Investigating Dust Properties of (Long) GRB Host Galaxies

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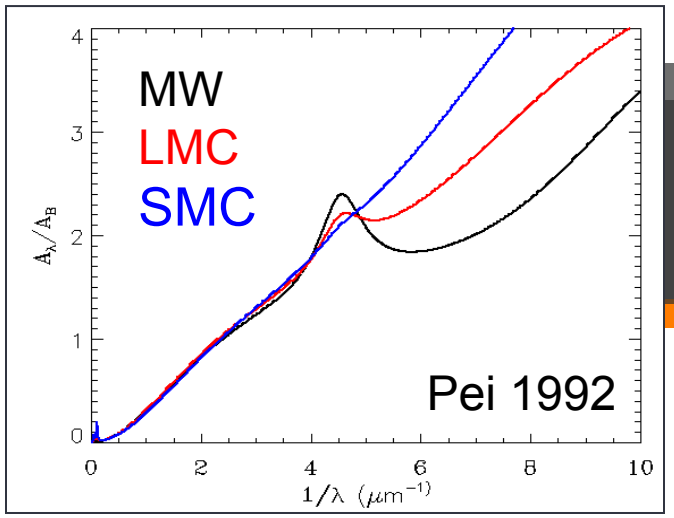


Dust Models

- Fitzpatrick & Massa (1986, 1988, 1990) Lorentzian + power law
- Pei (1992) MW, LMC, SMC templates
- Calzetti (1994) starburst galaxy template
- Li (2008) the Drude model

Graphite and Silicate Model

- Based on dust models of Draine & Lee (1984, 1985)

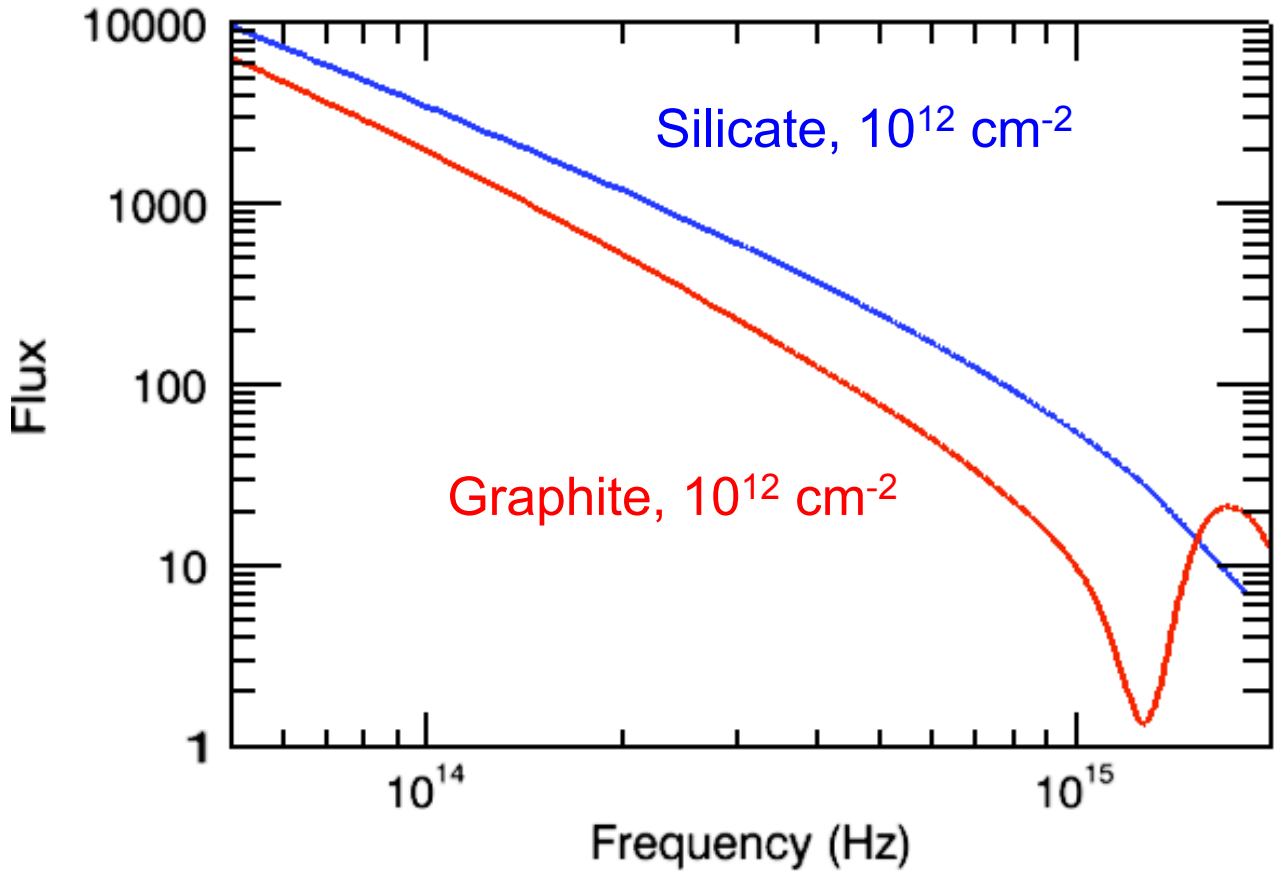
$$\tau_\lambda = \int_{a-}^{a+} \pi\, a^2\, C\, \Sigma_d \left(\frac{a}{a_0}\right)^{-3.5} Q_{ext}\, da$$

- Assumes spherical particles, MRN size distribution, dust temperature of 20 K (Pei 1992)

$$F_\lambda = F_0\, \nu^{-\beta}\, e^{-(\xi_s \Sigma_s + \xi_g \Sigma_g)}$$

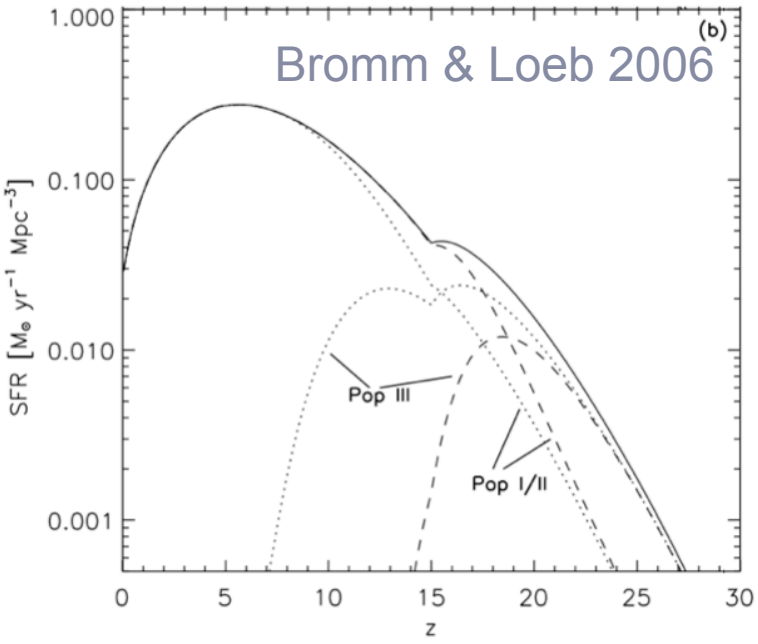
$$\xi_d = \tau_\lambda / \Sigma_d$$

Extinction Curves

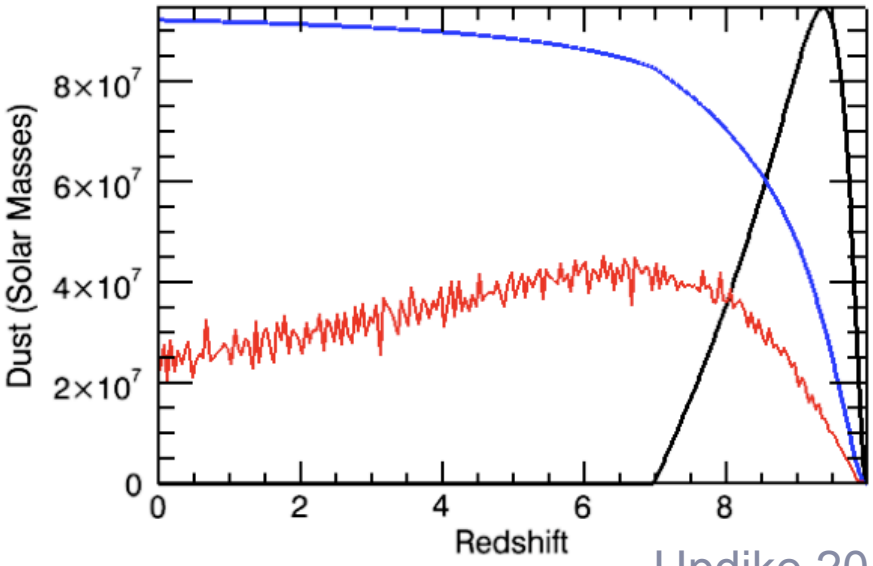


Dust Formation

- 9+ $M_\odot$: Core-collapse supernovae (Cherchneff & Dwek 2009, 2010) form silicates
- 0.1 – 9 $M_\odot$: Asymptotic Giant Branch stars (Karakas 2010) form carbon



Pop III Silicates, Pop I/II Silicates, Pop I/II Carbon

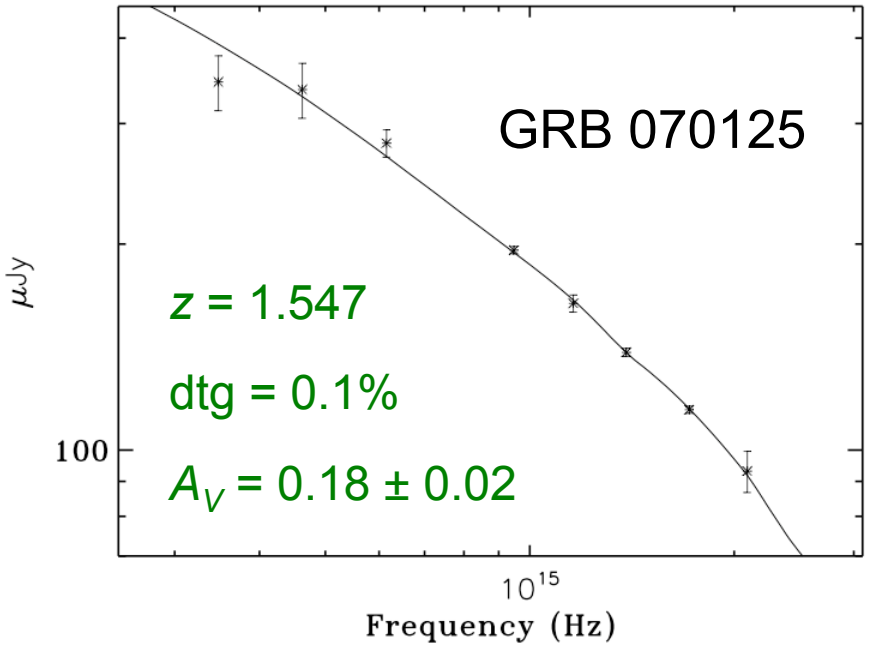


Updike 2010

GRB SED Data

- Photometric SEDs, data from the literature with established redshifts
- Data from the literature compiled using the methods of Zeh et al. 2006 and Kann et al. 2006 to construct broad-band afterglows at one day after the trigger assuming no achromaticity
- 82 GRBs total, 77 with good reduced χ^2
- 5+ SED data points red of Lyman alpha

A Few Results of our Fit



z = 1.547

dtg = 0.1%

A_V = 0.18 ± 0.02

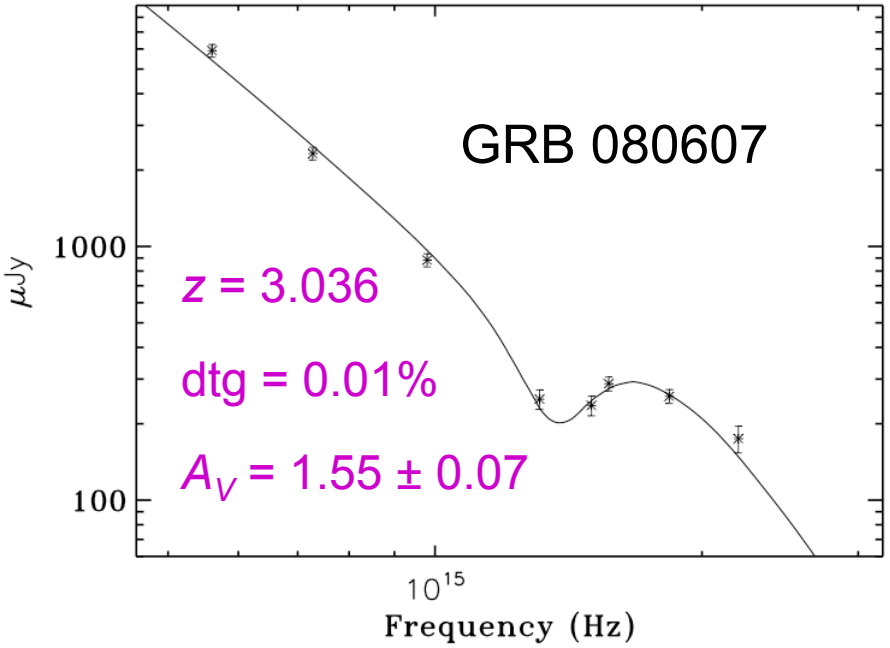
Σ_G = 1.03 (± 0.47) × 10^{10} cm^{-2}

Σ_S = 1.67 (± 0.08) × 10^{11} cm^{-2} data from Updike et al. 2008

Σ_G = 3.23 (± 0.18) × 10^{11} cm^{-2}

Σ_S = 8.11 (± 0.23) × 10^{11} cm^{-2}

data from Perley et al. (accepted)

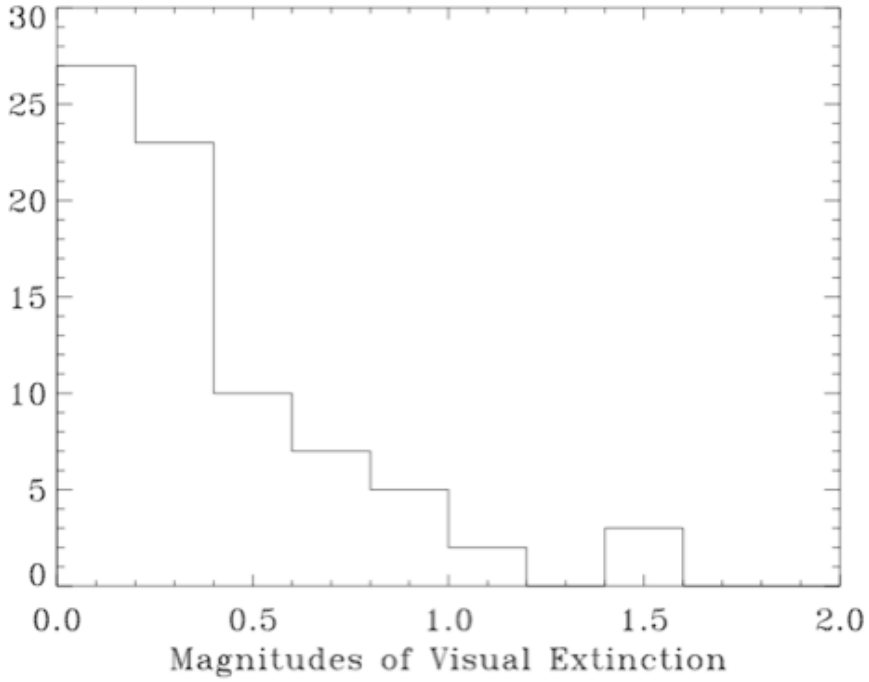


z = 3.036

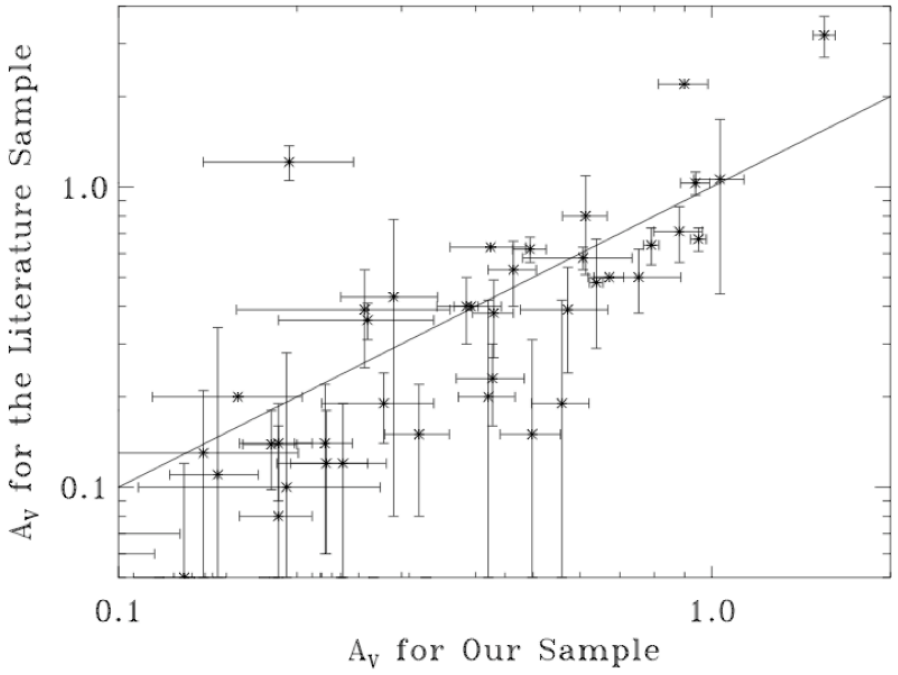
dtg = 0.01%

A_V = 1.55 ± 0.07

A_V Distribution in Our Data Set

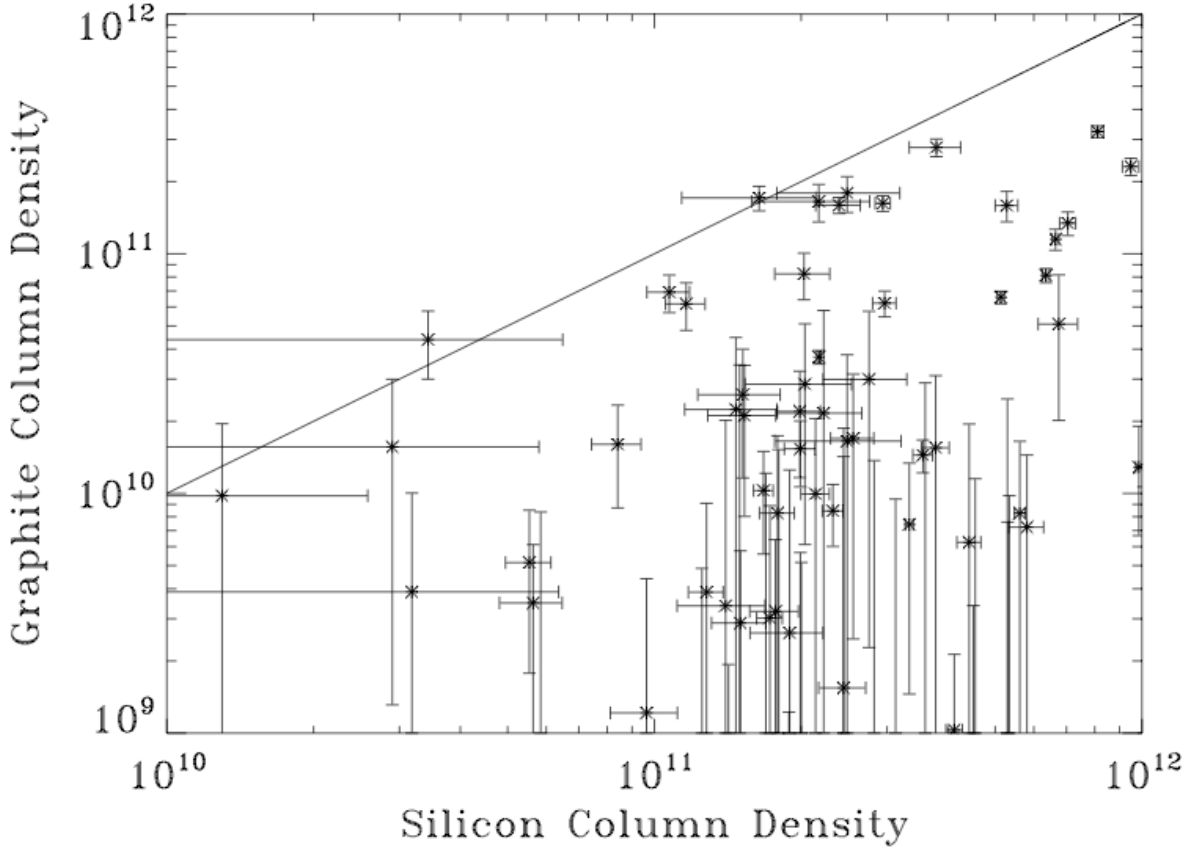


A_V distribution in our data set

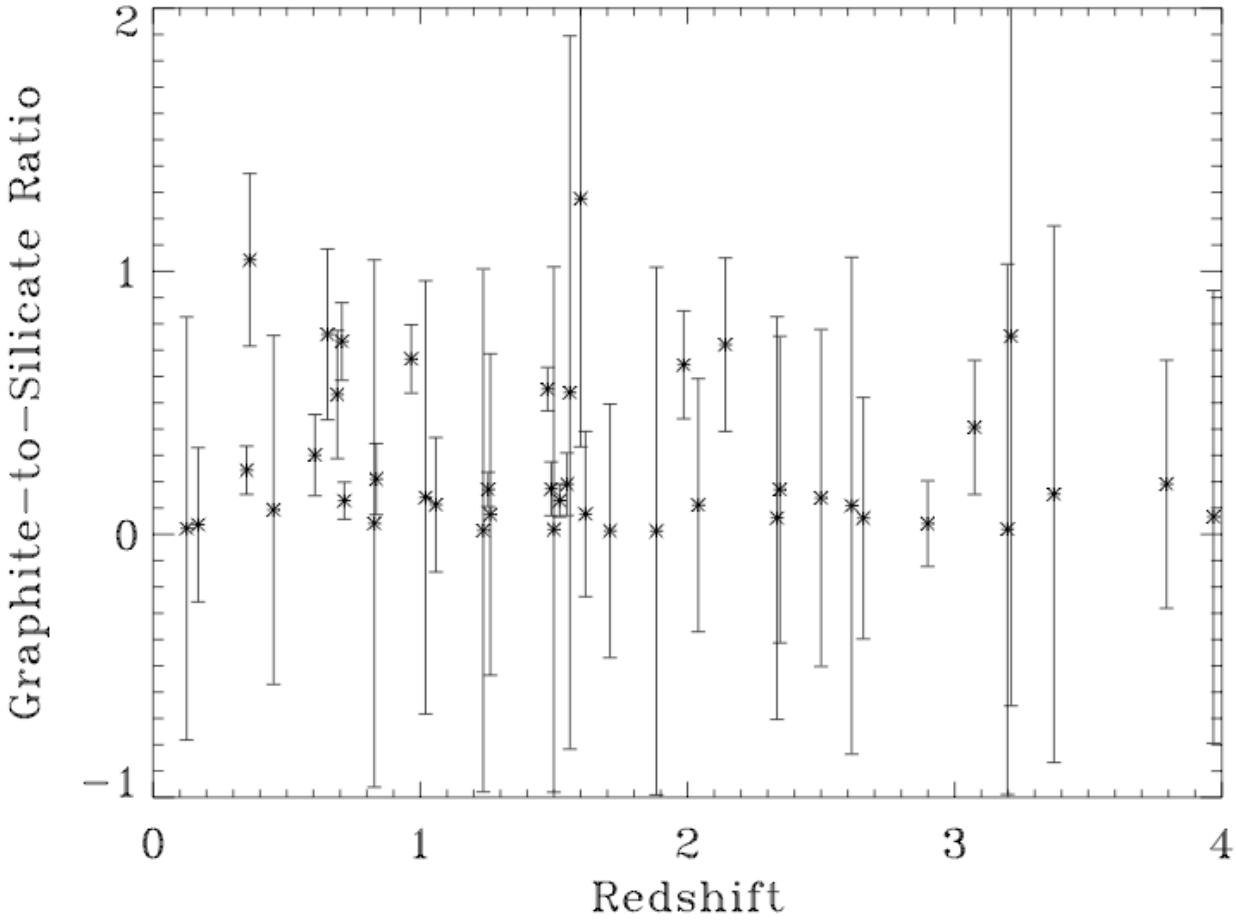


A_V distribution for our sample versus the same GRBs for which A_V values existed in the literature.

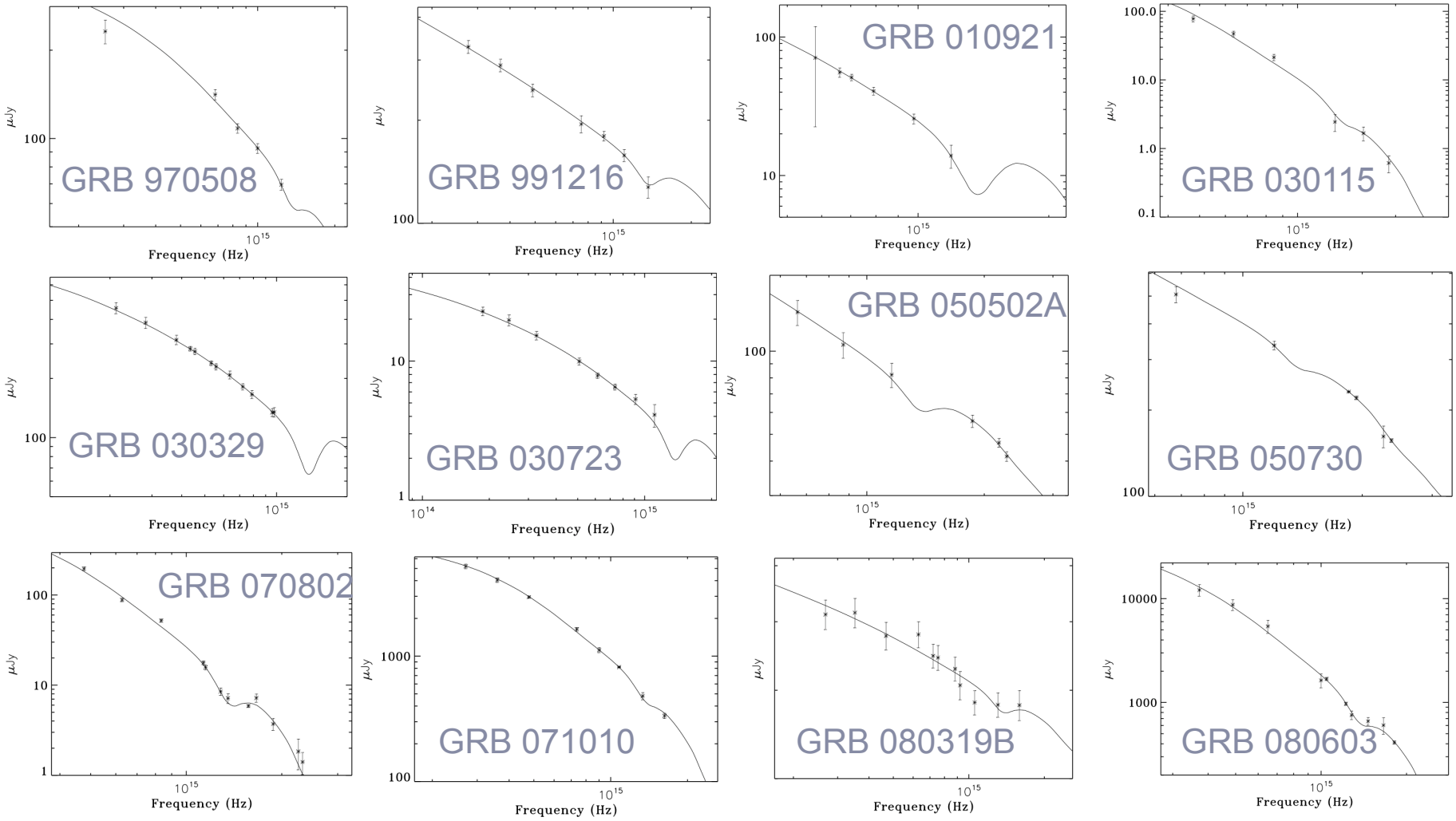
Graphite vs Silicate in GRB Host Galaxies



Graphite-to-Silicate in GRB Host Galaxies



Graphite Detections in 17 GRB Hosts



Conclusions

- Moving away from templates gives more information about the dust properties of the hosts
- Graphite and silicate model has four parameters with physical significance
- More silicate than graphite is found in all hosts
- 17 / 77 hosts show significant graphite column densities
- No evidence for evolution of graphite-to-silicate ratio between redshifts ~ 0 – 4.8