The Diversity of Kilonova Emission in Short Gamma-Ray Bursts

Ben Gompertz (University of Warwick)

A. J. Levan[1], N. R. Tanvir[2], J. Hjorth[3], S. Covino[4], P. A. Evans[2], A. S. Fruchter[5], C. González-Fernández[6], Z. P. Jin[7,8], J. D. Lyman[1], S. R. Oates[1], P. T. O'Brien[2], K. Wiersema[1]

[1]*University of Warwick*
[2]*University of Leicester*
[3]*University of Copenhagen*
[4]*Osservatorio Astronomico di Brera*
[5]*Space Telescope Science Institute*
[6]*University of Cambridge*
[7]*Purple Mountain Observatory*
[8]*University of Science and Technology of China*

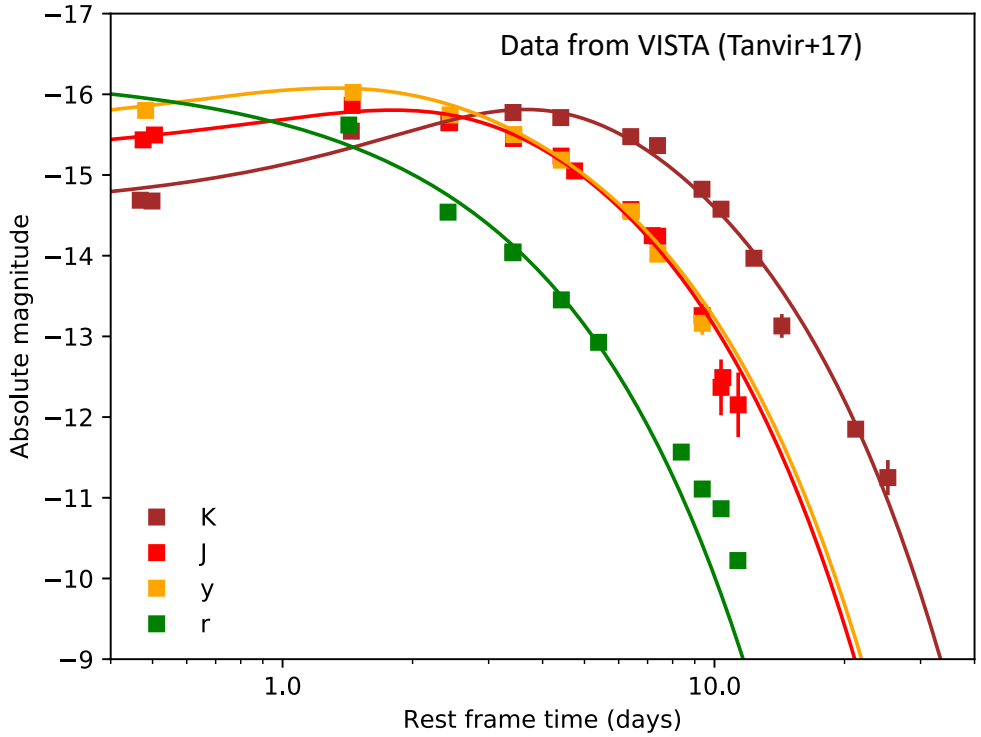
WARWICK
THE UNIVERSITY OF WARWICK

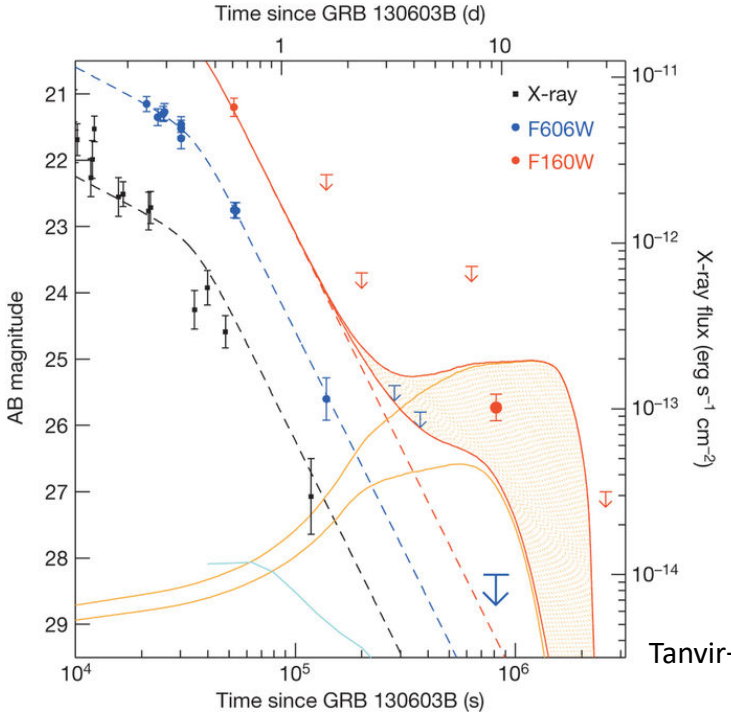
GRB 170817A / AT2017gfo gave us a template for a kilonova

Are similar events present in the known SGRB population?

How does AT2017gfo compare to the SGRB kilonova candidates?

Could similar events be masked by the SGRB afterglow?





Tanvir+13

We collect 23 SGRBs with z < 0.5 to compare their light curves with AT2017gfo.

3 of these are KN candidates: 130603B (Tanvir+13; Berger+13); 060614 (Yang+15); 050709 (Jin+16)

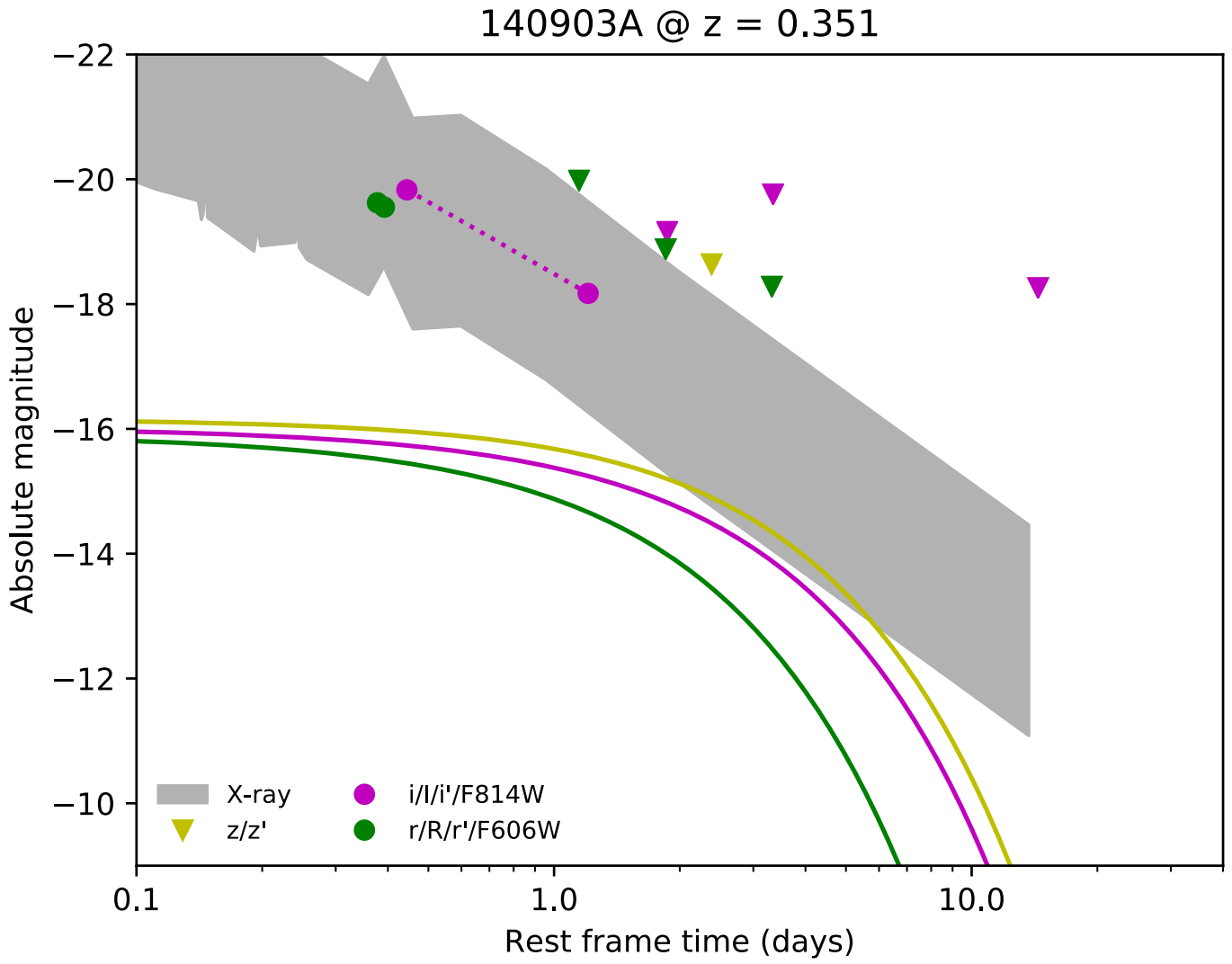
1 further marginal case: 160821B (Jin+17)

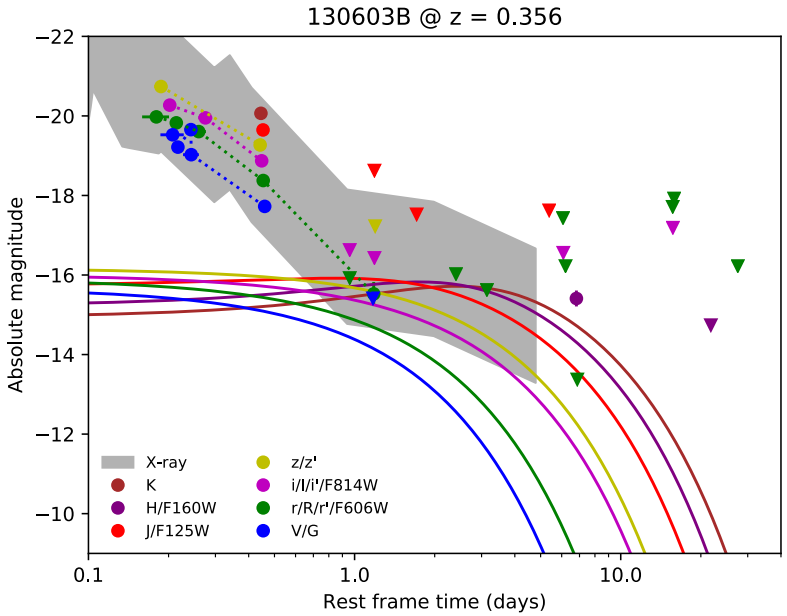
- Observations are shifted to absolute magnitudes (including k-correction)

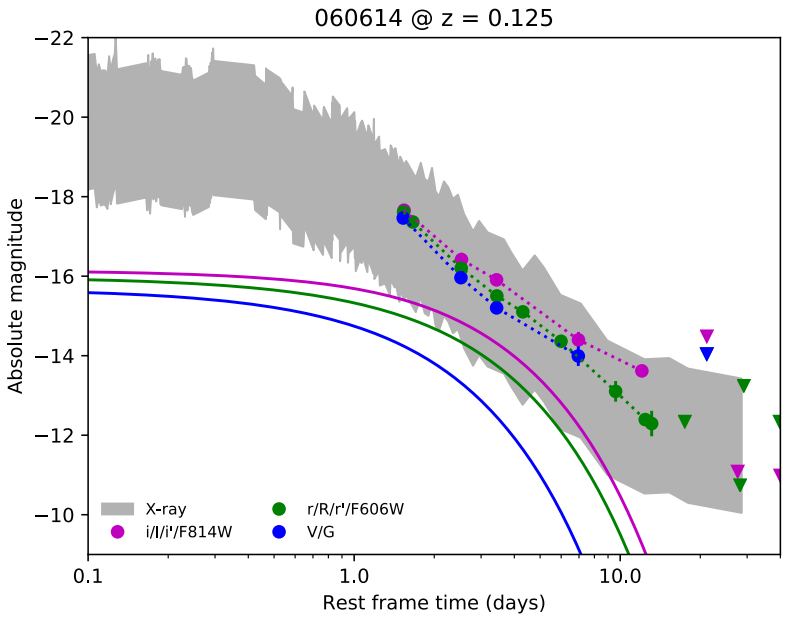
- Bazin fits are interpolated to the relevant rest-frame wavelengths (augmented by fits to UVOT data from Evans+17 where necessary)

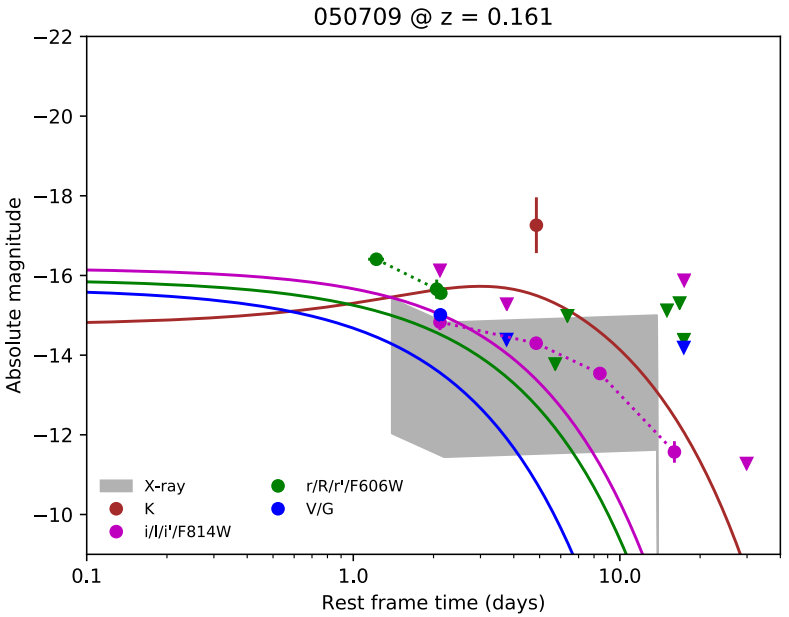
- X-ray observations are extrapolated to the rest-frame r-band (grey band)

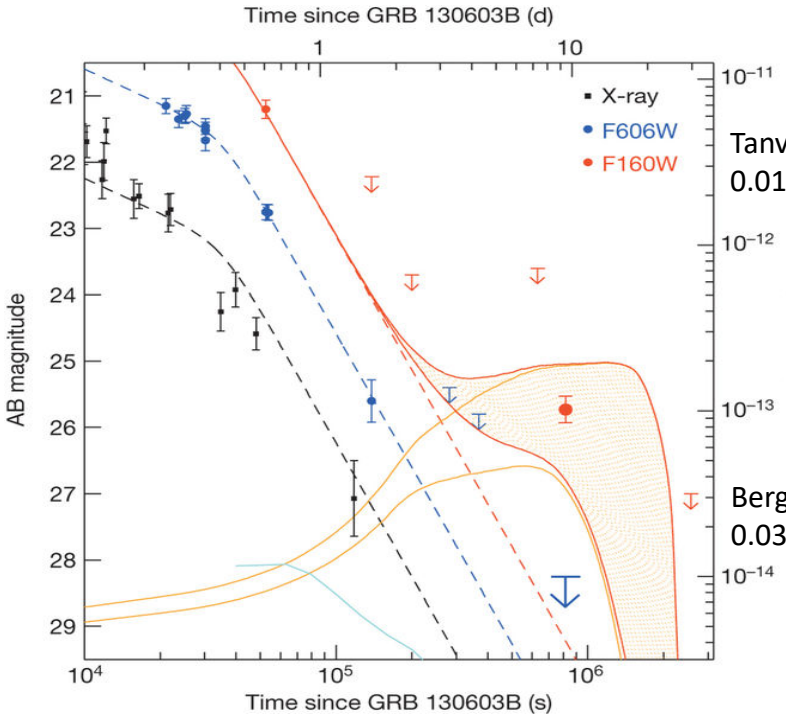
- KN models can then be compared to SGRB observations





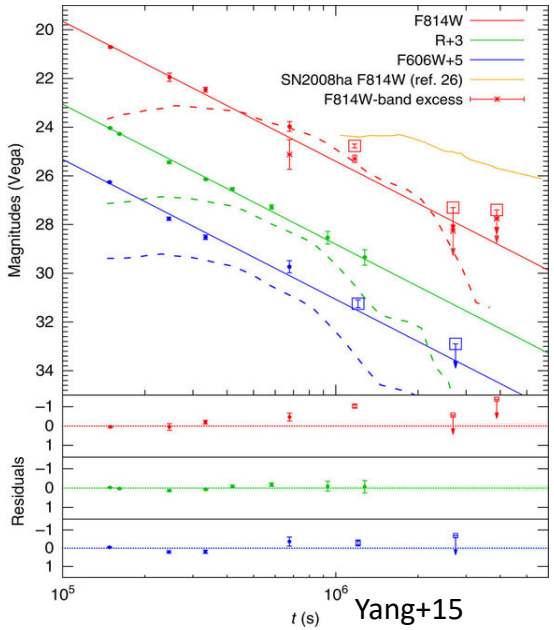






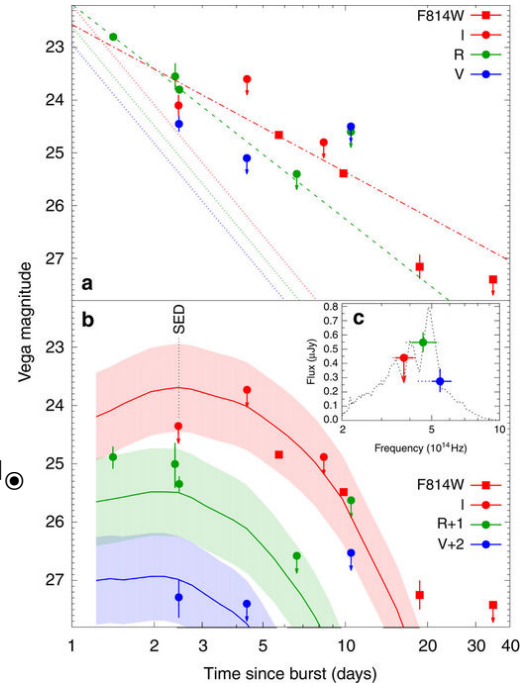
Tanvir+13
$0.01M_\odot \leq M_{ej} \leq 0.1M_\odot$

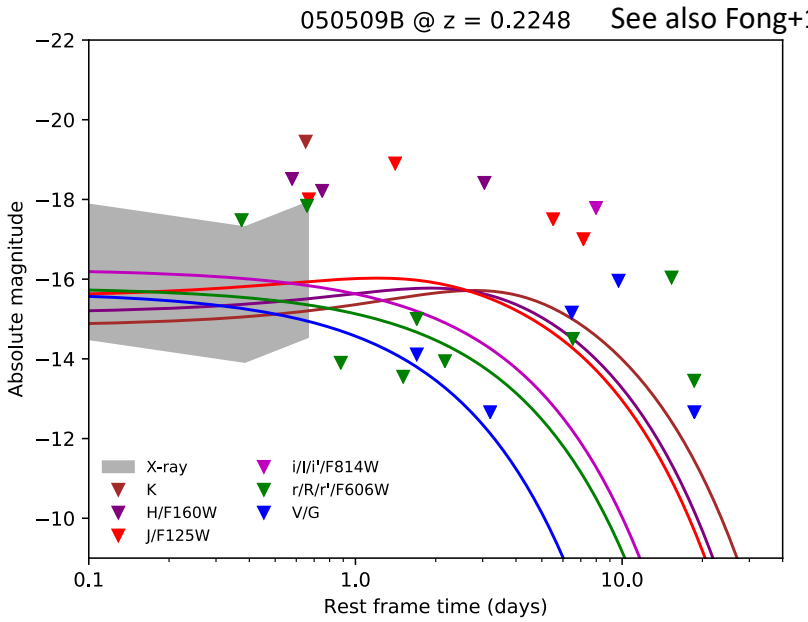
Berger+13
$0.03M_\odot \leq M_{ej} \leq 0.08M_\odot$



Yang+15
$M_{ej} \sim 0.1M_\odot$

Jin+16
$M_{ej} \sim 0.05M_\odot$



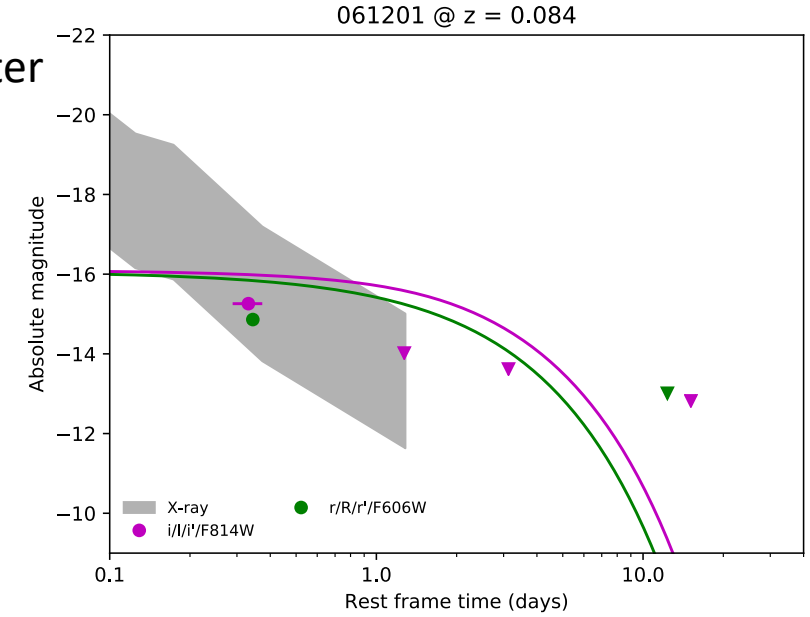


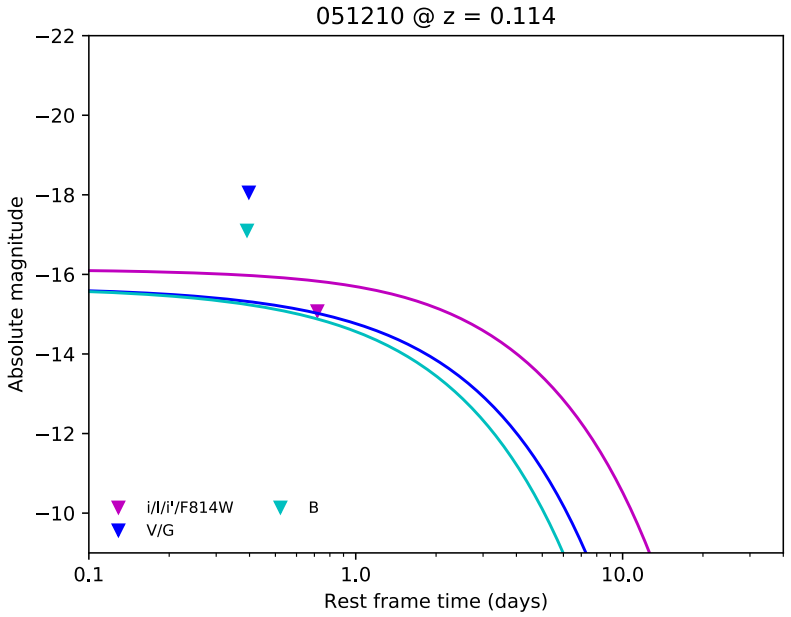
See also Fong+17

≥ 3x fainter

NB this is based on the limits (can't tell if the detections are KN or afterglow)

≥ 4x fainter



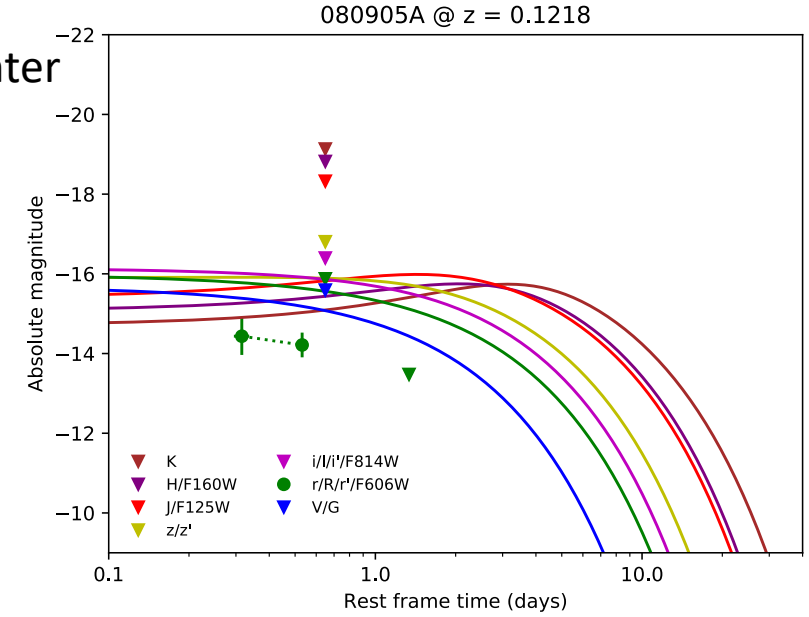


≥ 2x fainter

Caveats:

- SGRB redshifts are assigned by putative host redshifts
- Intrinsic (host galaxy) absorption was not included

≥ 4.5x fainter



Conclusions

We see quite a diversity in KN emission

What could drive such a difference?

Unlikely to be viewing angle
(Range exists in SGRB population)

Mass ratio?

Fainter → Lower ejecta mass
Faster evolving → Higher ejecta velocity/lower ejecta mass
Difference in opacity? (higher opacity → later peak)

Contributions from re-processed X-ray activity? (e.g. Kisaka et al. 2016)

See Gompertz+2017 (arxiv:1710.05442)