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# Piecing together the long gamma-ray burst's progenitor puzzle

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In context of GRB 221009A

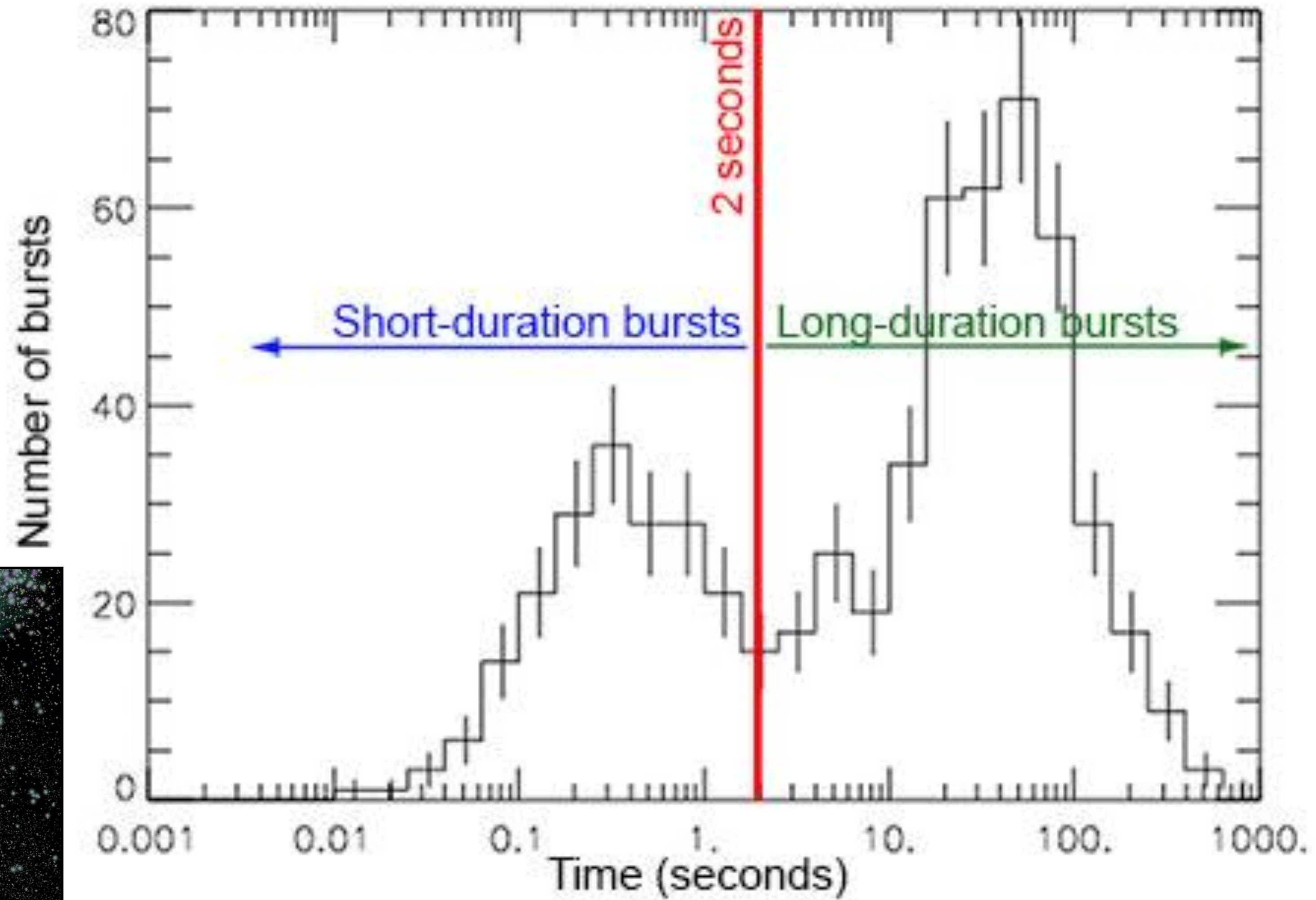
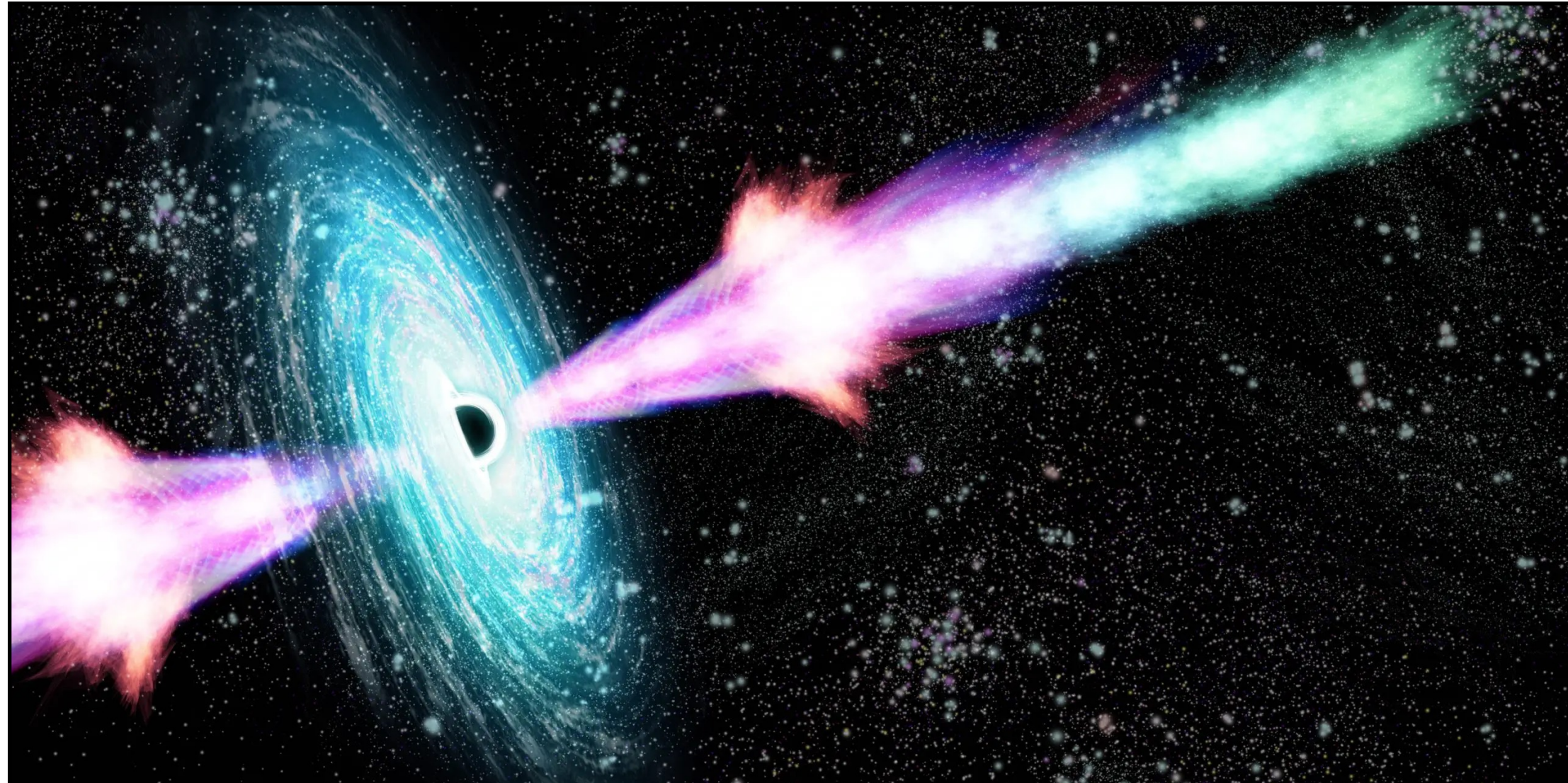


**Manisha Shrestha**  
Postdoctoral Researcher  
University of Arizona

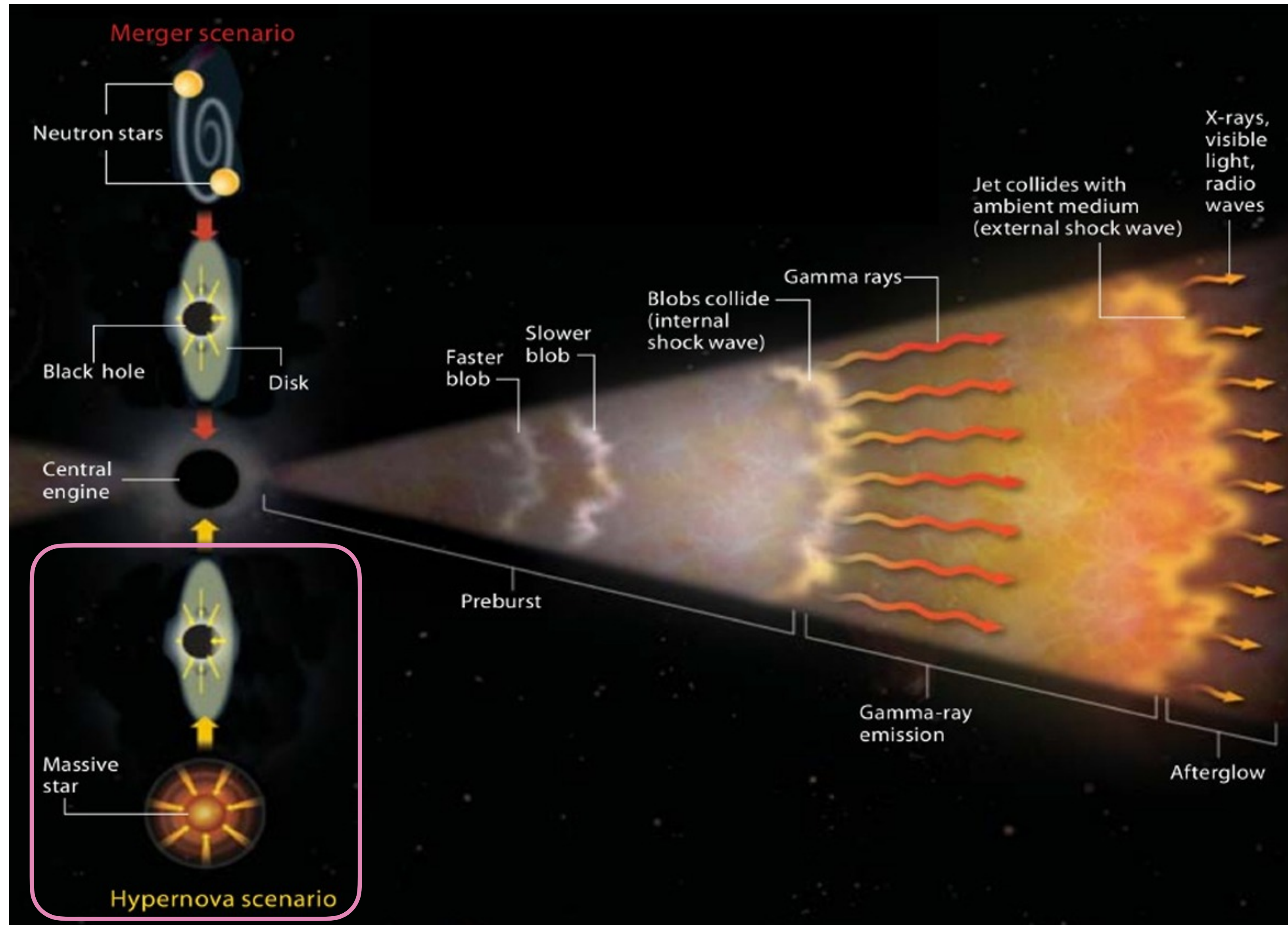
# Gamma-ray bursts

Highly energetic

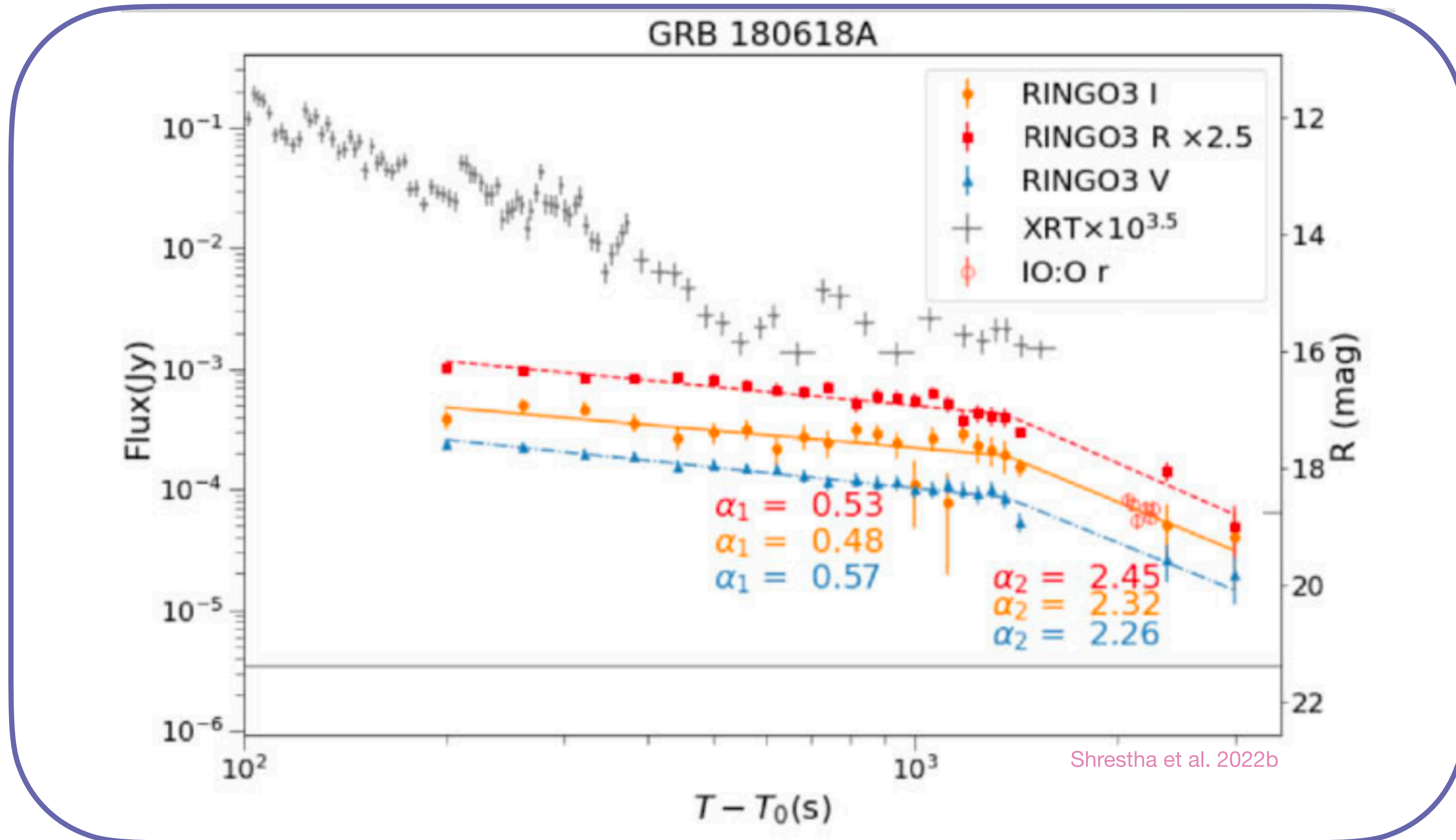
Classified in two groups



# Progenitors of GRBs



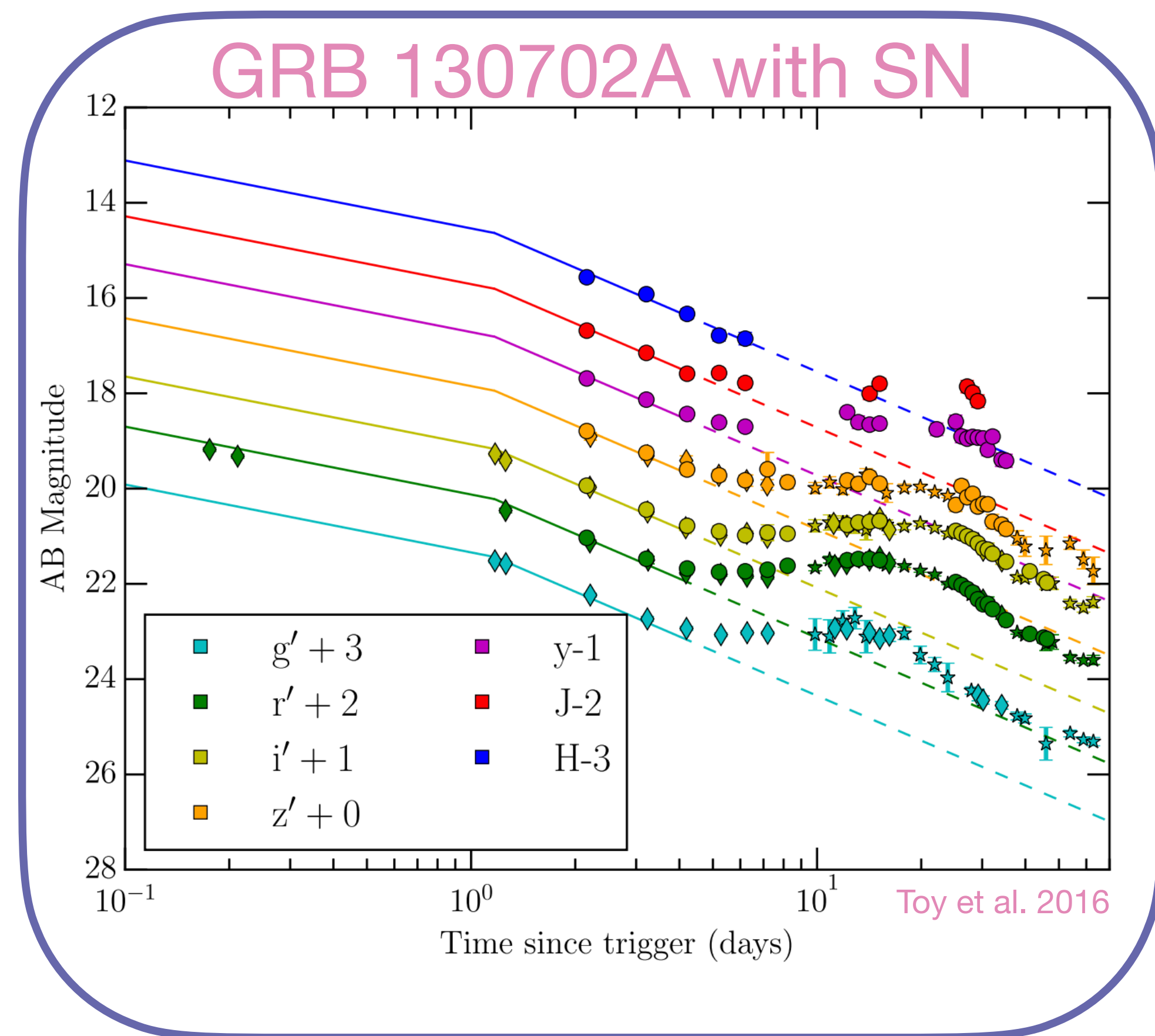
# GRB afterglow example



# Supernova associate to LGRBs

Bump in light curve

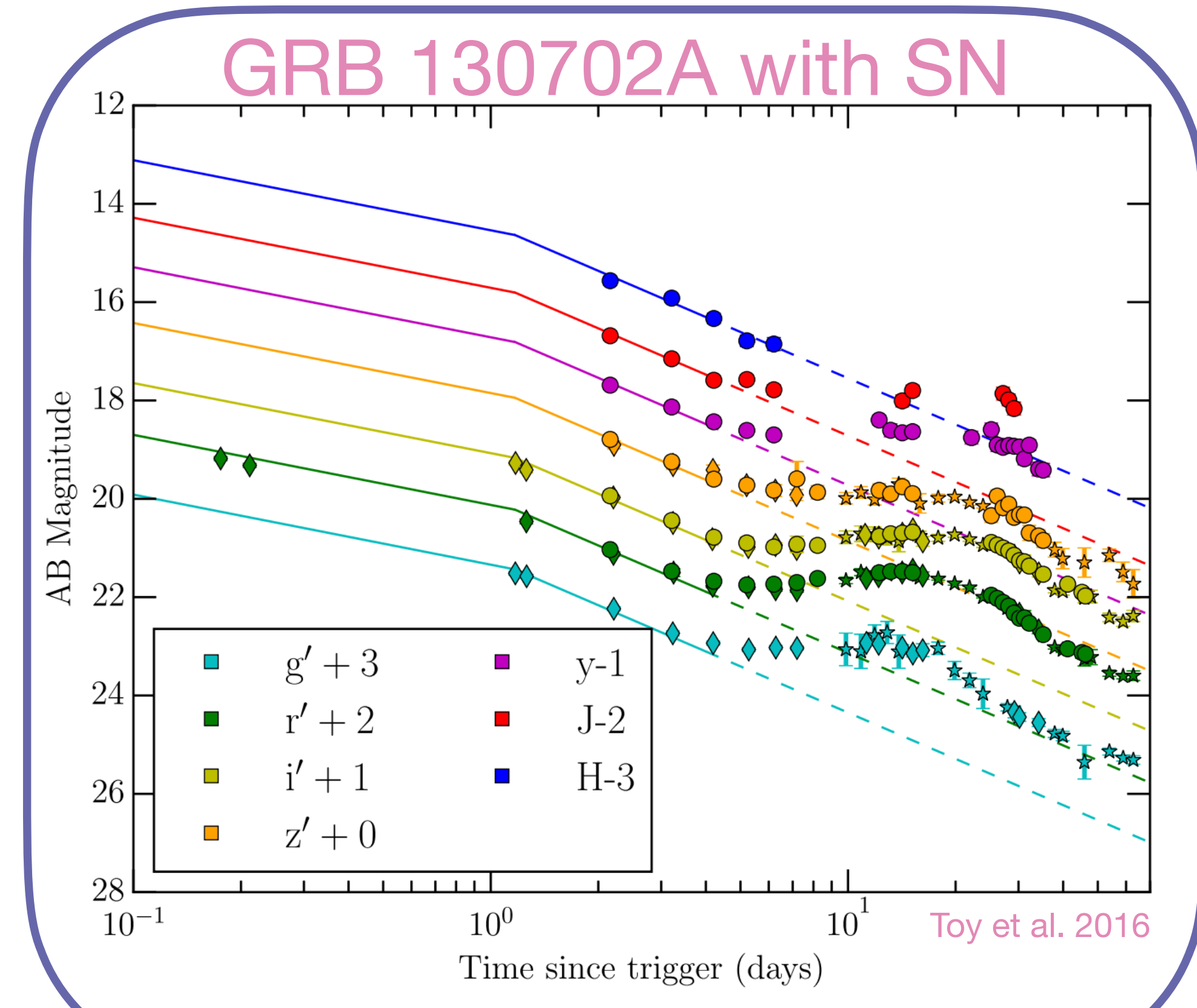
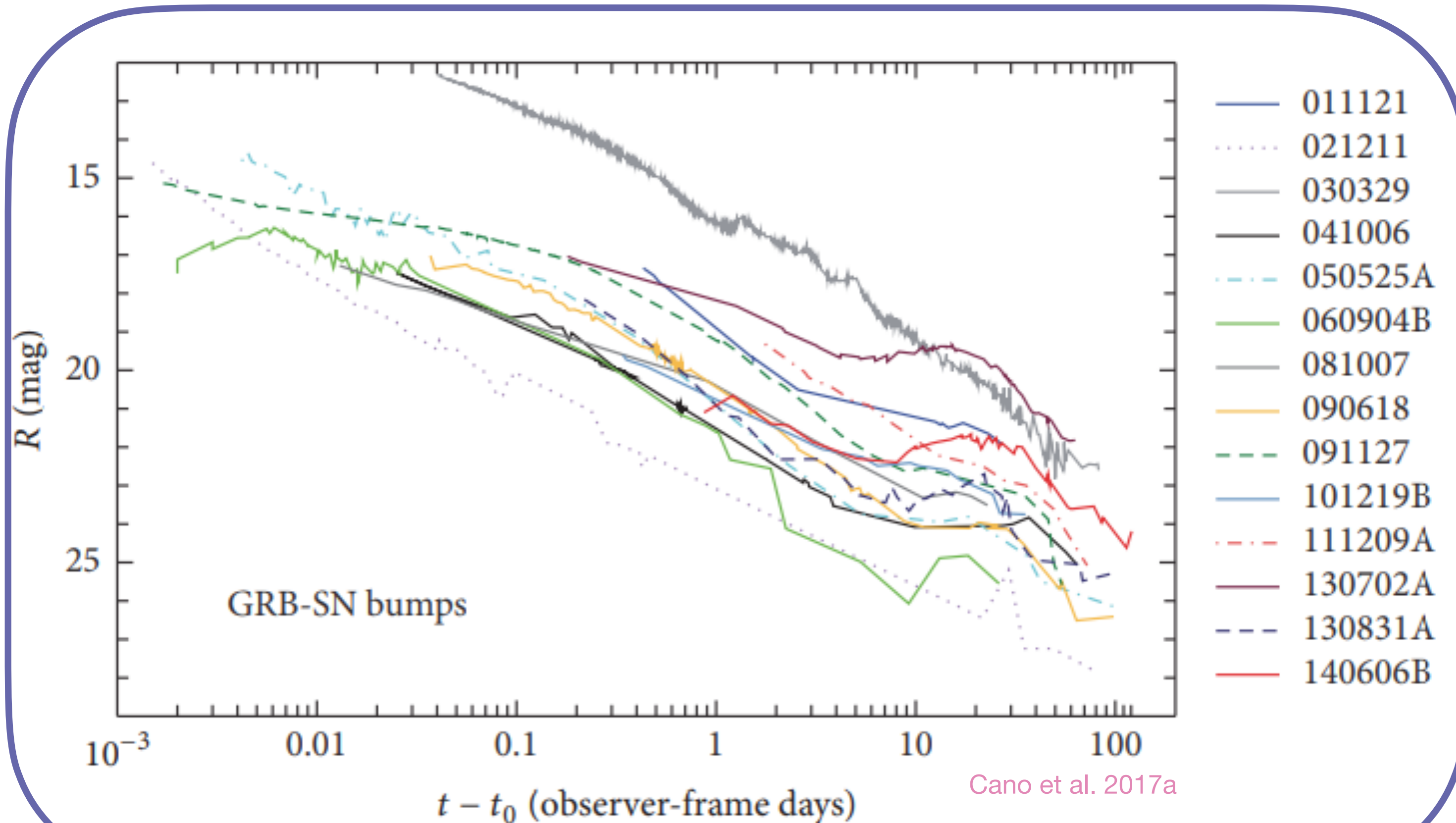
40-50 LGRBs show this bump



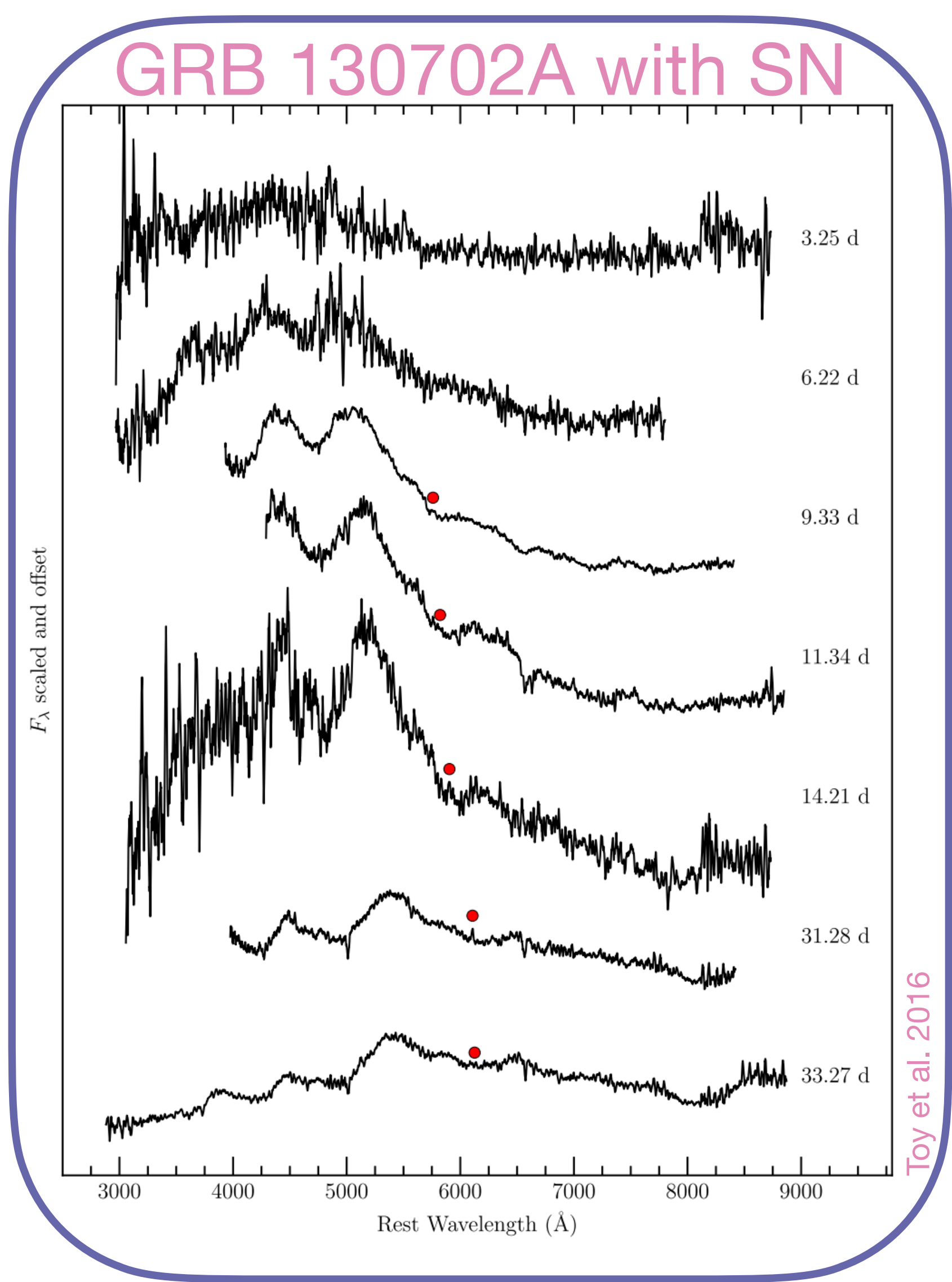
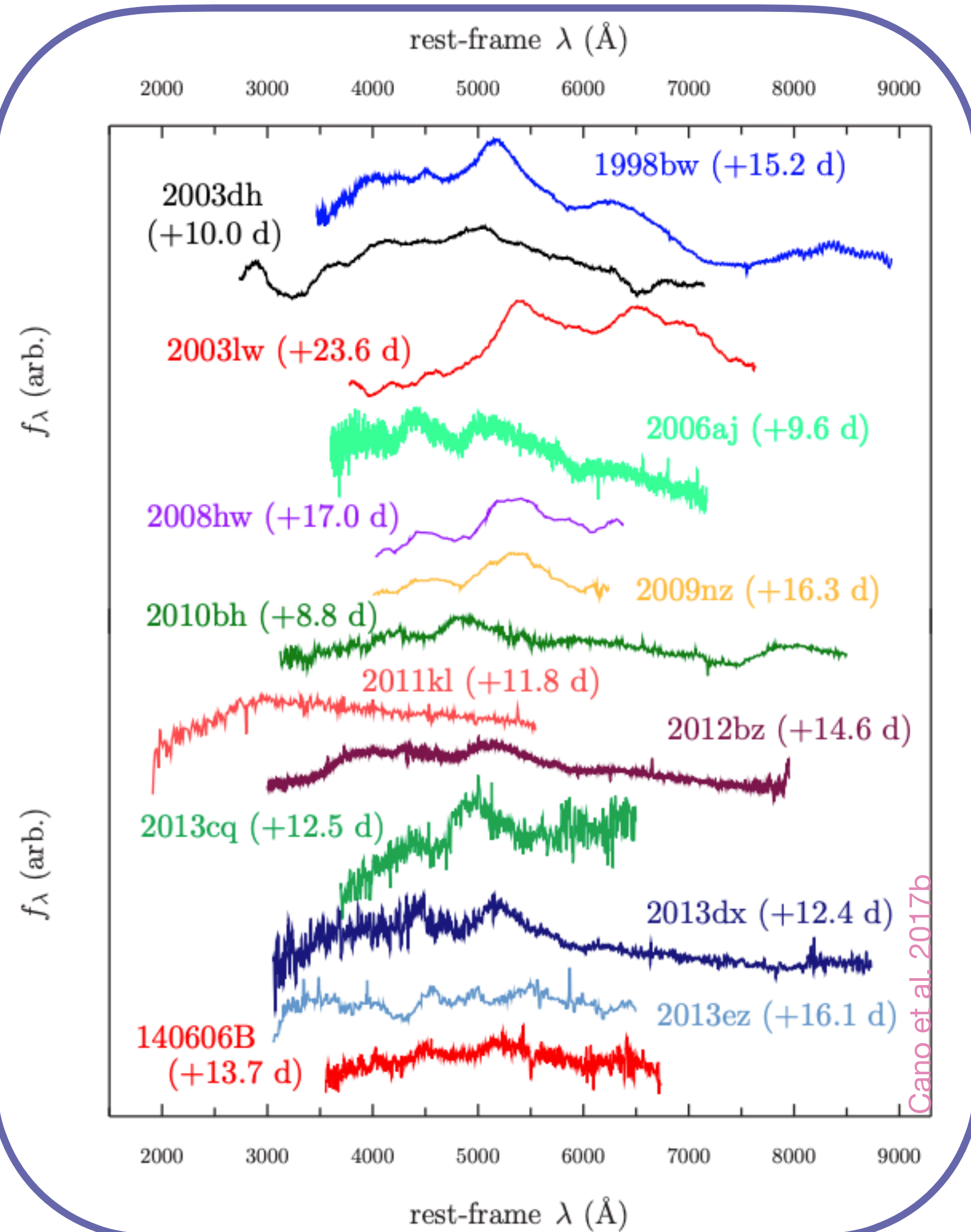
# Supernova associate to LGRBs

Bump in light curve

40-50 LGRBs show this bump



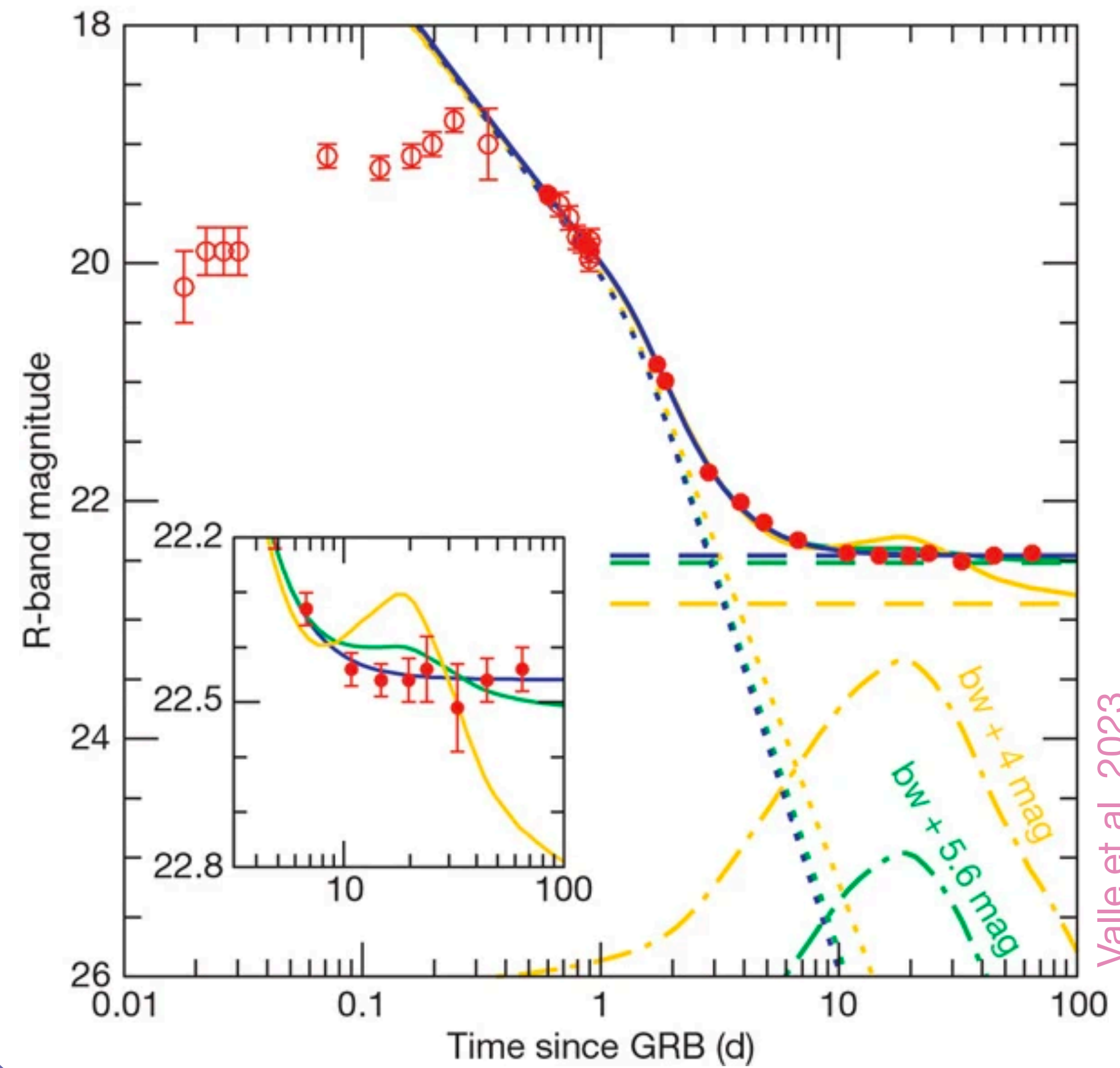
# Supernova associated to LGRBs



~28 LGRB + SN Ic-BL  
Broad features

# Progenitors of LGRBs: open questions

GRB 060614 with no SN

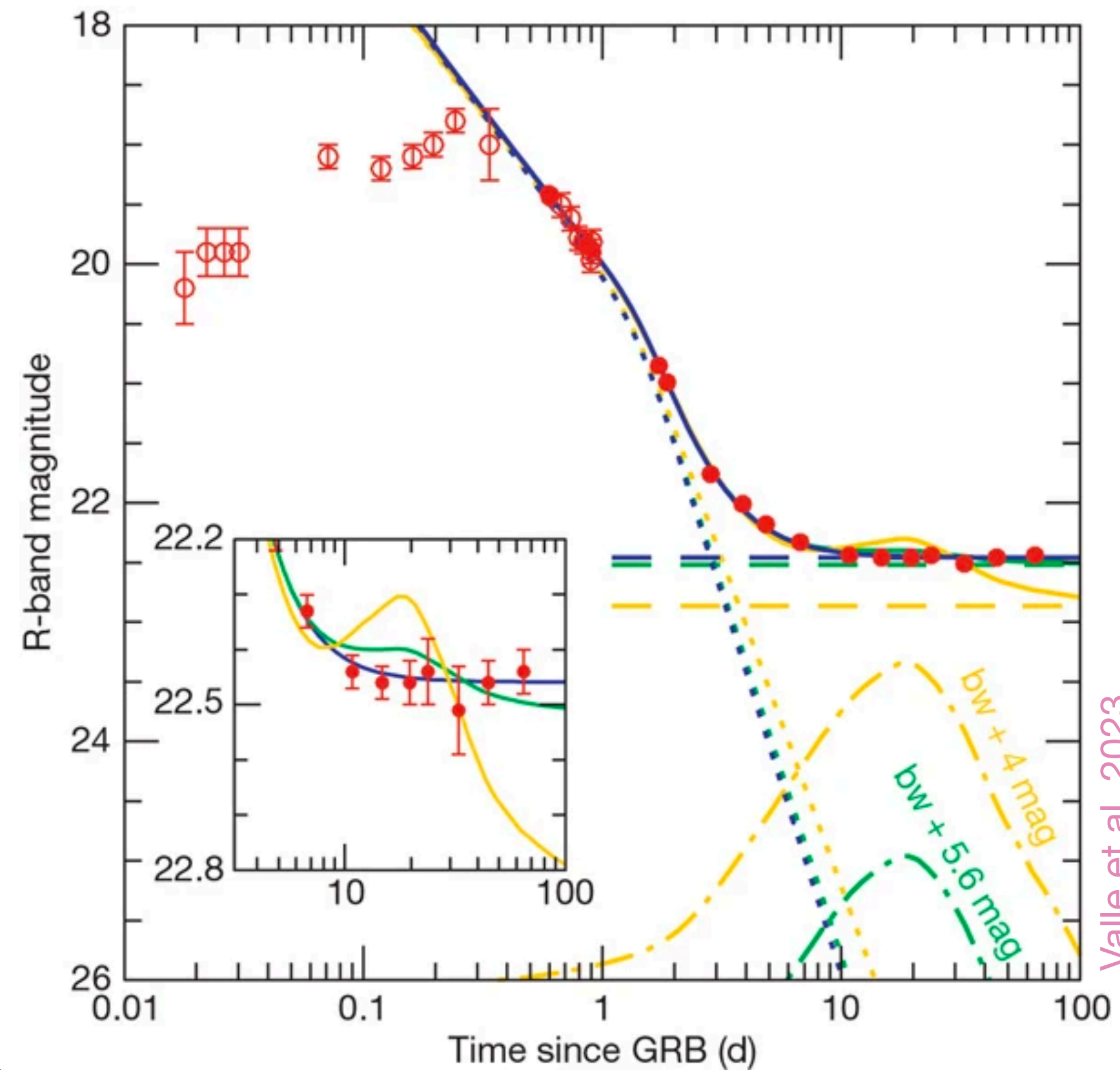


Valle et al. 2023

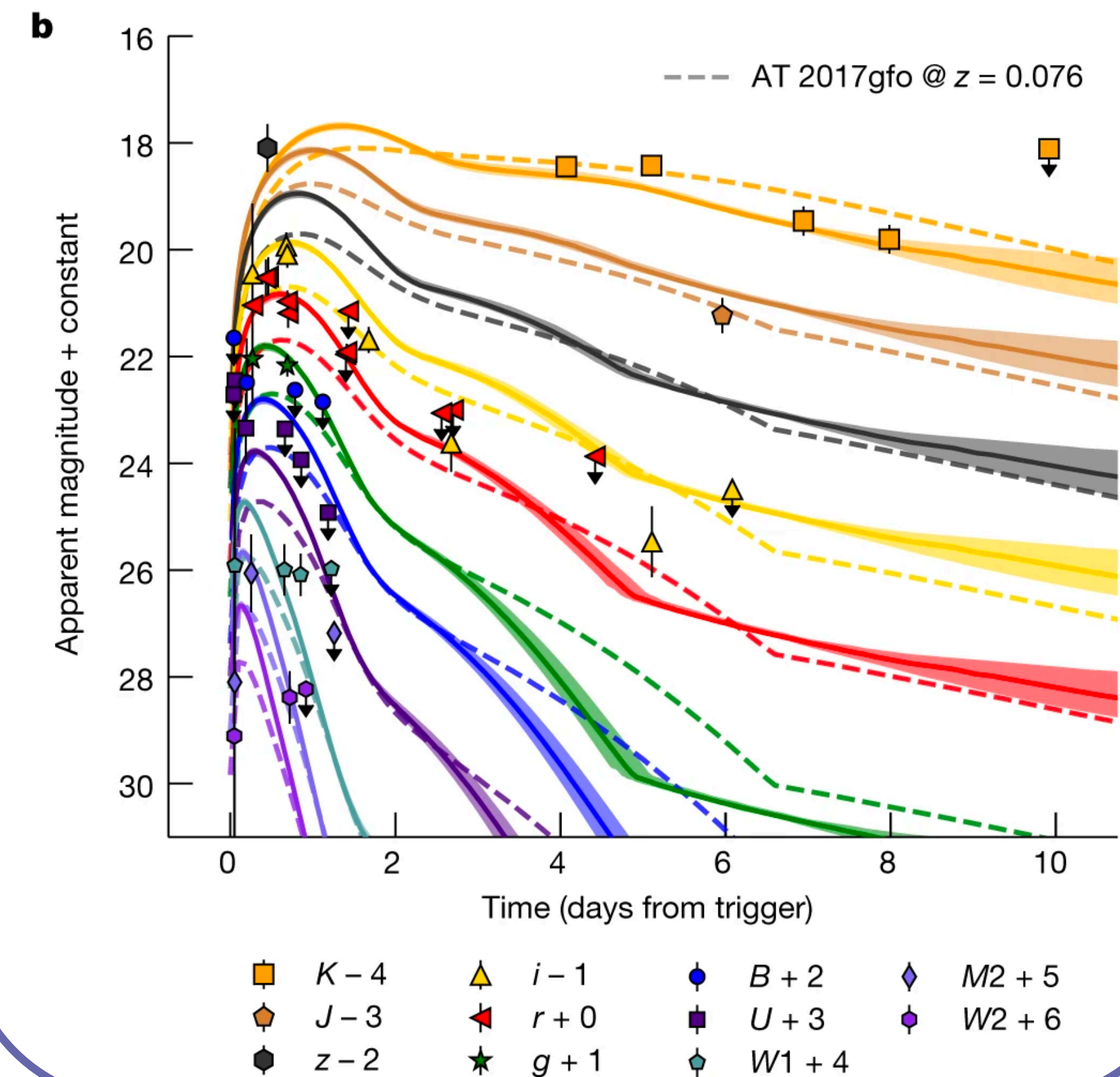


# Progenitors of LGRBs: open questions

## GRBs with no SN

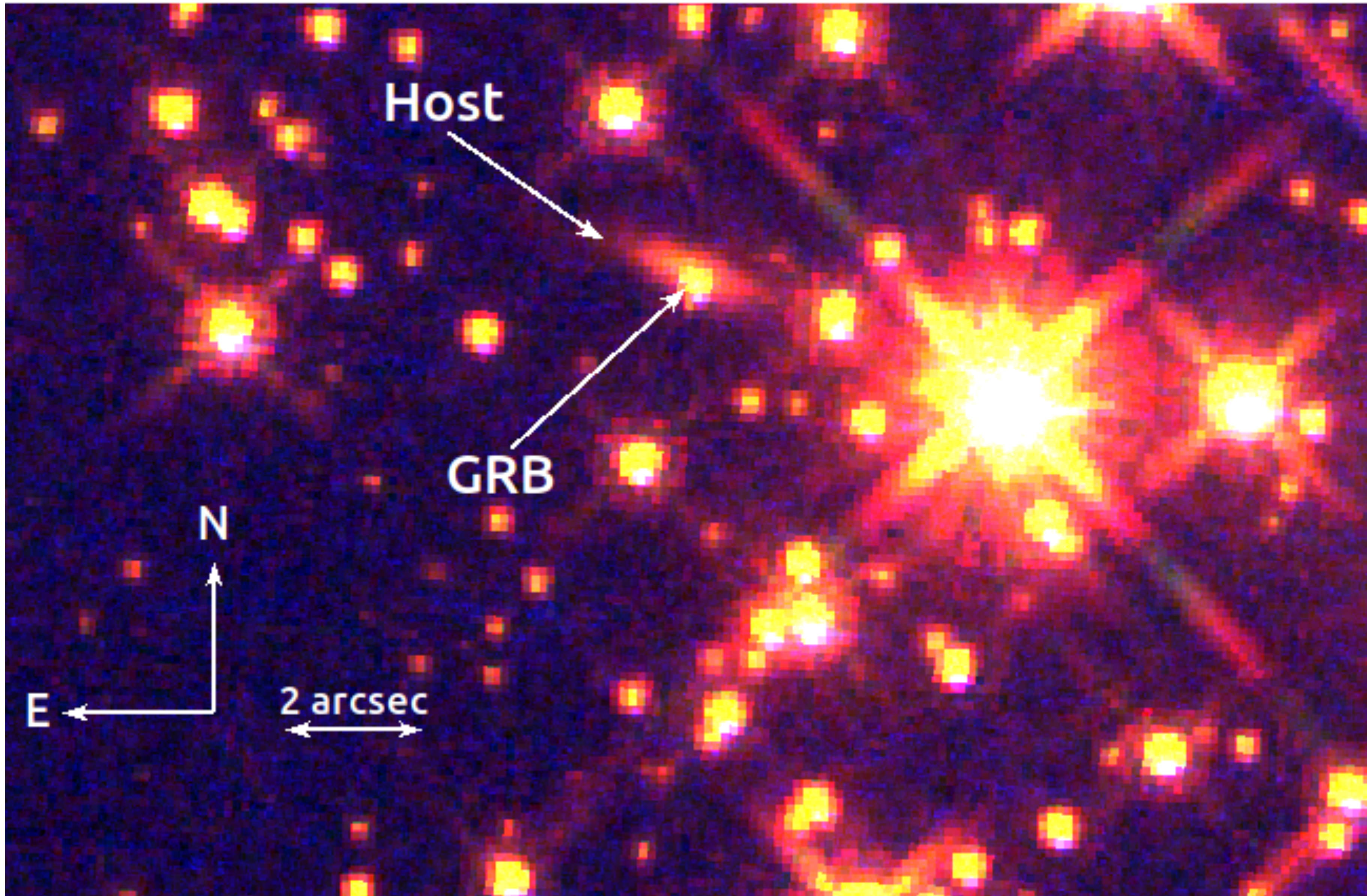


## GRB 211211A + KN emission



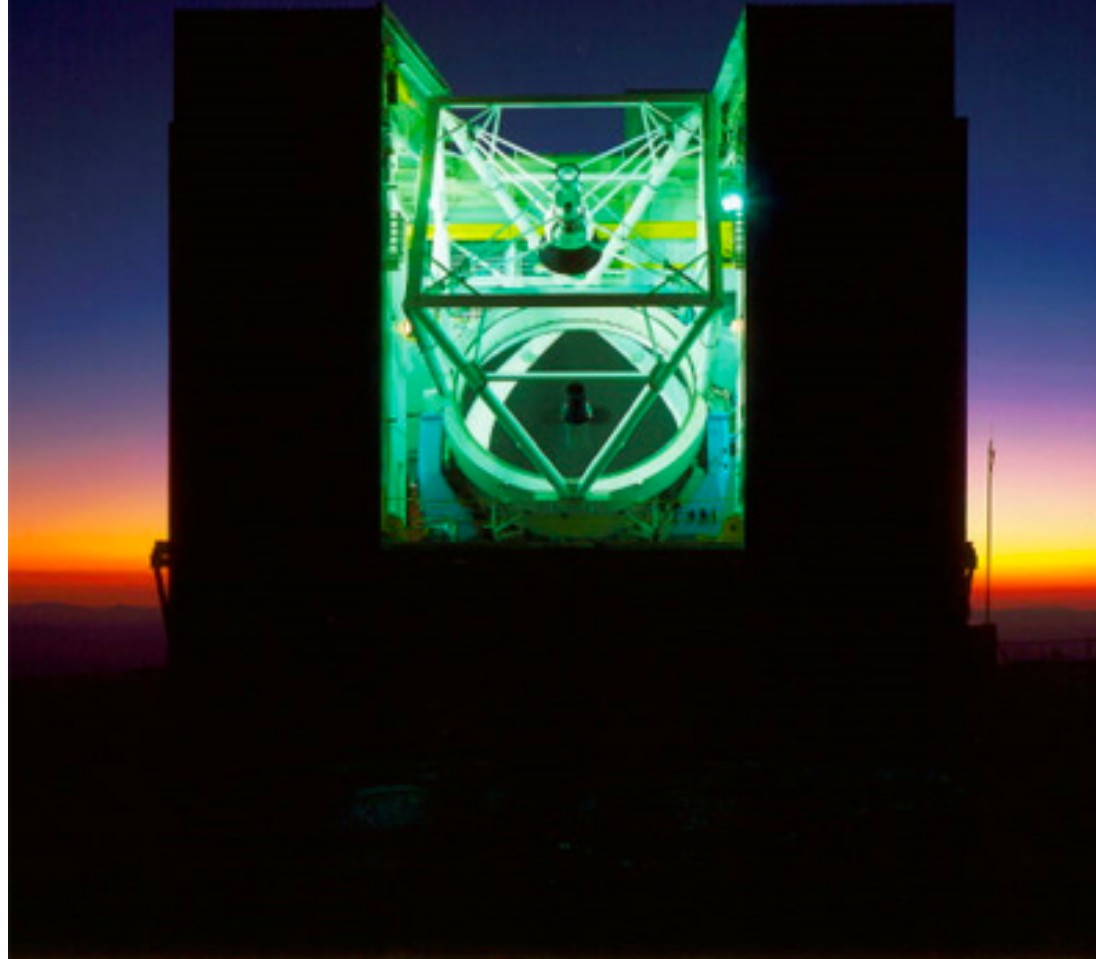
# GRB 221009A: the brightest GRB ever

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# GRB 221009A: ground based follow-up

MMT



LBT



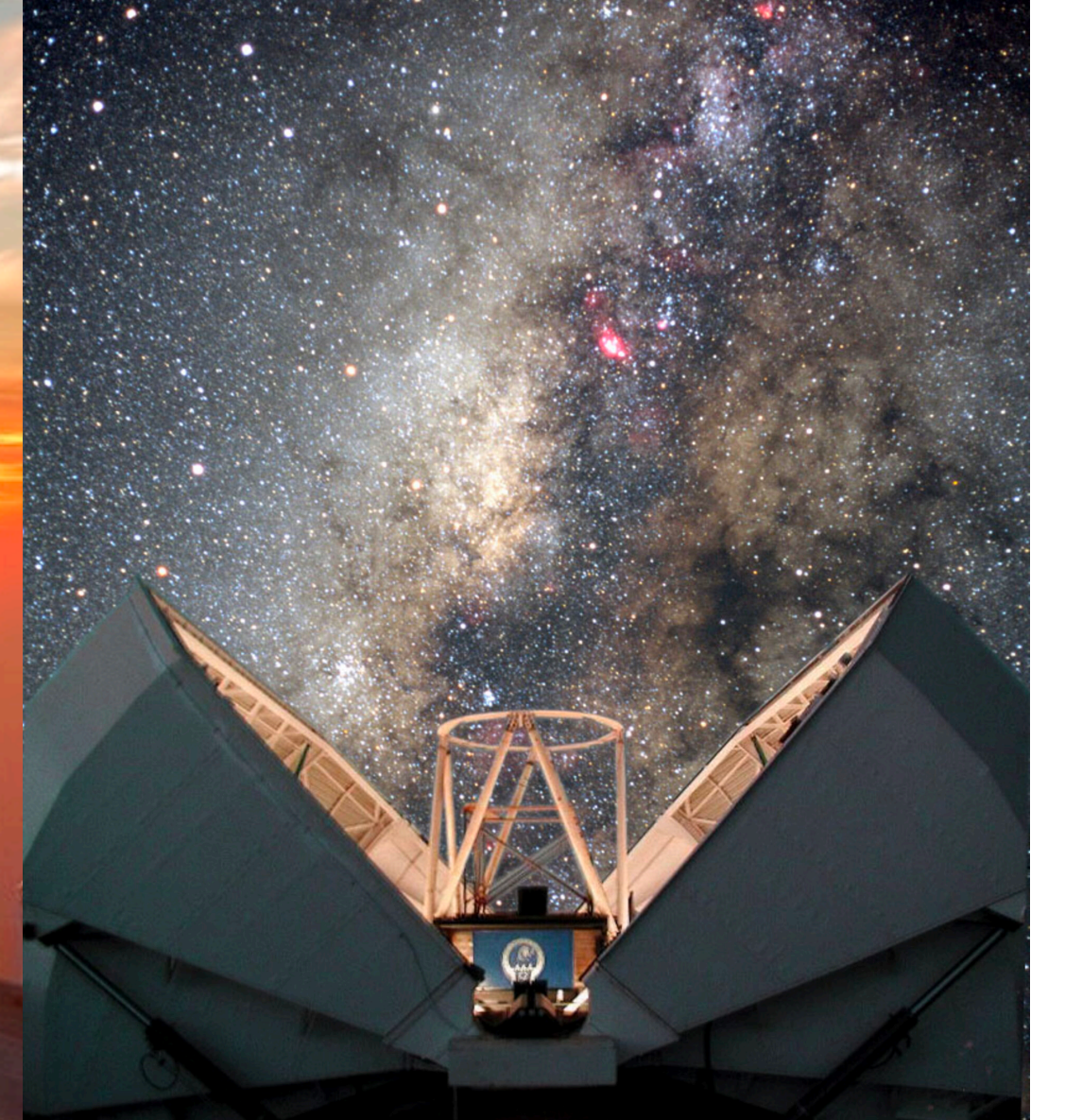
SOAR



CTIO

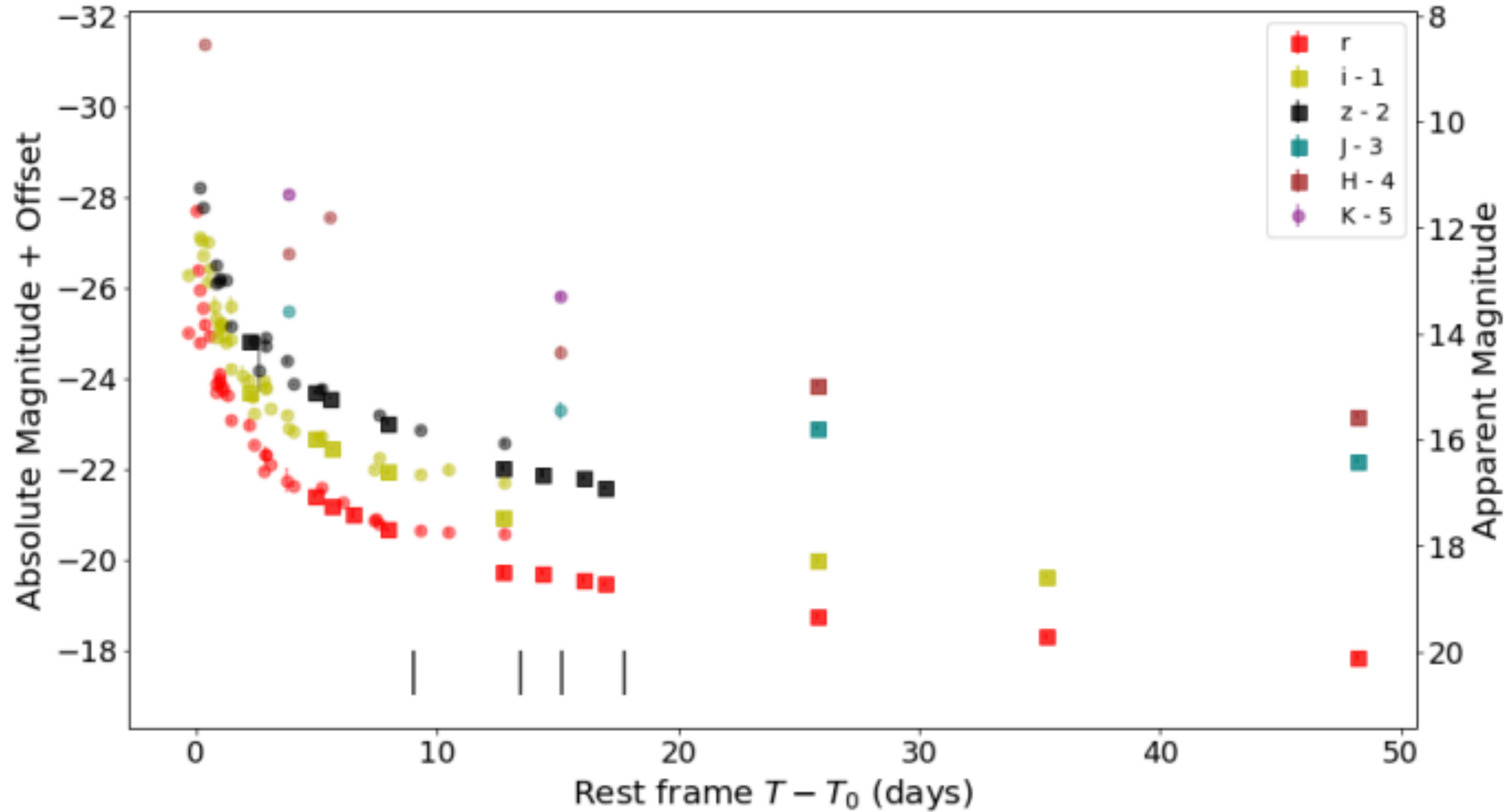


FTN

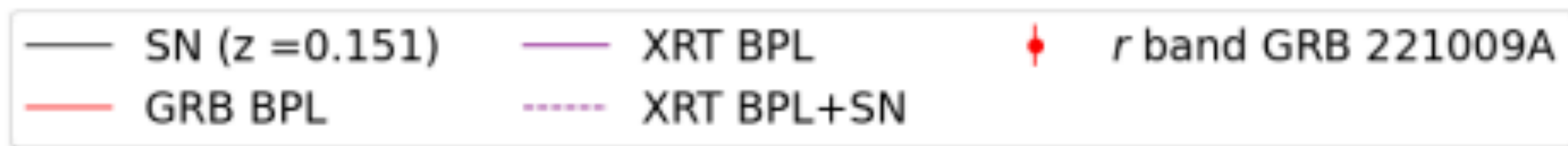


# GRB 221009A: search for associated SN

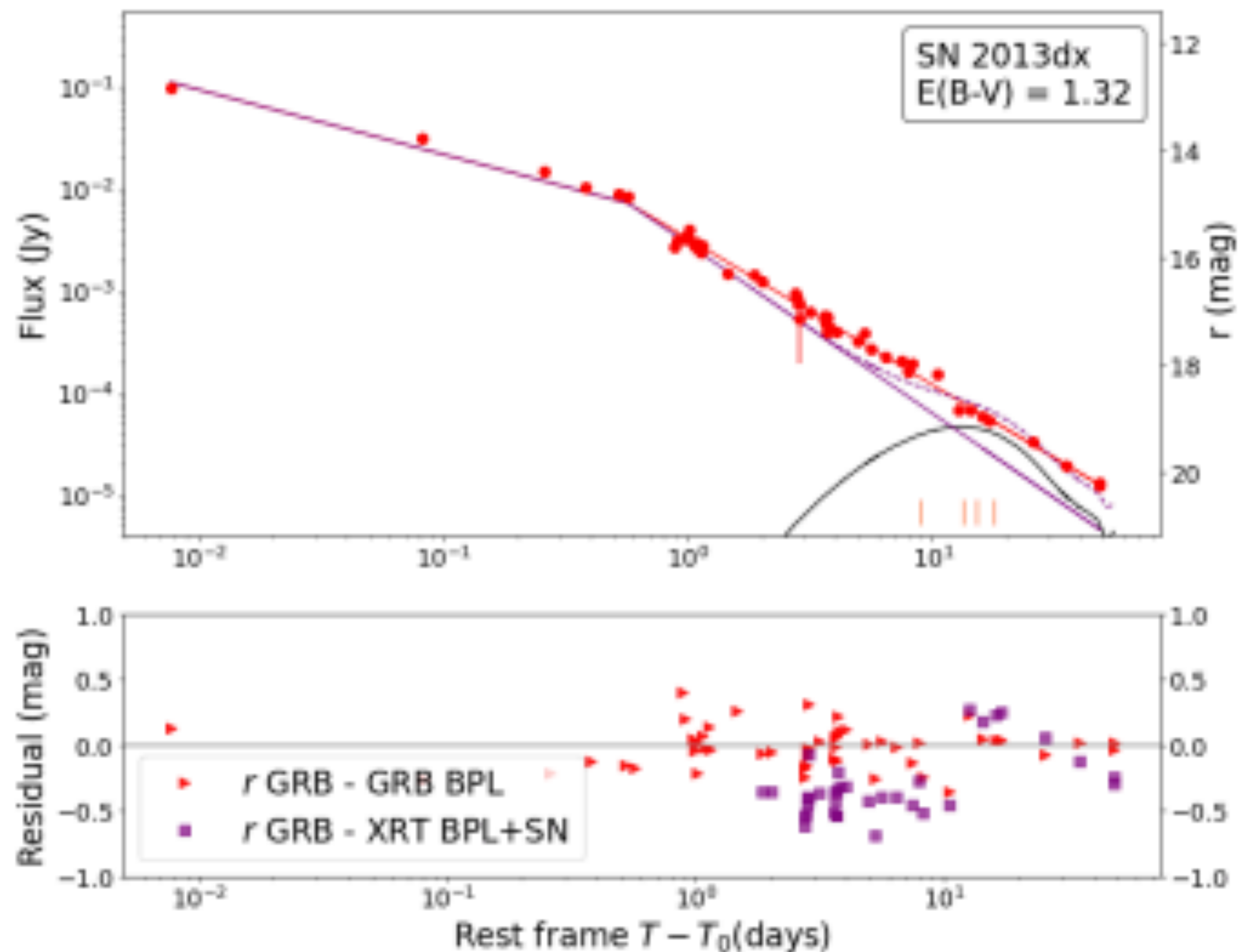
Shrestha et al. 2023a



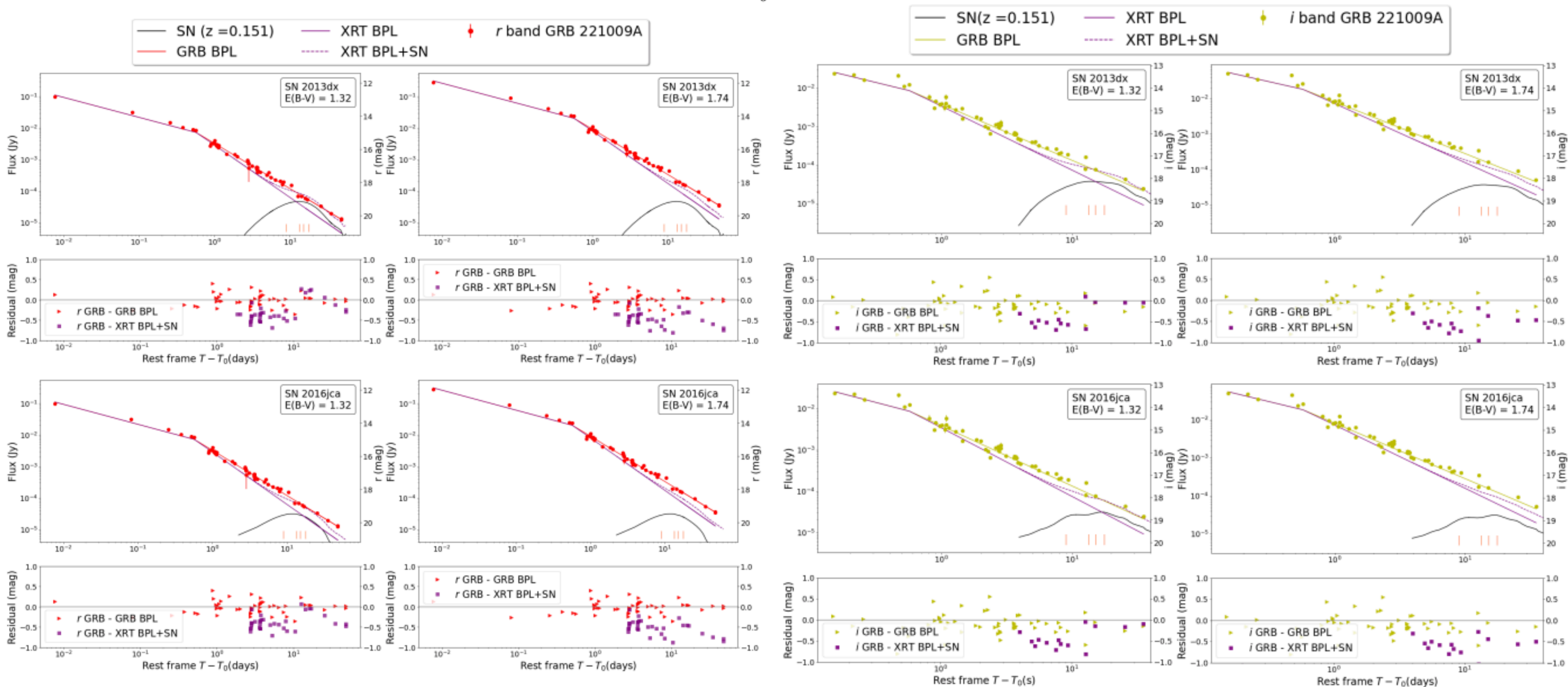
# GRB 221009A: no clear SN in light-curve



Shrestha et al. 2023a



# GRB 221009A: no clear SN in light-curve

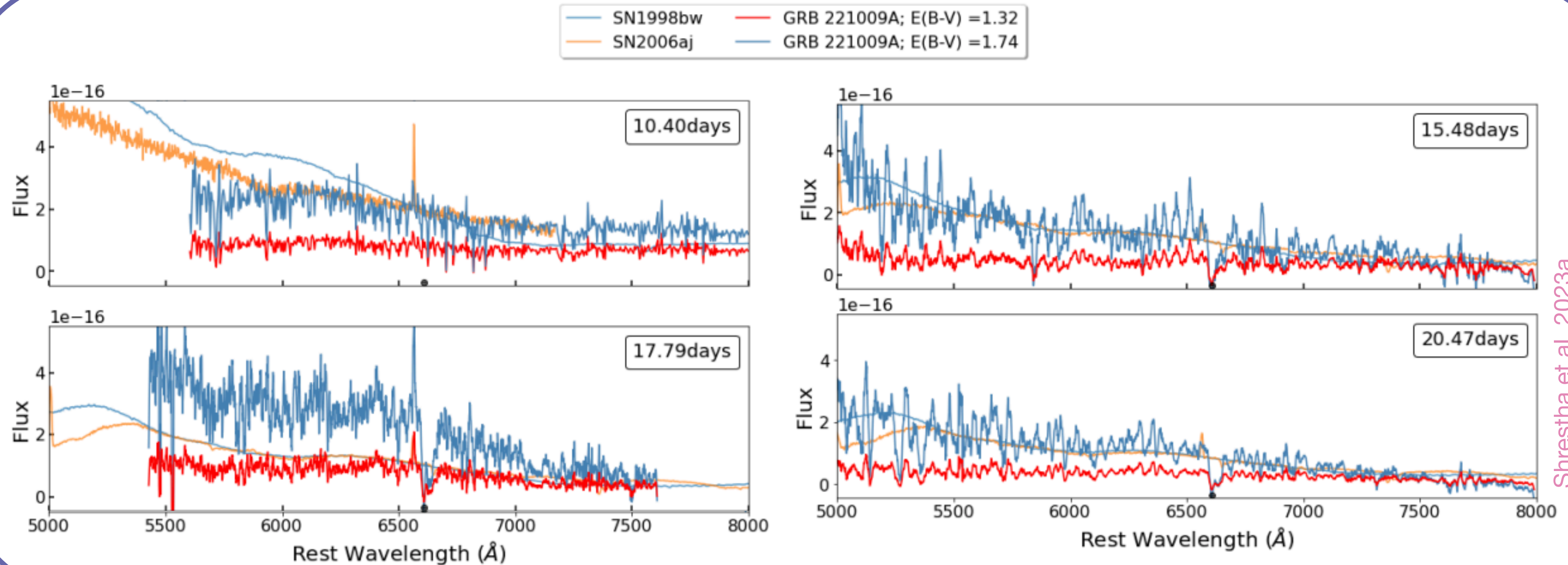


# GRB 221009A: no clear SN in spectra

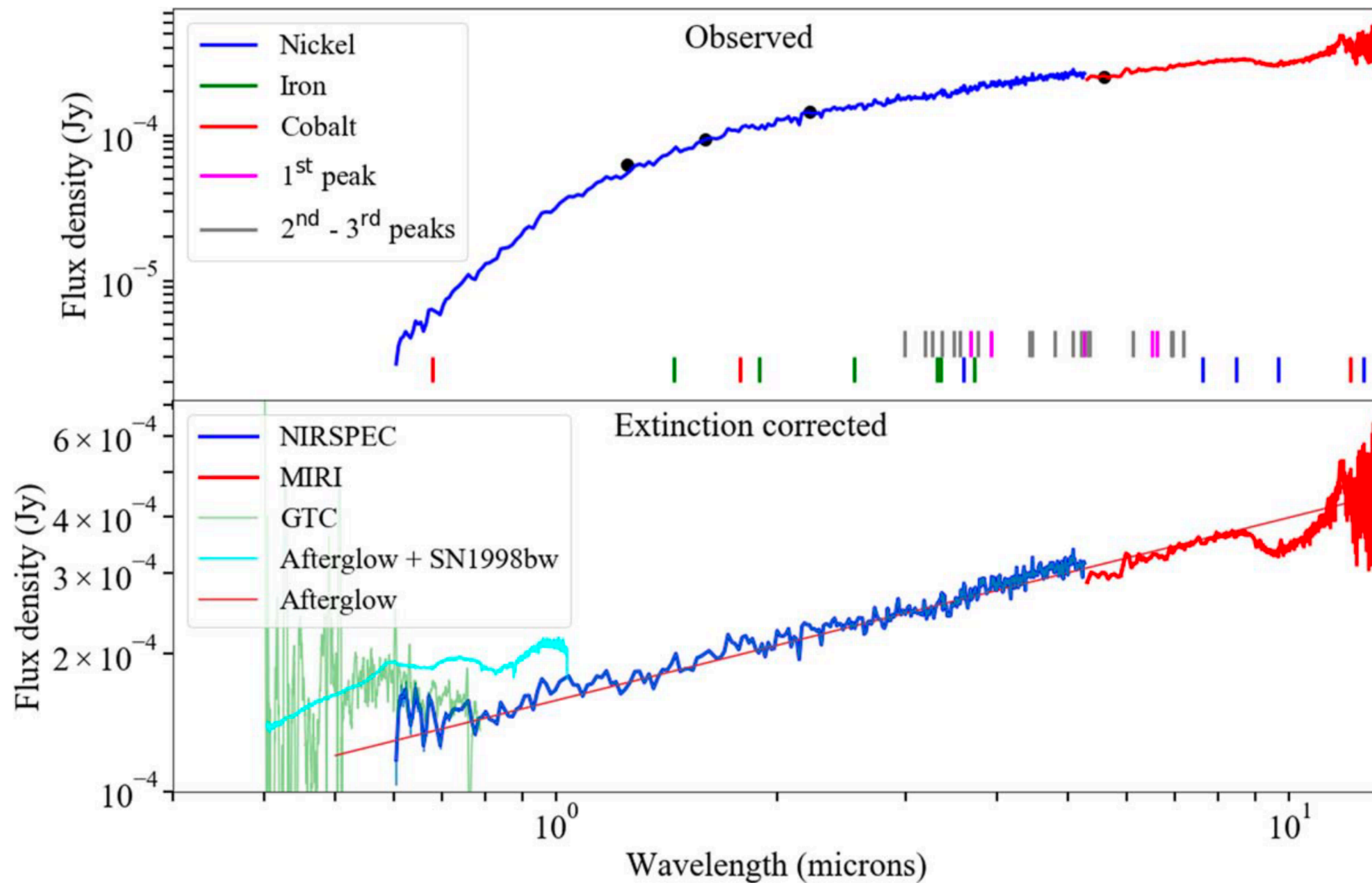
No clear broad features

Low SNR

One epoch at expected peak of SN



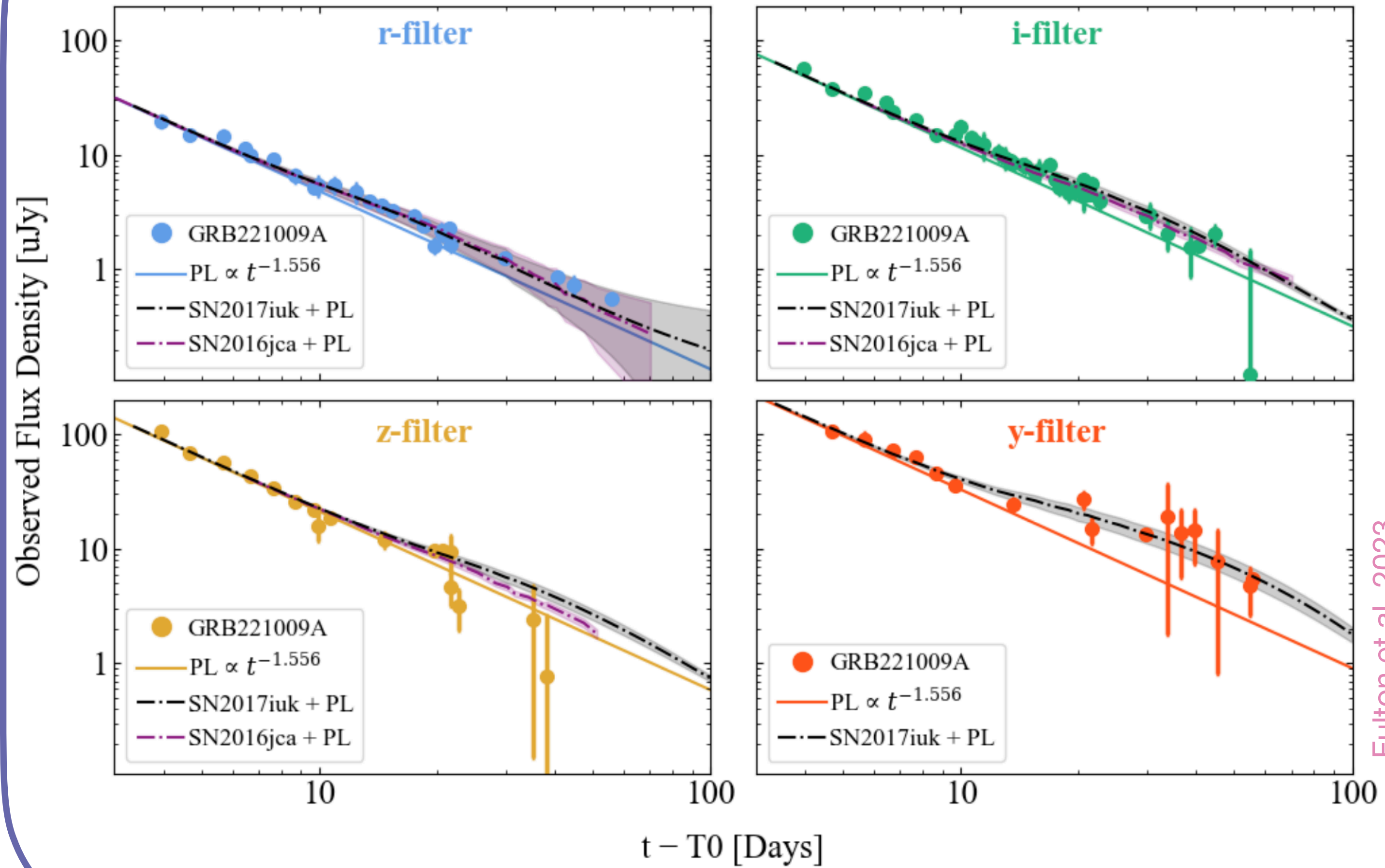
# GRB 221009A: no clear SN in JWST





# GRB 221009A: SN detected?

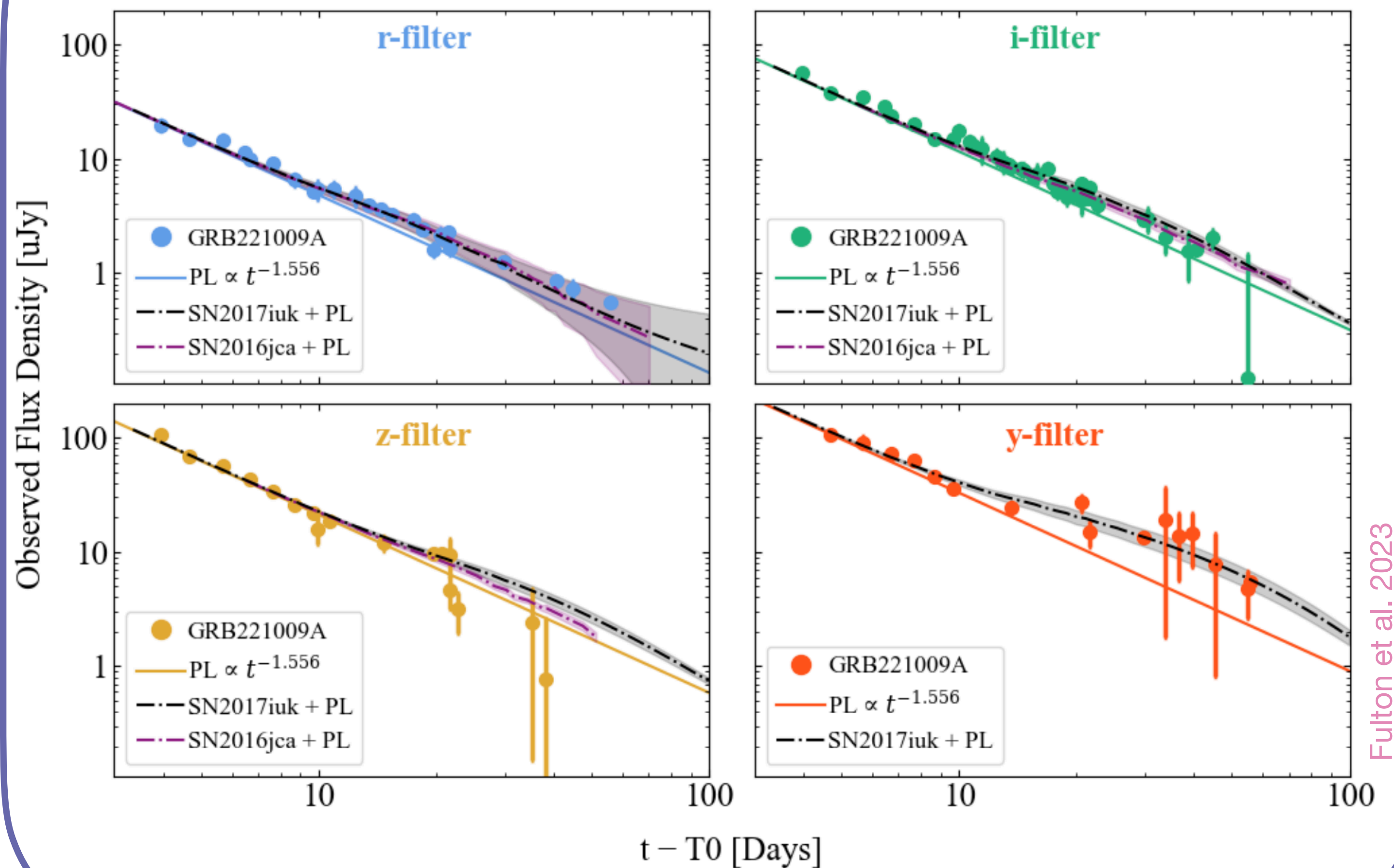
## Pan-STARRS LC with a bump



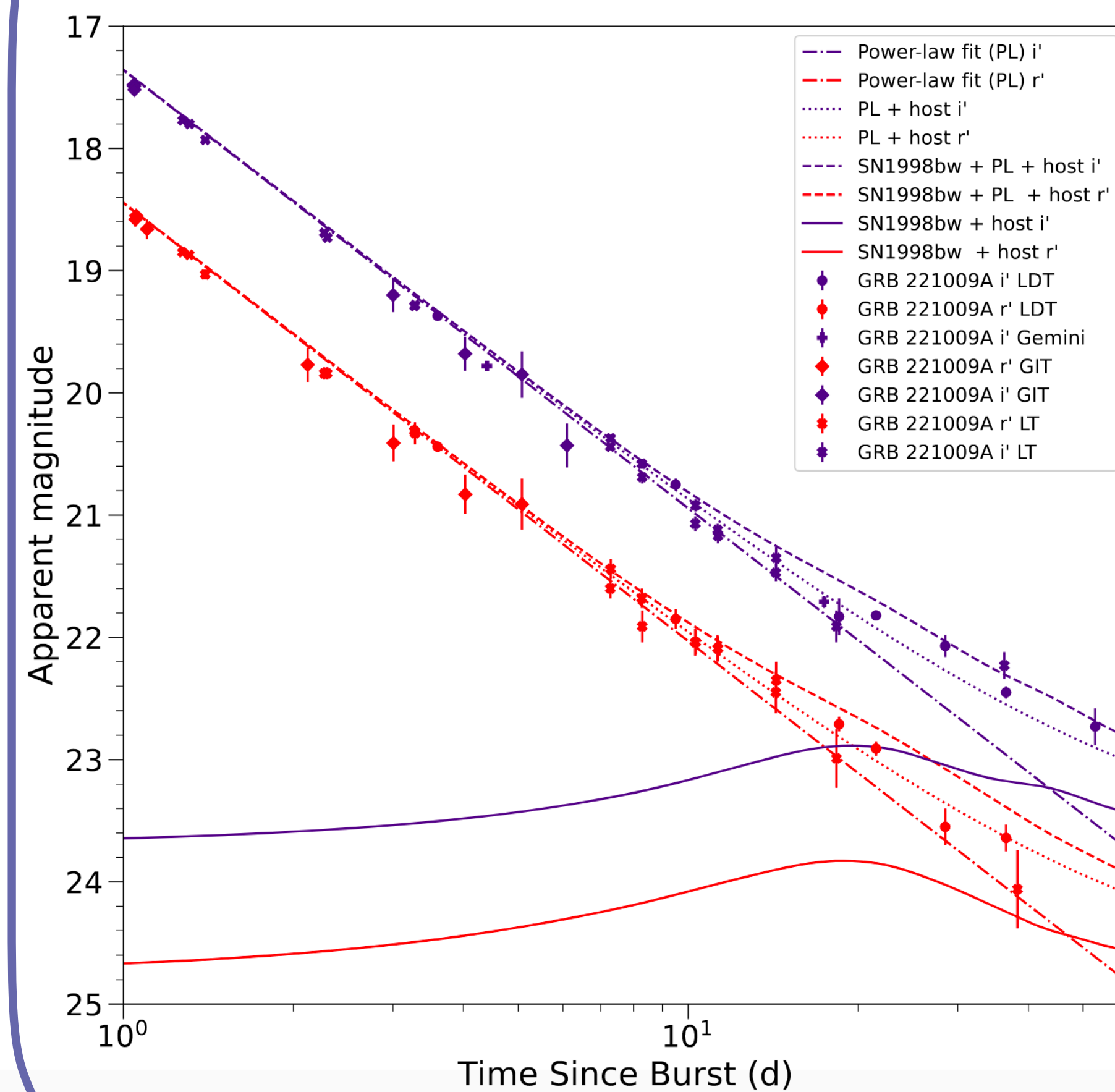
Fulton et al. 2023

# GRB 221009A: SN detected?

## Pan-STARRS LC with a bump



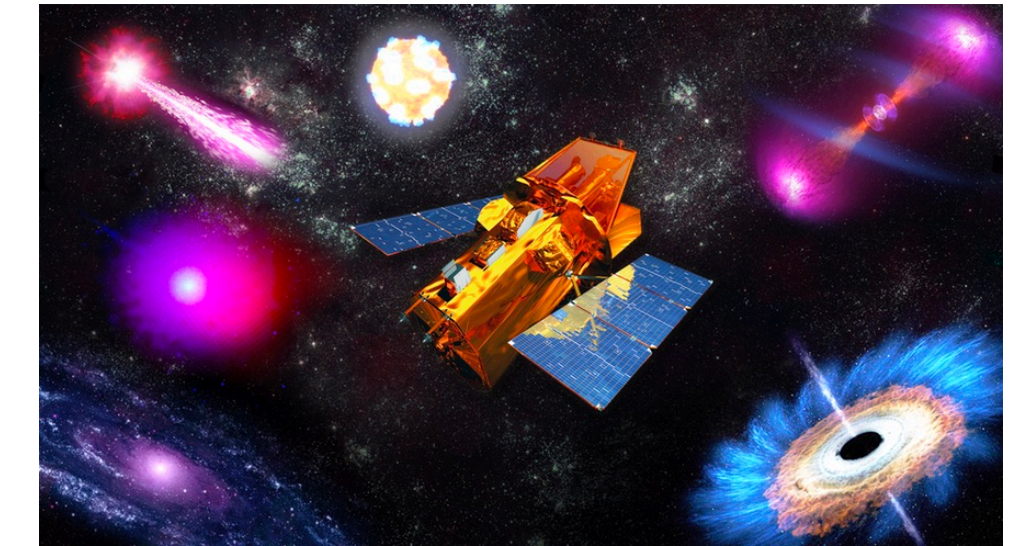
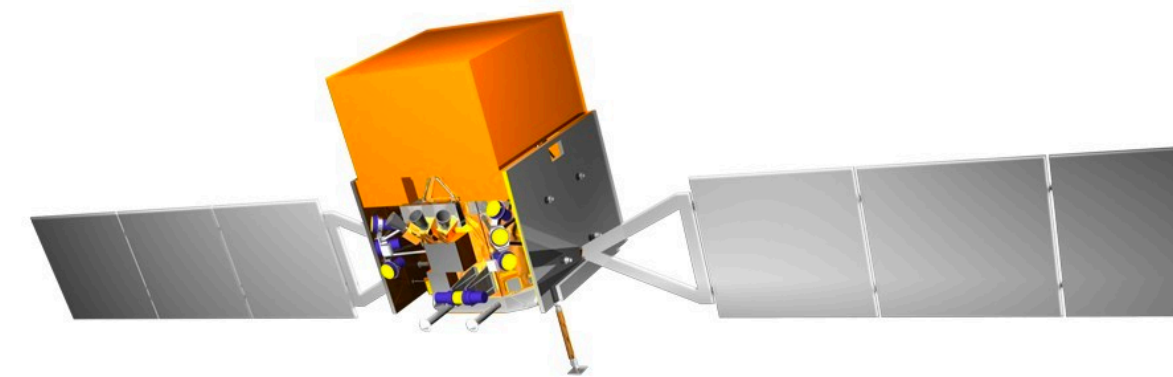
## Bayesian model for SN



# GRB progenitors: looking forward

- Larger sample size
- Collaborative co-ordinated follow-up
- GRB mission + JWST/HST

## GRB search



## GRB follow-up

