Is Spectral Width a Reliable Measure of GRB Emission Physics?

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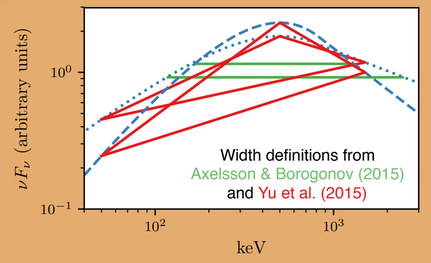
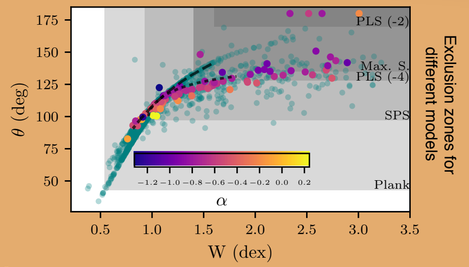
We often want to use *empirical* measures from fits of *empirical* functions to quickly assess the viability of emission mechanisms in GRBs: line-of-death, Ep clustering, and now, spectral width.

Problem



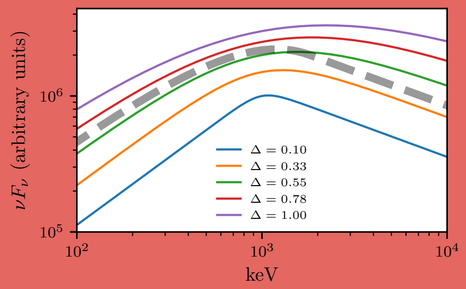


Axelsson & Borogonov (2015) and **Yu et al. (2015)** define measures for the spectral width which classify pre-Band function-fitted GRB spectra and compare these measured widths with physical emission mechanisms.

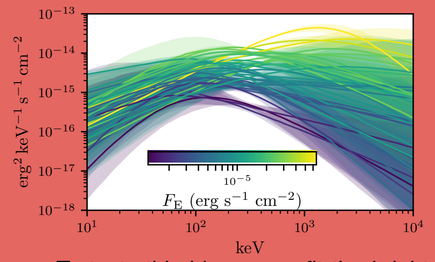
From these measures, they conclude **most GRB spectra are too narrow to be produced by synchrotron.**

Solution

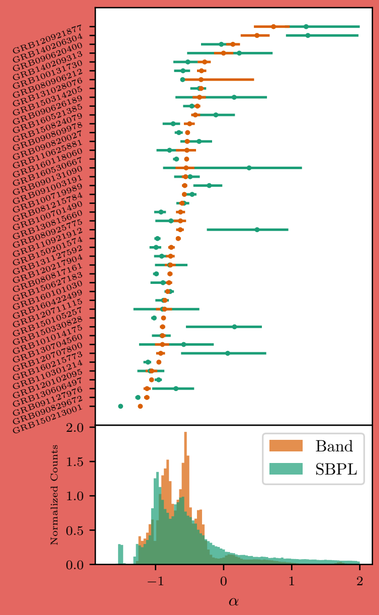
Spectral shape of a smoothly broken power law as a function of width

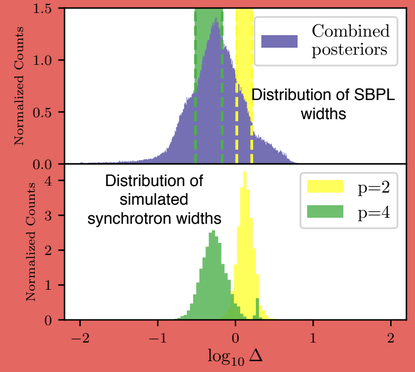


However, the width of the Band function is determined by its power law indices only. We could choose a broken power law with an adaptable width to fit for the width directly in the data.



To tests this idea, we refit the brightest peak flux spectra from the GBM spectral catalog with a smoothly broken power law (leaving the width parameter free) and the Band function via Bayesian posterior sampling. Bayesian model selection is applied and we find all but one GRB is better fit with the smoothly broken power law. Moreover, the spectra exhibit a variety of widths that would not be measured via the Band function!



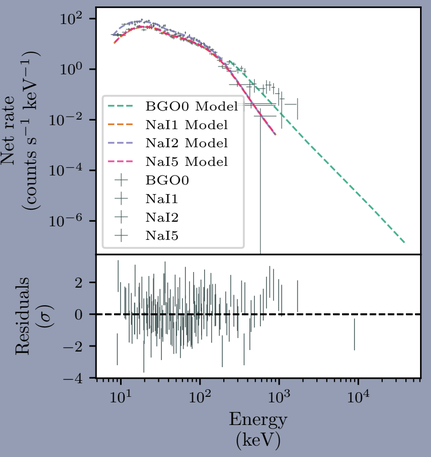


Even more interesting is that the directly measured widths are mostly consistent with synchrotron emission in contrast with the results from **Axelsson & Borogonov (2015)** and **Yu et al. (2015).**

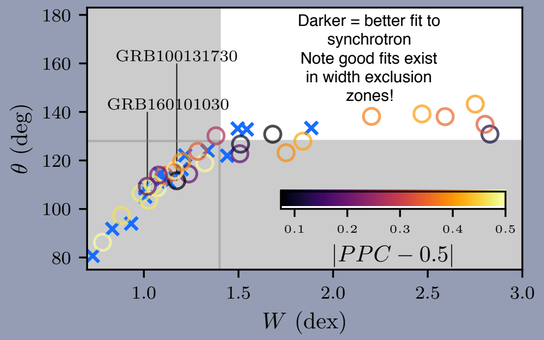
Results

With these results, it is pertinent to see if it is possible to fit GRB spectra with a synchrotron spectrum that were excluded as synchrotron via the width measures of **Axelsson & Borogonov (2015)** and **Yu et al. (2015).**

Synchrotron fitted count distribution for a GRB excluded via width measurement



Thus, Bayesian posterior sampling was performed on all the data with a simple power law electron synchrotron model. Using posterior predictive checks, the quality of the synchrotron fits were assessed and several of the spectra were fully consistent with synchrotron even though they would have previously been excluded.



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ABSTRACT

The spectral width and sharpness of unfolded, observed GRB spectra have been presented as a new tool to infer physical properties about GRB emission via spectral fitting of empirical models. Following the tradition of the 'line-of-death', the spectral width has been used to rule out synchrotron emission in a majority of GRBs. This claim is investigated via examination of both cataloged GRB spectra as well as reanalyzed spectra leading to the introduction of another empirical characterization of the spectra: the data width. This new auxiliary quantity is a direct measure of the folded data's width. Examination of the distribution of data widths suggests that a large fraction of GRBs can be consistent with synchrotron emission. To assess this prediction, a sample of peak-flux GRB spectra are fit with an idealized, physical synchrotron model. It is found that many spectra can be adequately fit by this model even when the width measures would reject it. Thus, the results advocate for fitting a physical model to be the sole tool for testing that model.

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