

# GRB host dust extinction: How to deredden data ?

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# What is an extinguished GRB afterglow (X-UV-VIS-NIR) ?

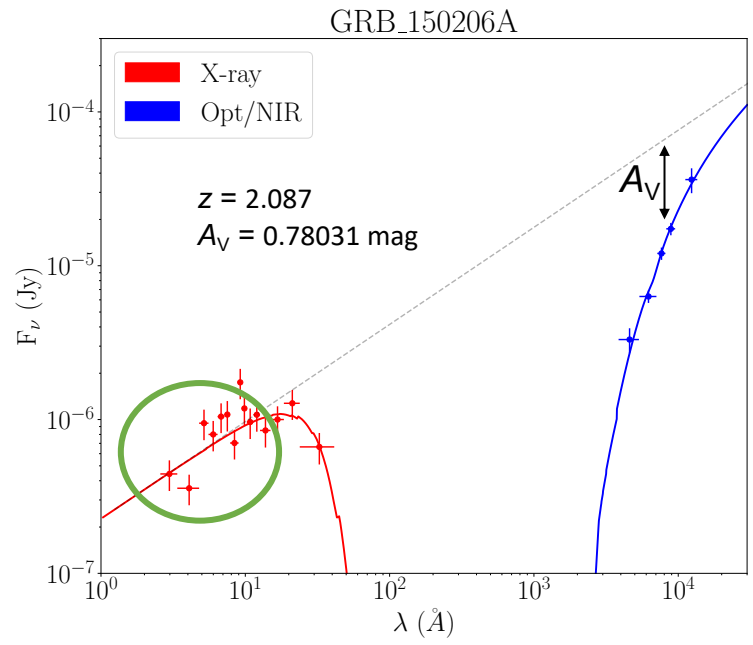
$$F_\nu^{\text{obs}} = F_\nu \times 10^{-0.4 A_\lambda} \times \exp[-N_{\text{H,X}}\sigma(\nu) - \tau_{\text{IGM}}(\nu)]$$

$$F_\nu = F_0 \begin{cases} \nu^{-\beta_0} & \nu \leq \nu_c \\ \nu_c^{\beta_x - \beta_0} \nu^{-\beta_x} & \nu > \nu_c \end{cases}$$

Intrinsic GRB afterglow

X-ray absorption in term of equivalent hydrogen column density

IGM attenuation



Wavelength dependent **extinction curve**:

Describe absorption or scattering from the dusty medium along the line of sight: **Galaxy + host**

## Problem of Galactic reddening

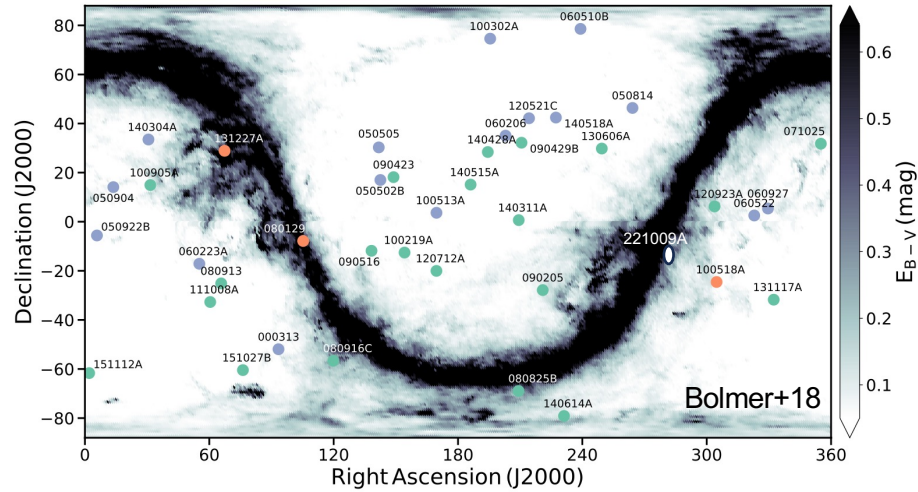
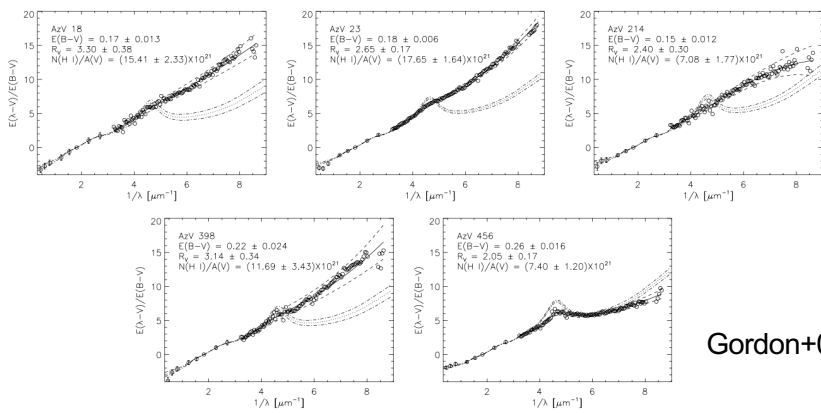
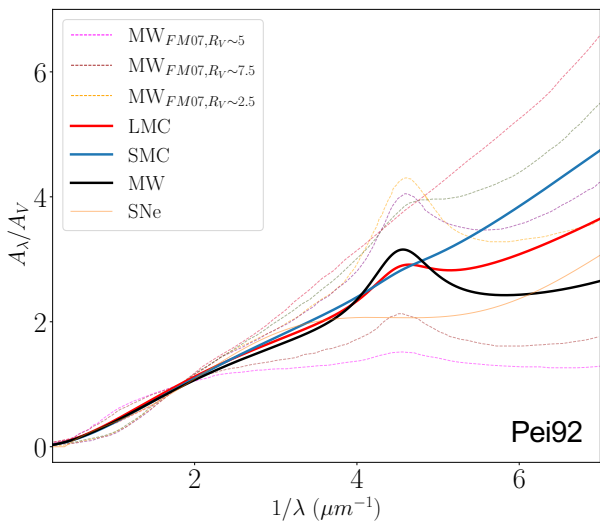
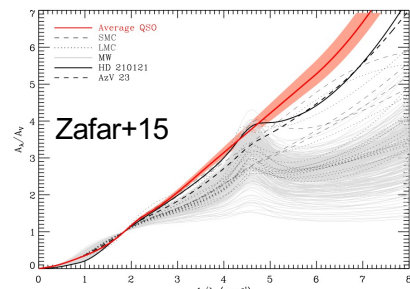
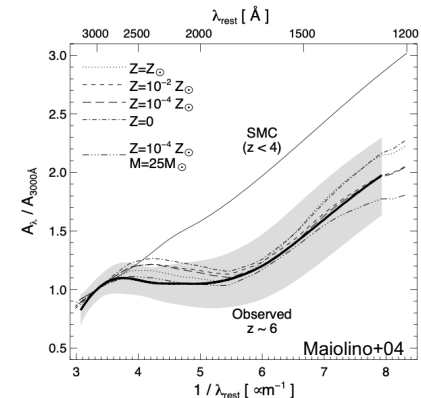


Fig. 4. All-sky map of the galactic dust reddening  $E_{B-V}$  as given by Schlafly & Finkbeiner (2011).

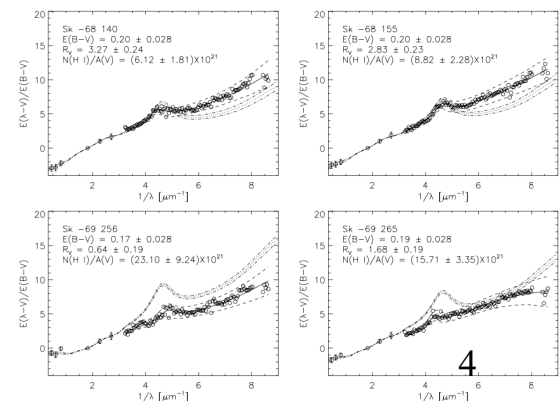
- Galactic plane is a problem
- Correct for the Galactic reddening with a standard method:
  - From the GRB position, we find the reddening  $E(B-V)$  (SFD (1998), SFD (2011), Planck+14...)
  - Deredden using an average extinction curve for the MW (Cardelli+89, Pei92, ...)

# Parametrizations of the extinction curve in the host

- Diversity of extinction curves in the Universe: in the Local Group, distant quasar, GRB host galaxies
- SED fitting of the afterglow considering the type and quality of data:
  - Photometric data = Average SMC, MW, LMC curves are the most used
  - Spectroscopic, multiband photo = FM86-kind (90, 99) extinction is the most flexible (spectroscopic data)

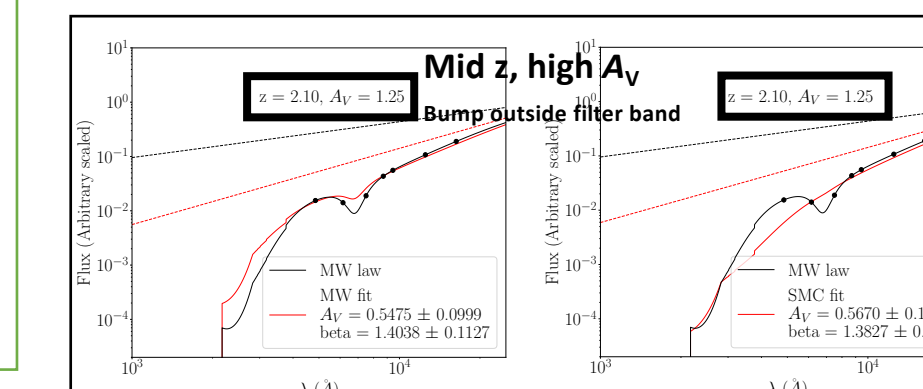
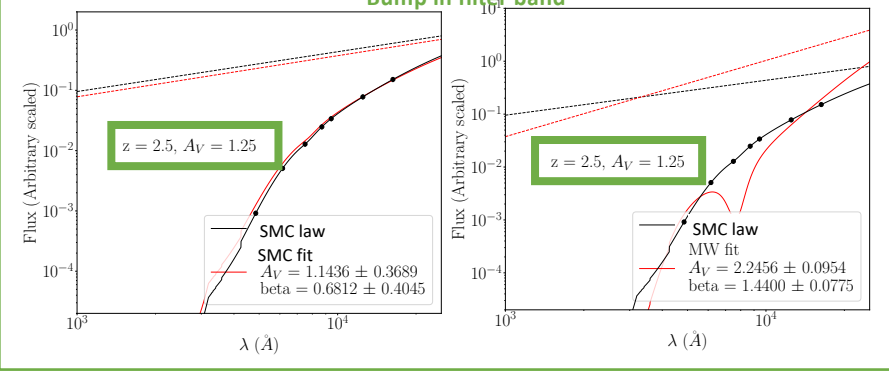
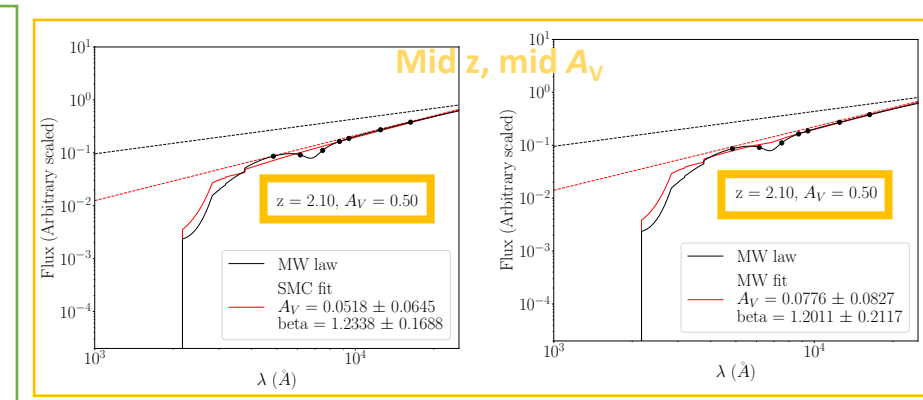
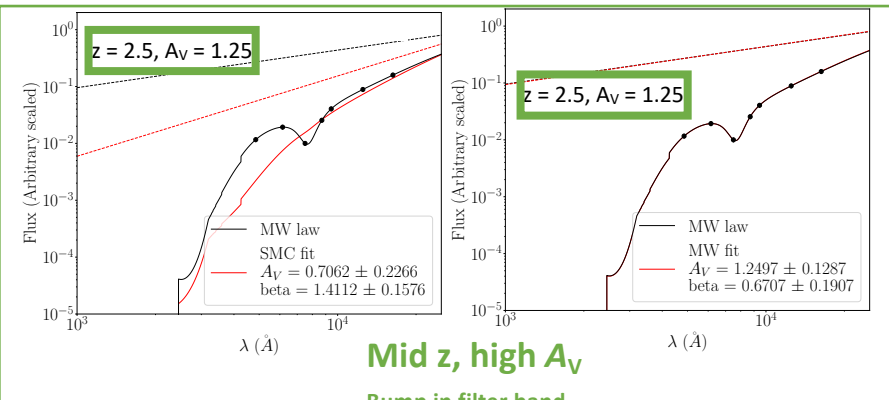
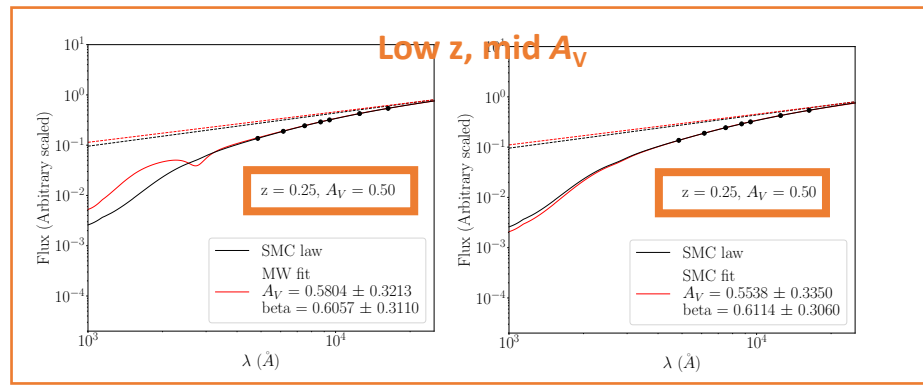
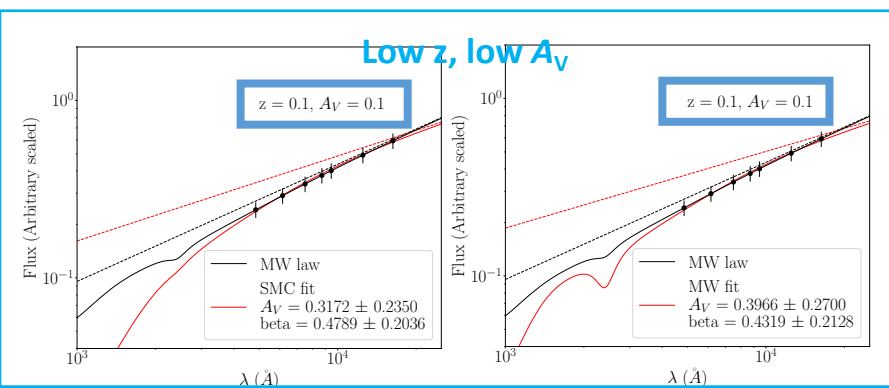


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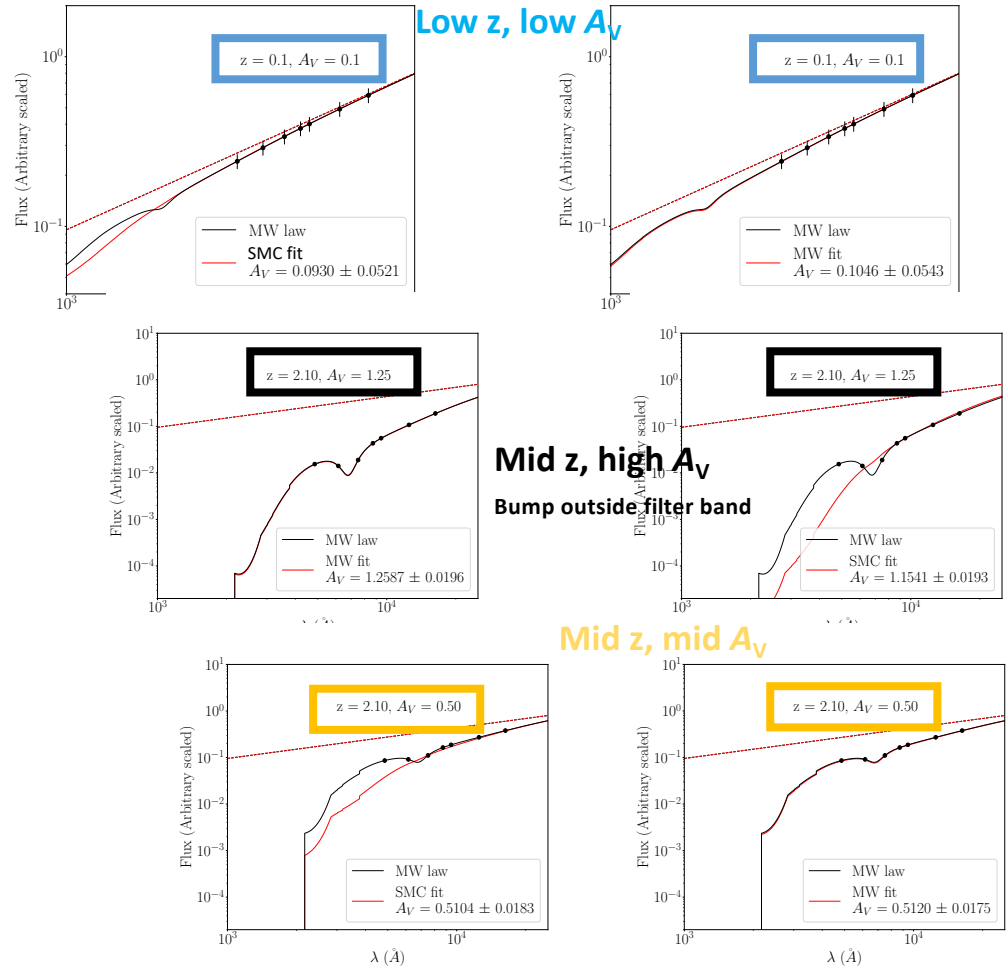


## Estimation of $A_V$ and extinction curve

- Impact on the estimation of  $A_V$  using one extinction curve or another
- Some idealized simulations and fits of GRB afterglows in the COLIBRI *grizyJH* band filters under different cases of  $z$  and  $A_V$

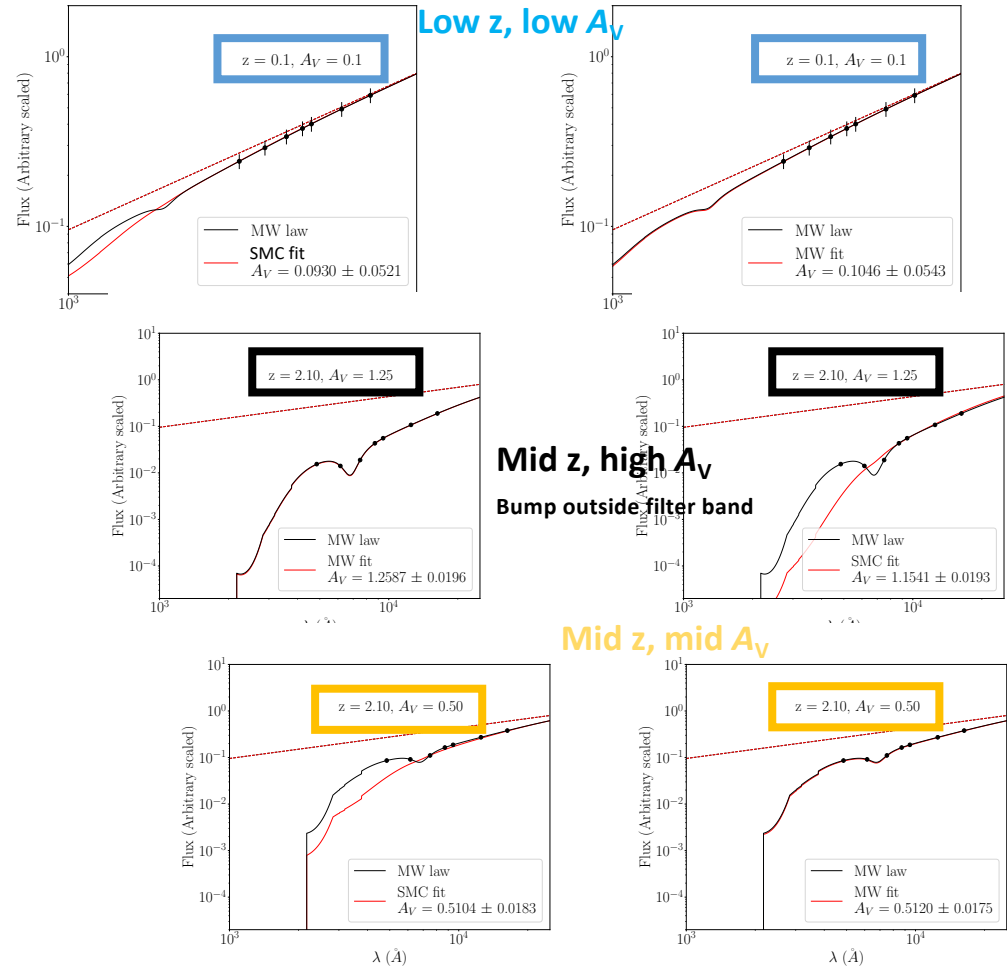


# WITH X SPECTRAL SLOPE



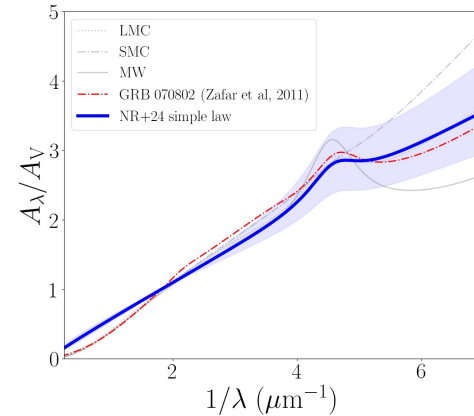
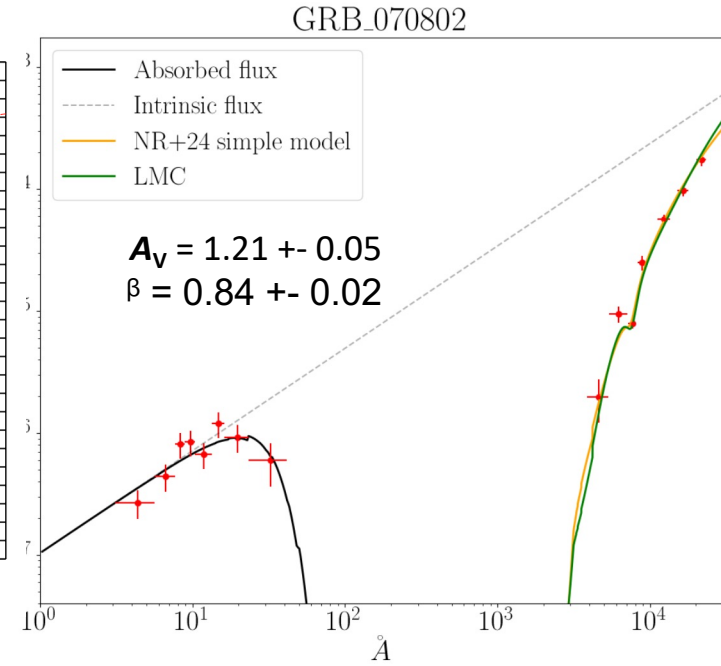
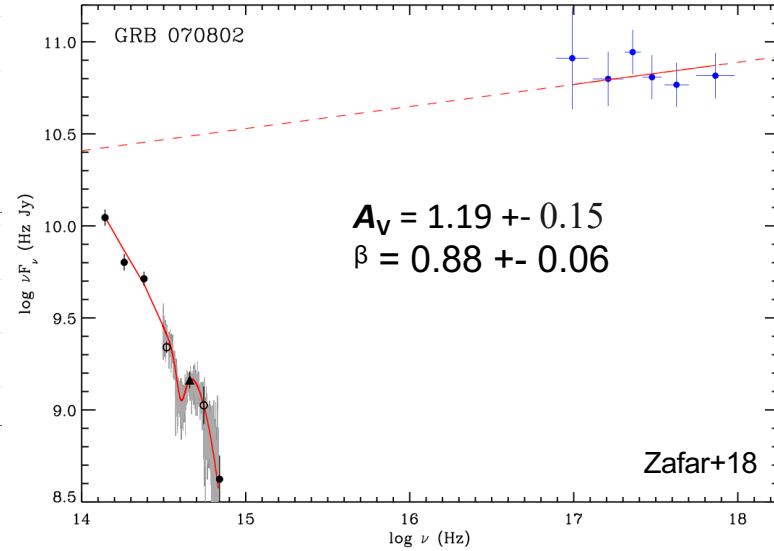
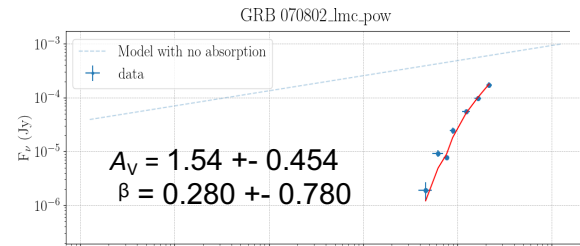
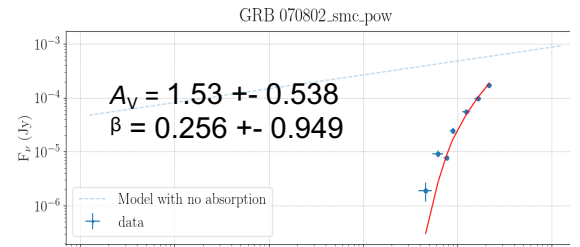
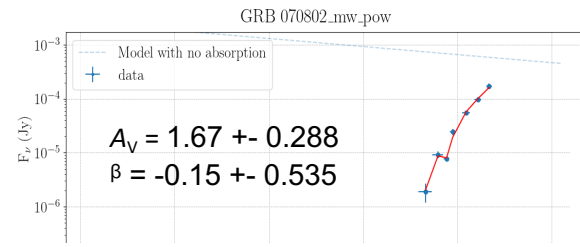
# WITH X SPECTRAL SLOPE

- No extinction = No extinction curve to characterize
- At low  $z$ , we cannot differentiate the extinction curves
- Better estimation of  $A_V$  using only optical data at higher extinction
- X-ray data is primordial !





# One case example w/ and w/o X-ray: GRB 070802



## Summary

- More accurate extinction curve = Better estimation of  $A_V$



- Having a substantial  $A_V$  = Differentiation of the extinction curves

- **Photometric data** (fixed curves) vs spectroscopic data (flexible curves)

- One solution is to have an extinction curve that can retrieve the different properties (N. A. Rakotondrainibe+2024, submitted)

- Having X-ray data = Anchor point in the afterglow

- **With all these informations we can now deredden our data !**

$$F_{\nu}^{\text{dereddened}} = F_{\nu}^{\text{obs}} \times 10^{0.4 A_{\lambda}}$$

## Open questions

- ***photo-z*** determination gives an estimation of  $A_V$  and the best extinction curve  
**impact on  $z$  estimation also**
- For our case, it is a post-processing step: data-process-result  
Does it need to be instantaneous in the pipeline ?
- Case per case study as each GRB is different