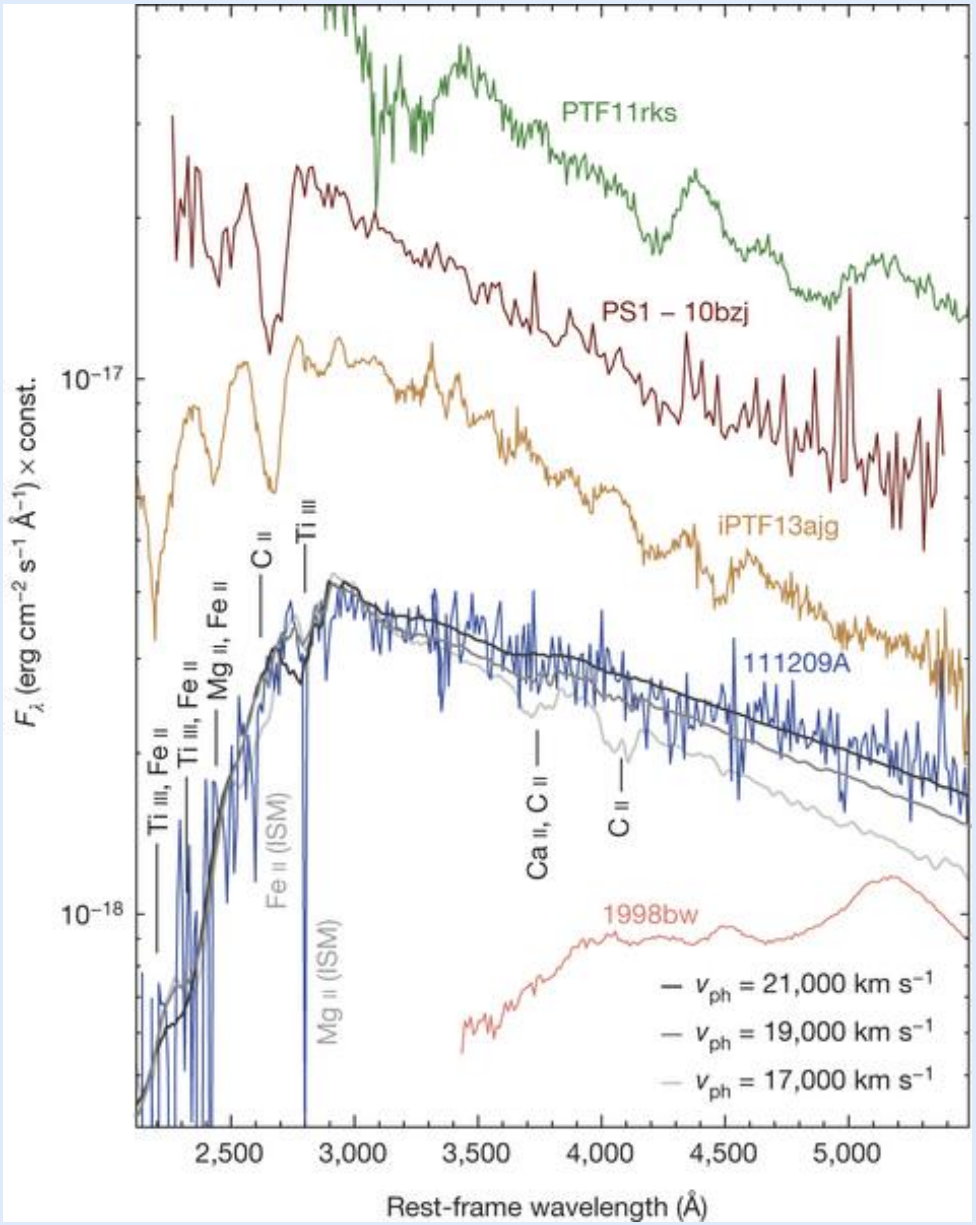
Multiple small „steps“: energy injections, possibly linked to multiple prompt-emission pulses

And then of course...

GROND discovery of SN 2011kl (Greiner+15)



SN 2011kl is different! (Greiner+15)



SN 2011kl (observations: Levan+14) is a clear Type Ic SN, and likely BL as well, but does not resemble GRB-SNe.

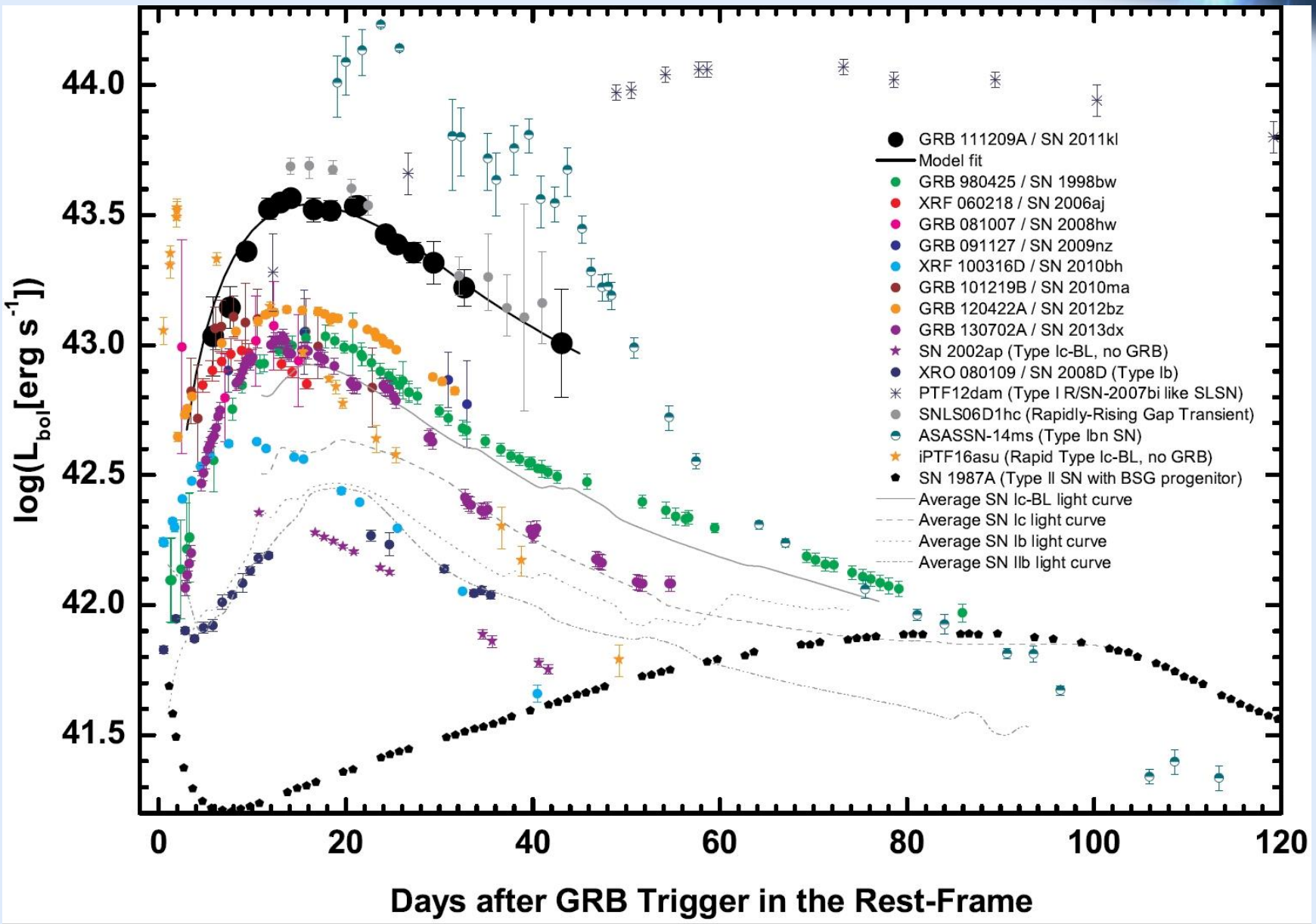
Significantly bluer, emission peak in the UV.

Spectral shape bears resemblance with spectra of superluminous SNe!

Spectral modeling yields evidence of magnetar central engine (see also Mazzali+16).

Kann+18: A magnetar can power the entire event.

SN 2011kl bolometrically (Kann+19)



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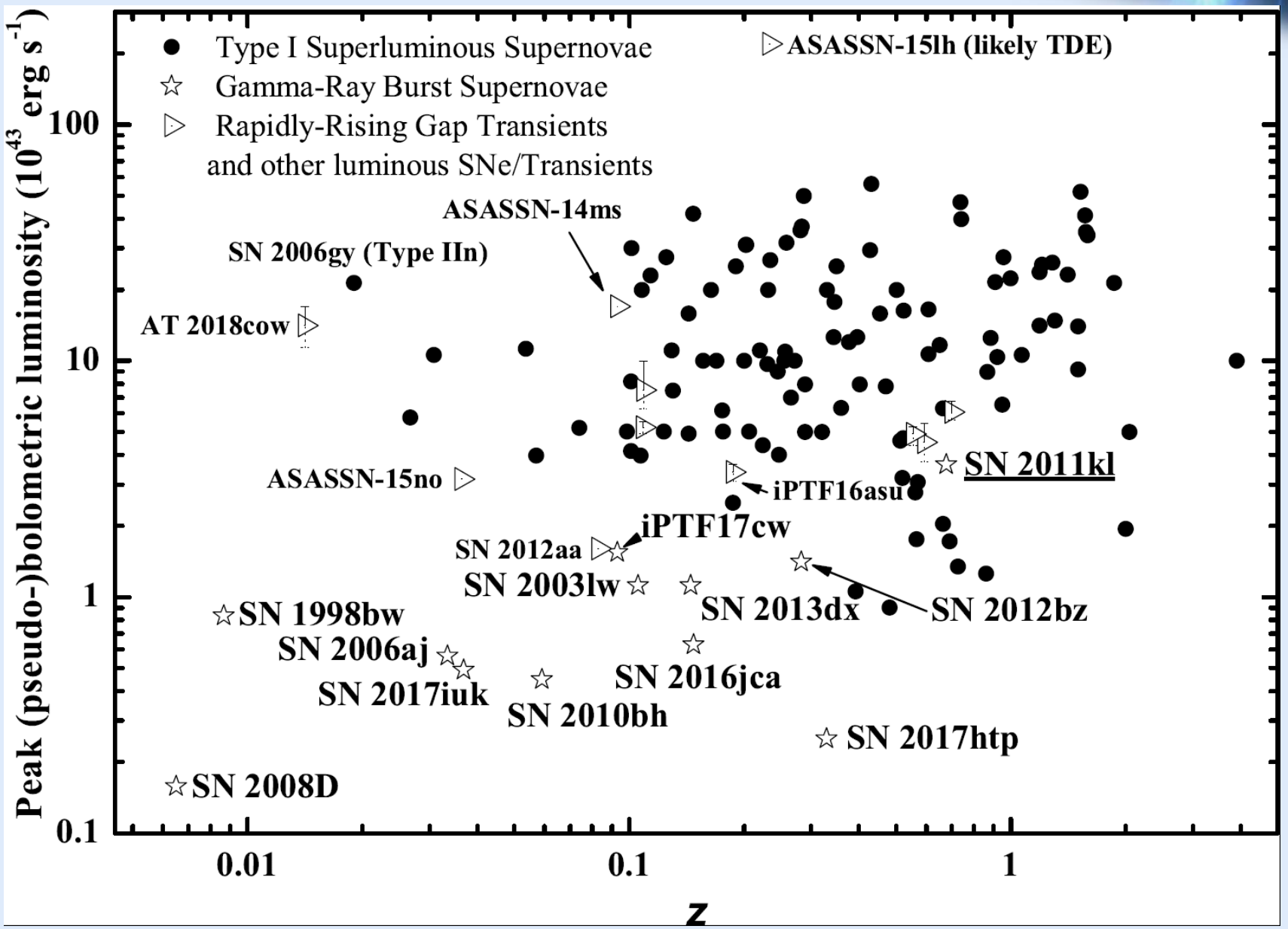
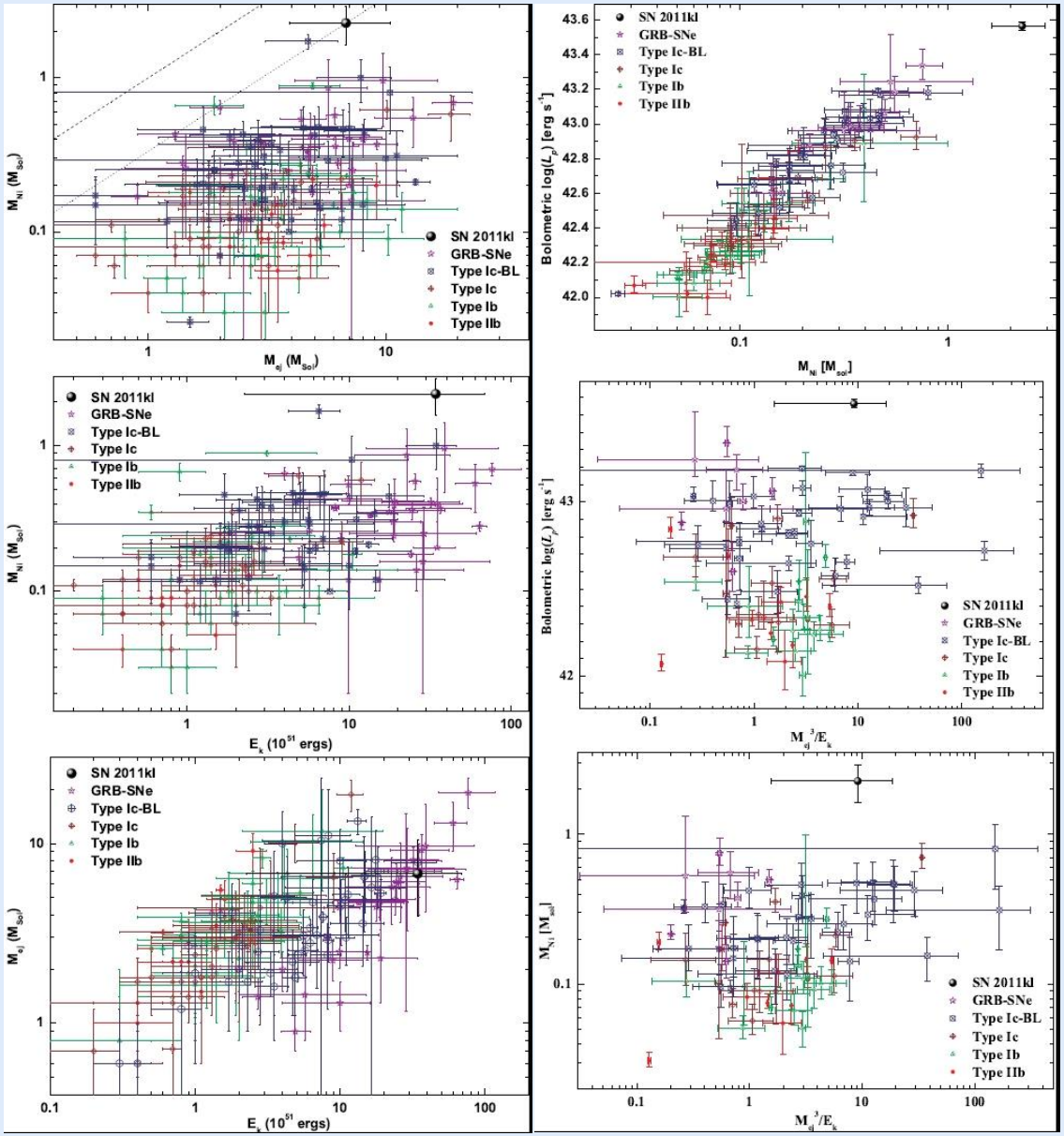


SN 2011kl and SE-SNe (Kann+19)



Assuming SN 2011kl is ^{56}Ni powered, the Ni mass is 2.27 M_o

Excepting SLSNe (if Ni-powered), this is a higher Ni-mass than any SE-SN in several large samples.

Ejecta mass and kinetic energy are not extraordinary.

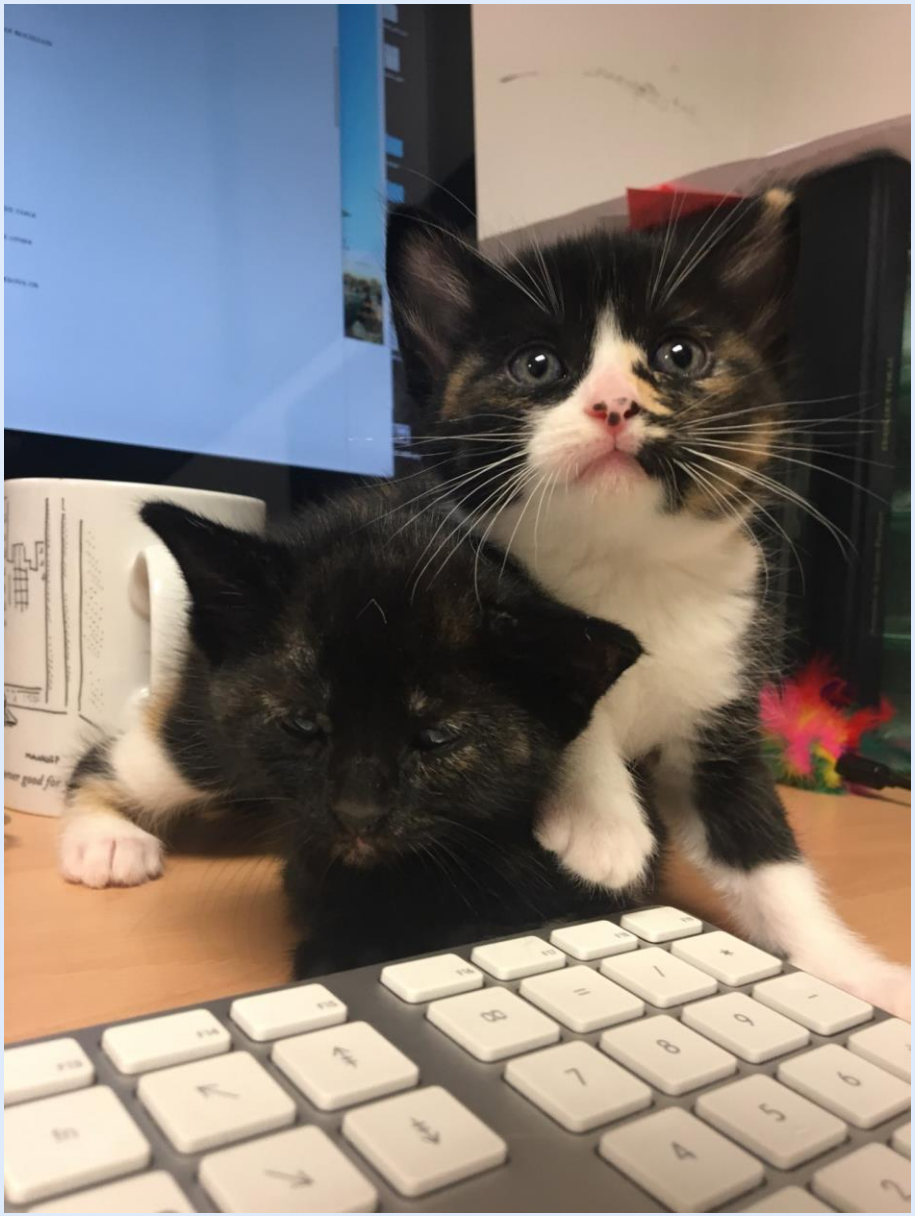
M(Ni) ~ 1/3 M(Ej) which is at the edge of being unphysical.

Takeaway:

SN 2011klis not Ni-powered like GRB-SNe usually are (Cano+17).

A typical SE-SN (Ginger+19)

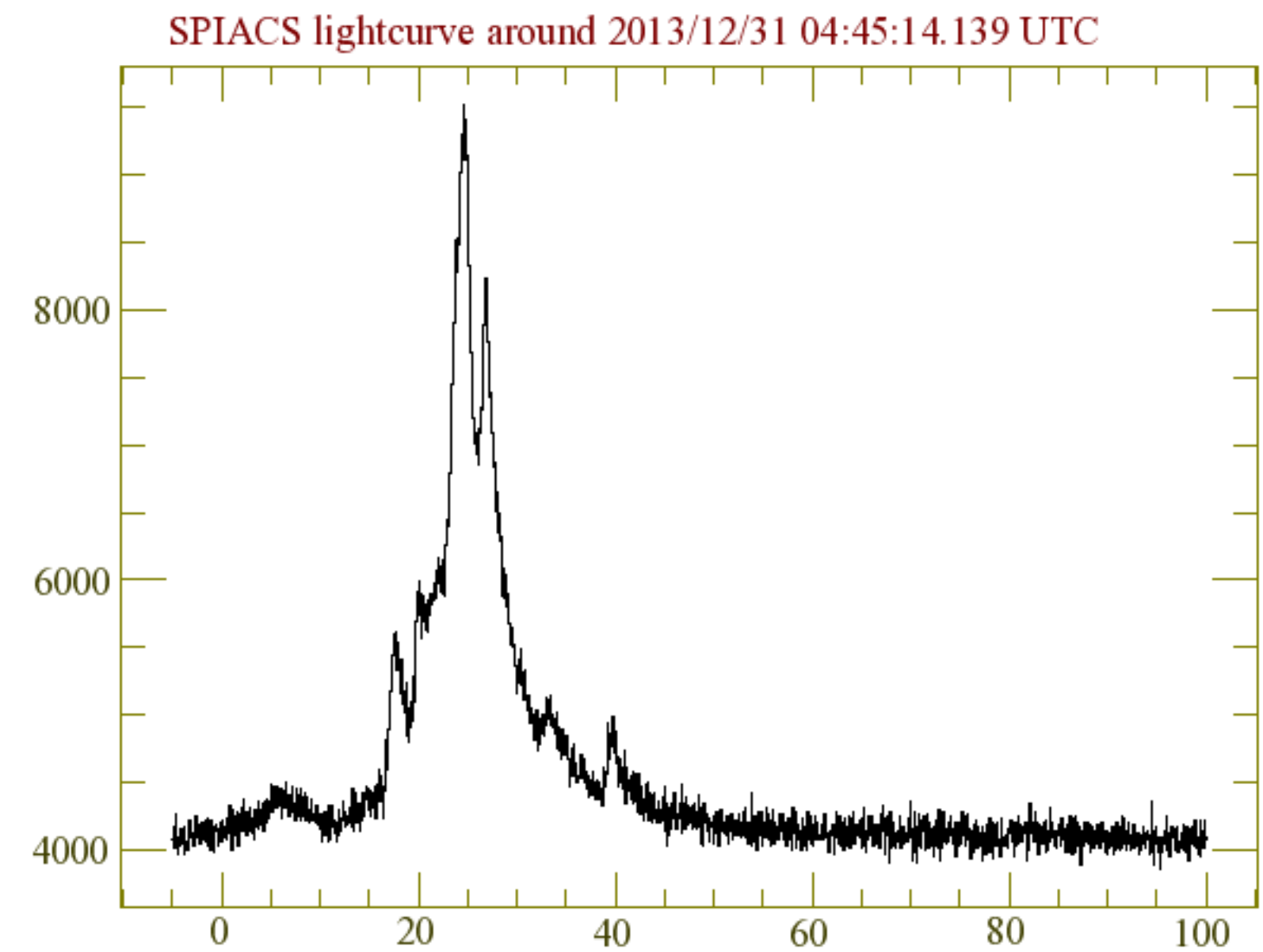
GRB-SNe! (Ginger+19)



SN 2011kl (Ginger+19)

Superluminous SNe (Buttercup+17)

A Challenger appears! (Kann+ in prep.)



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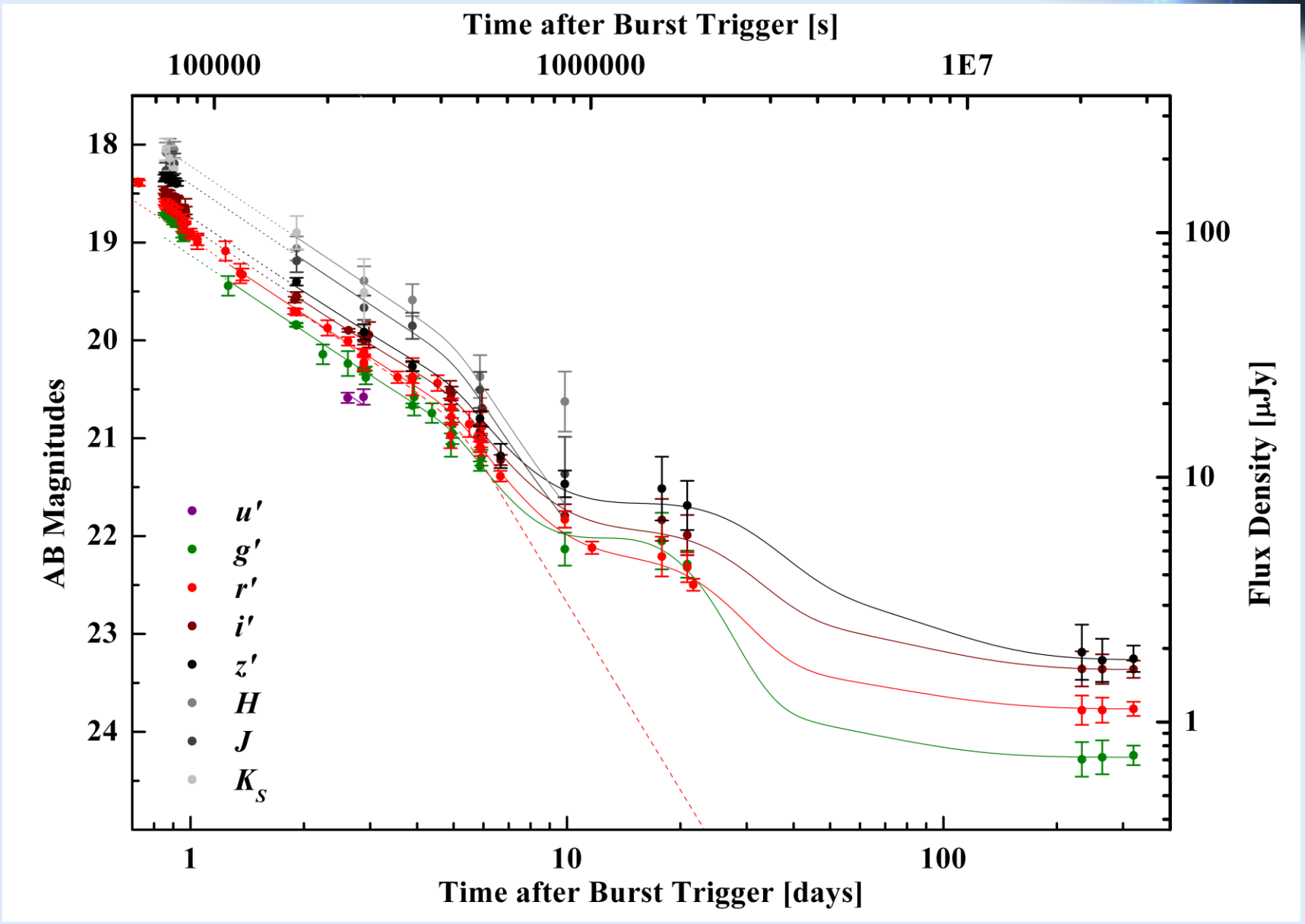

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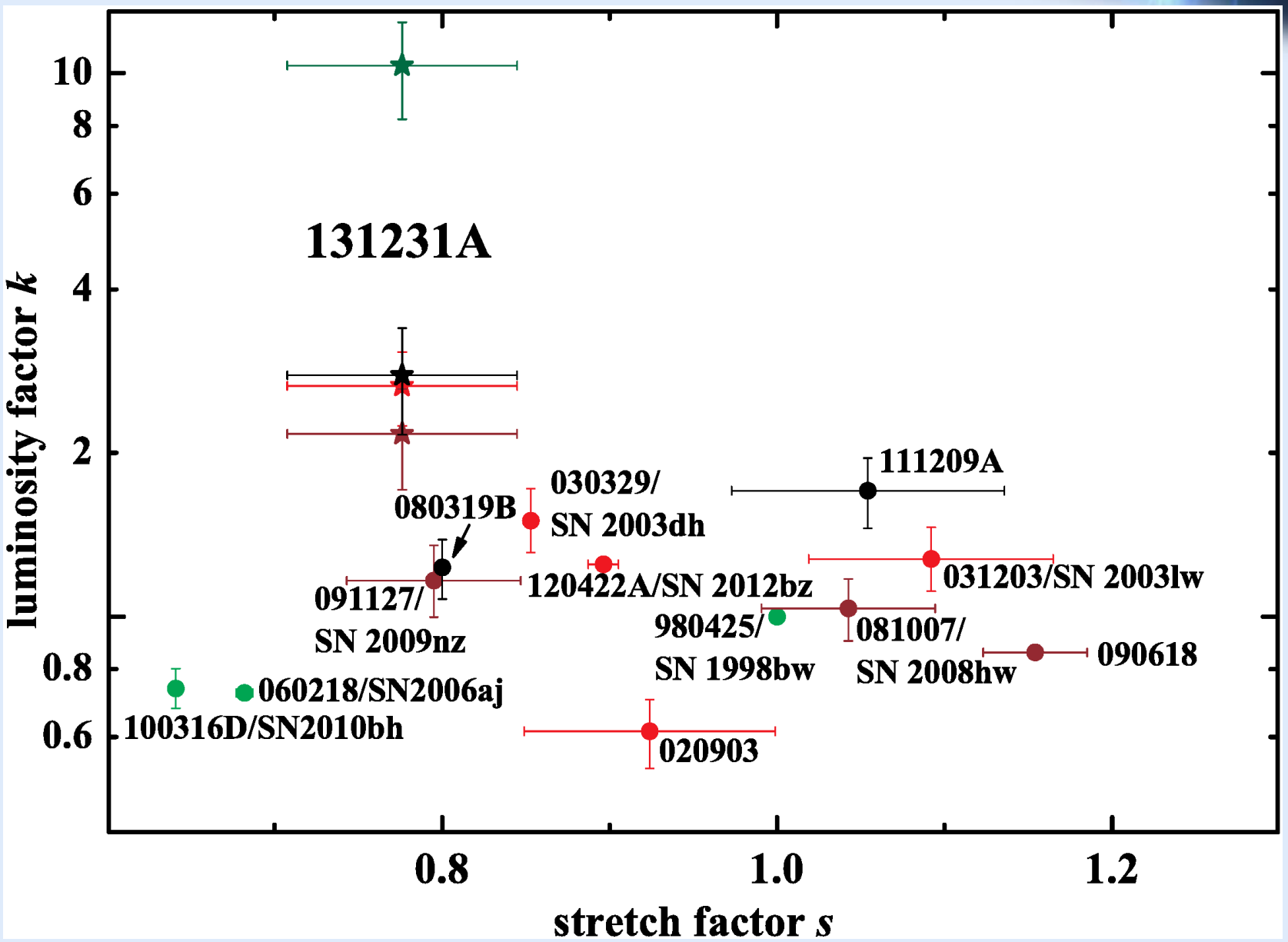

Наоми говорит: Спасибо за внимание!