



# Observations of the Extraordinarily Bright, Long, Nearby GRB 130427A

**Judy Racusin  
(NASA/GSFC)**

**On behalf of the Fermi-LAT and  
Fermi-GBM Collaborations  
(especially Sylvia Zhu, Giacomo  
Vianello, Chuck Dermer, Jim  
Chiang, Nicola Omodei, Shaolin  
Xiong, Dan Kocevski)**

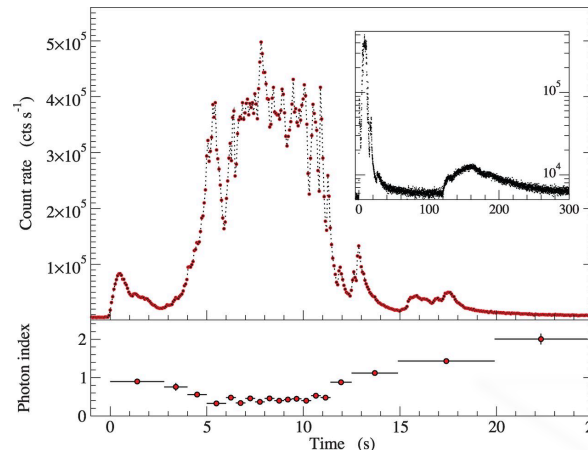


- **Bright!** - Highest GRB fluence ever recorded
- **LAT (>100 MeV) emission was extremely bright and long-lasting**
- **Relatively low redshift, but not subluminal**
- **Bright prompt optical flash and afterglow**
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- **Most Luminous SN-GRB association – SN2013cq**

Fine timescale (TTE)  
buffer filled-up +  
Photon pile-up

More on GBM  
Observations in Talk by  
Michael Burgess

## Swift-BAT

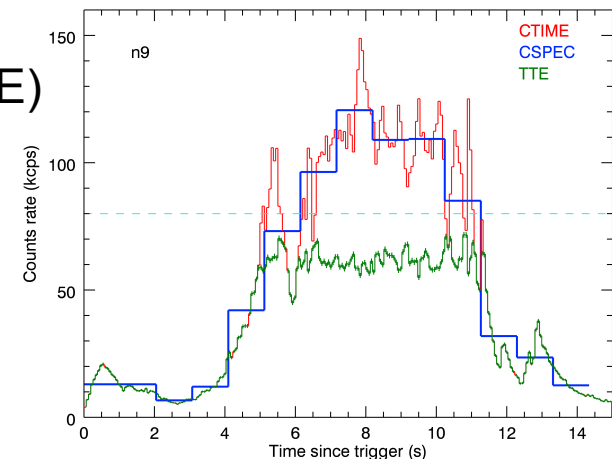


Maselli et al. 2013, Science

**Prompt  $\gamma$ -ray emission detected by:**

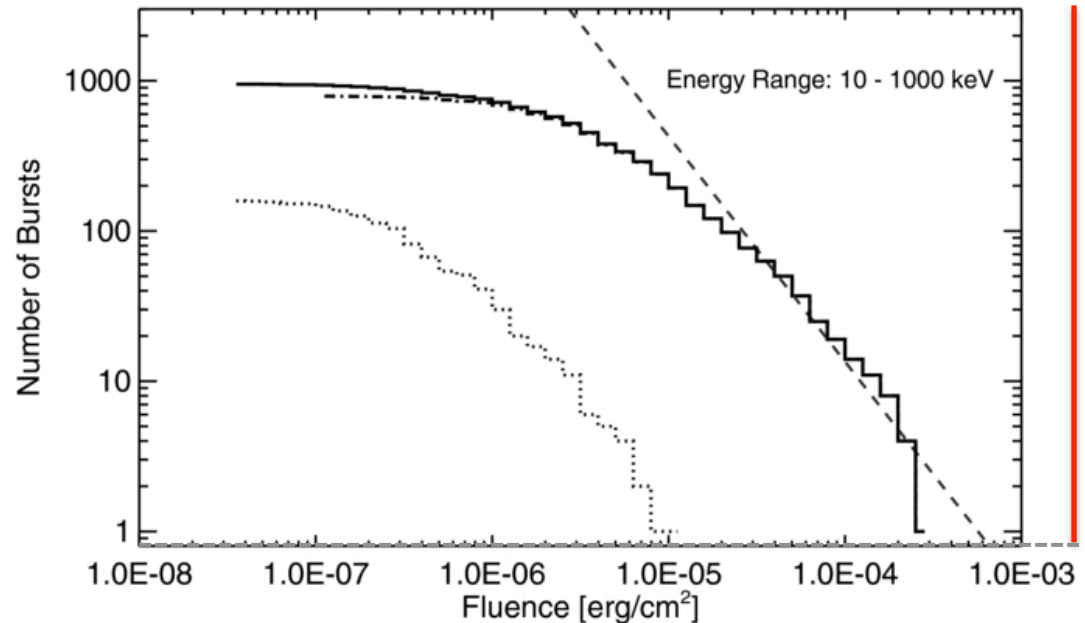
*Fermi*  
*Swift*  
Konus-Wind  
IPN  
RHESSI  
AGILE  
INTEGRAL  
MAXI

## Fermi-GBM





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GRB 4 Year Catalog  
von Kienlin et al. 2014

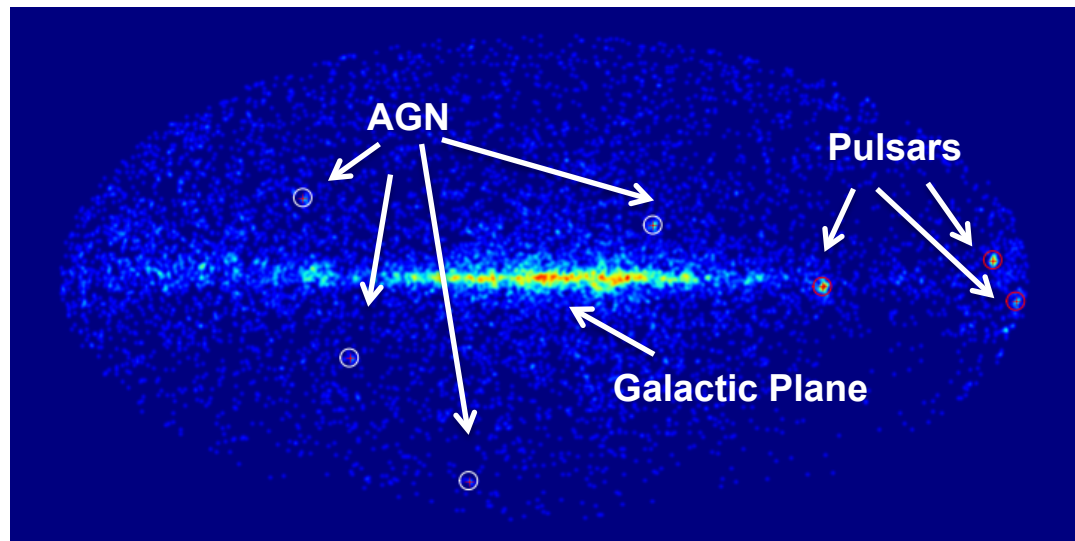
Only GBM fluence shown, but has also been compared to BATSE and other archives



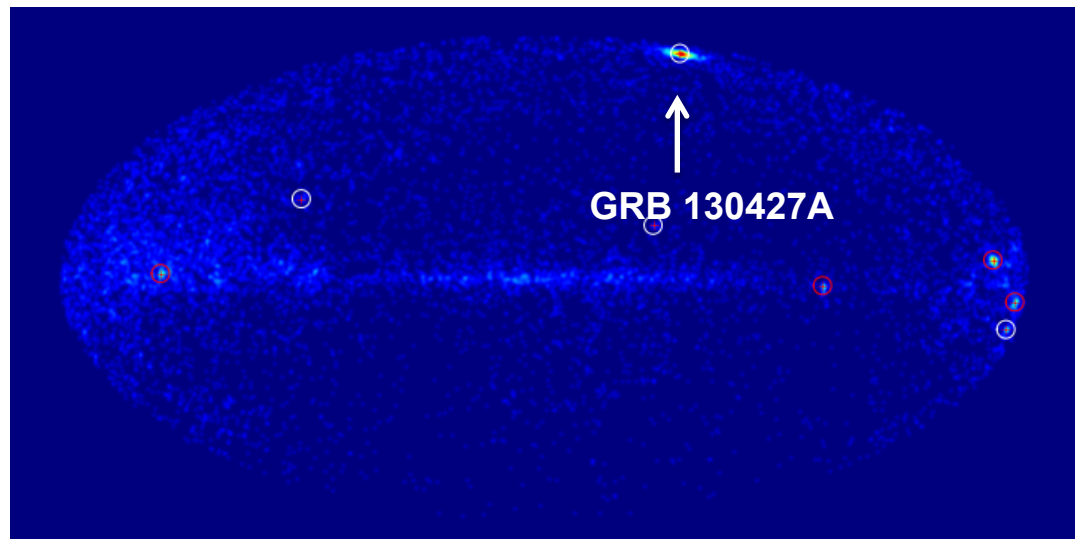
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Autonomous repoint led to burst centered exposure

6 hours before burst



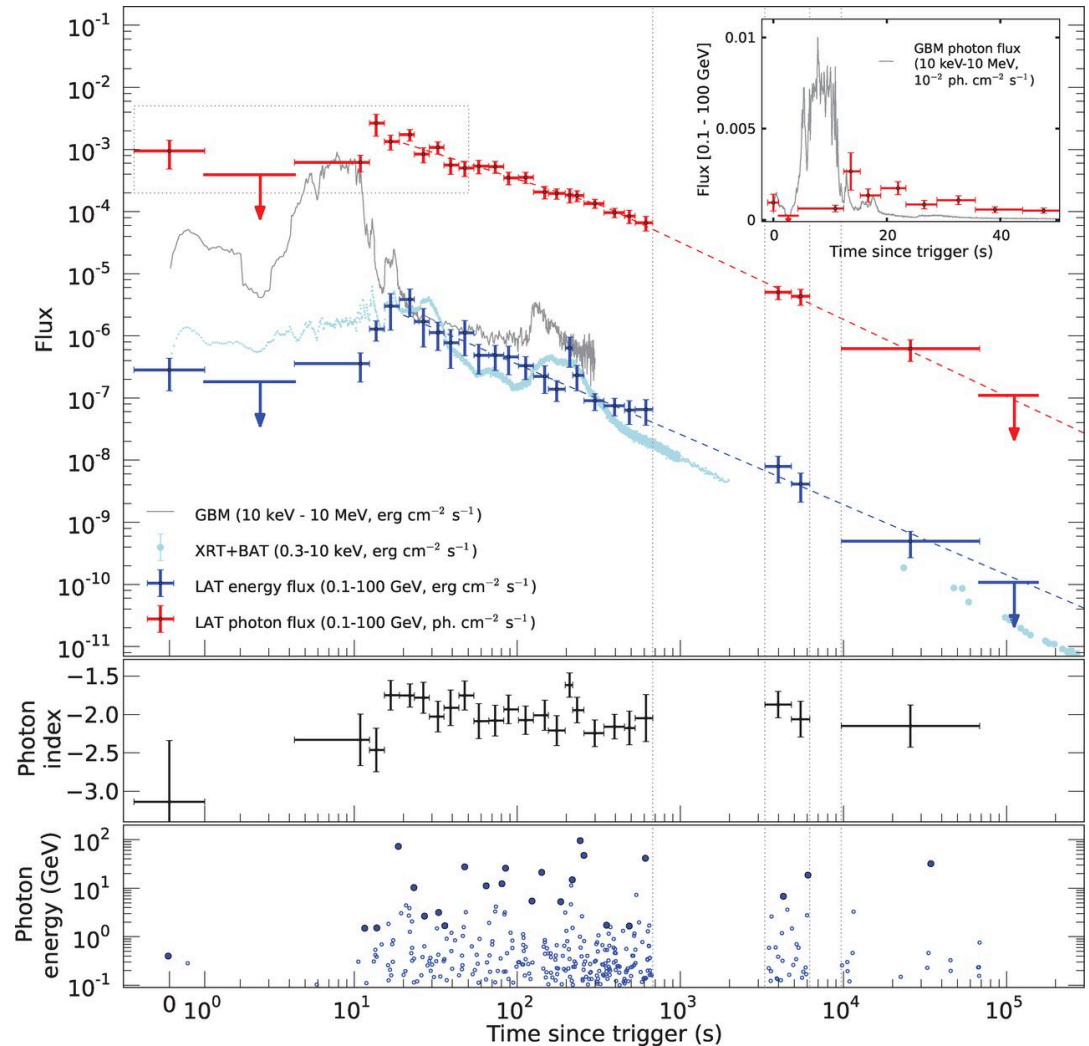
6 hours including burst



# Remarkable Features of GRB 130427A

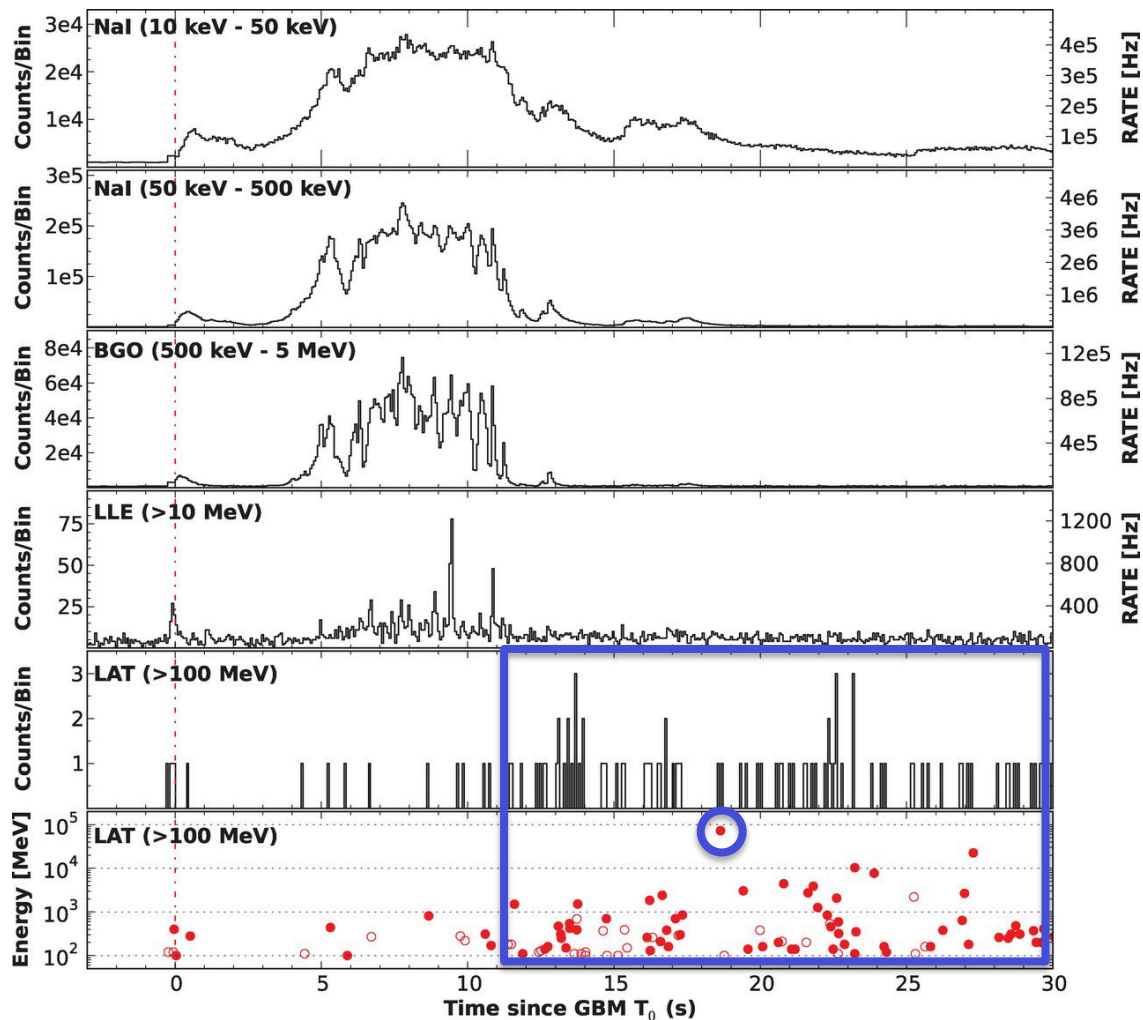


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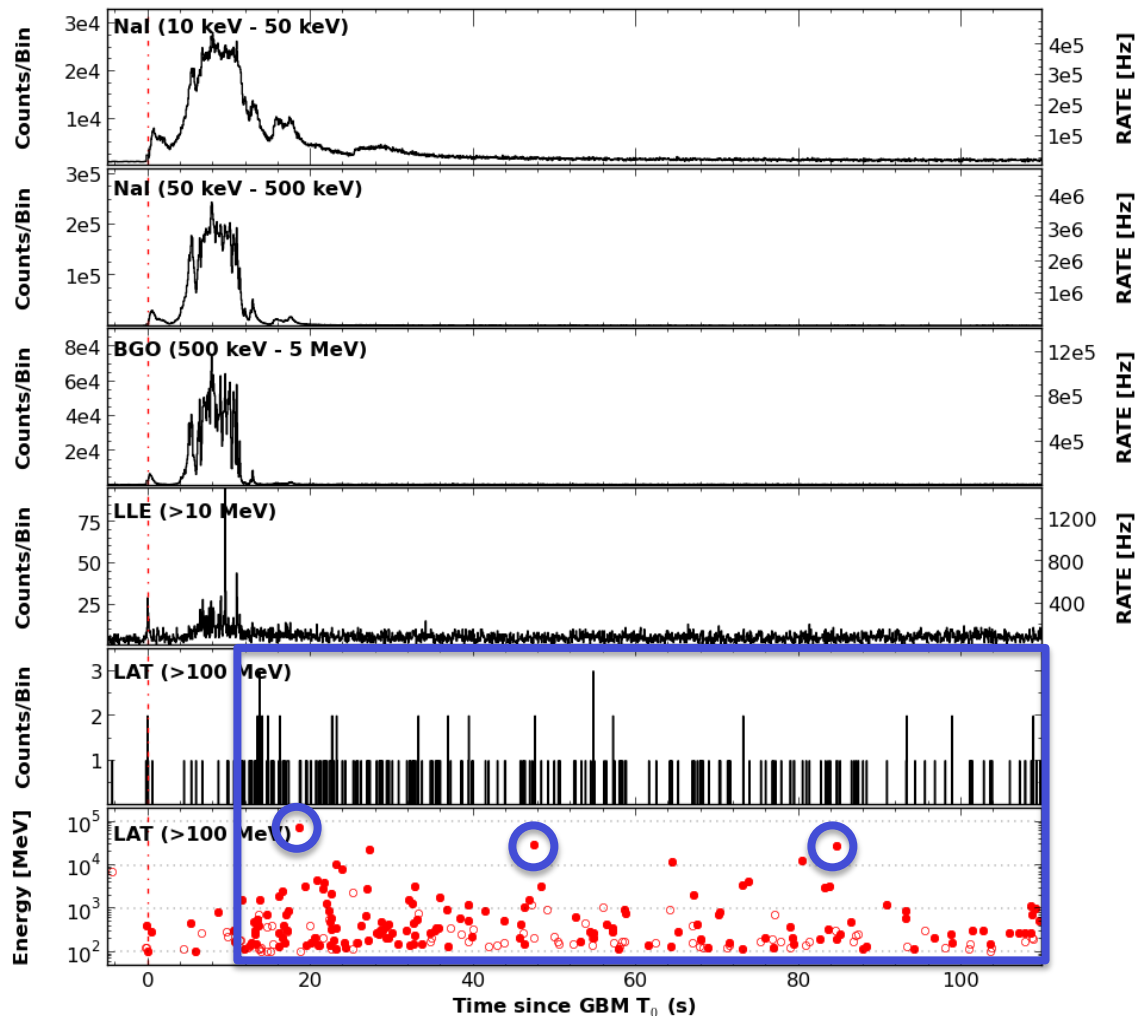


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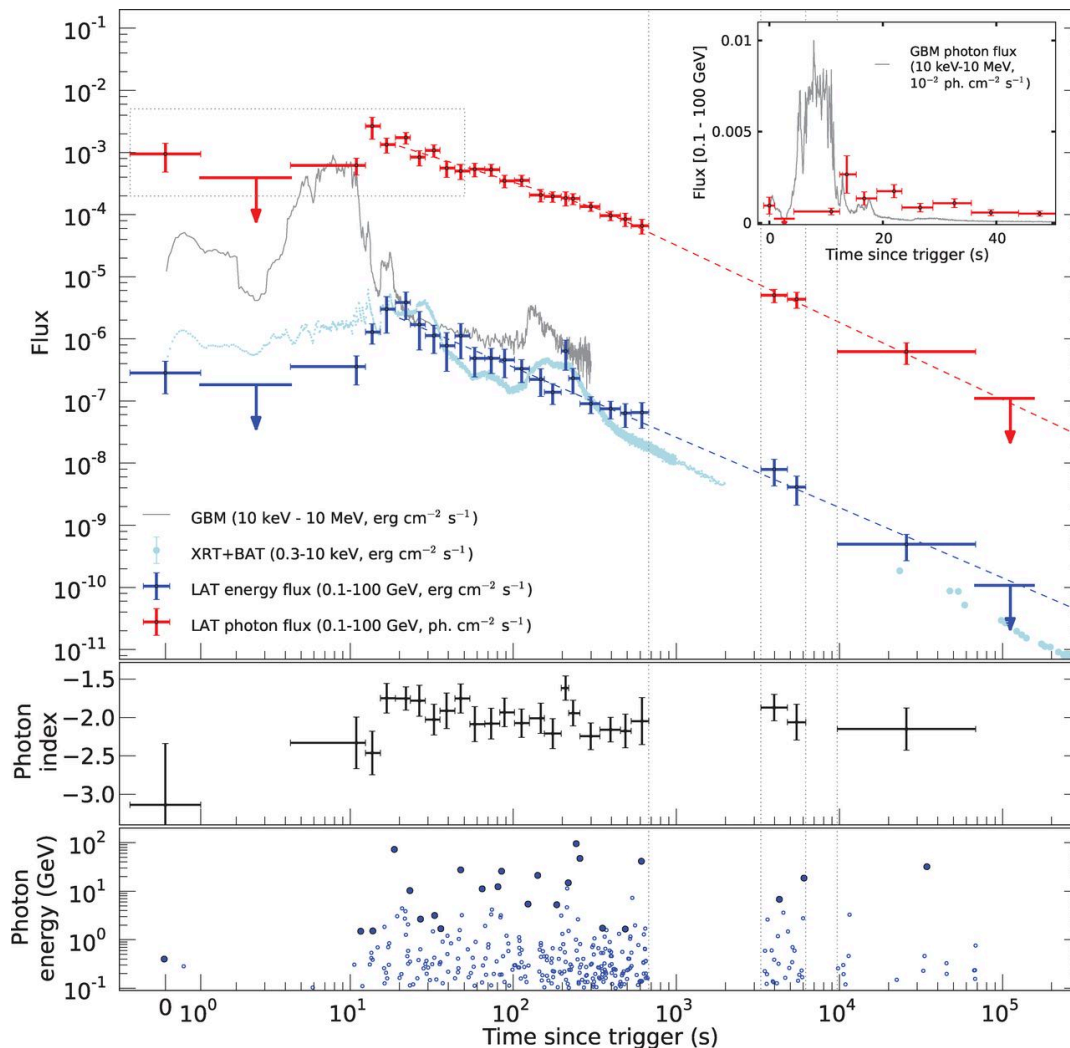


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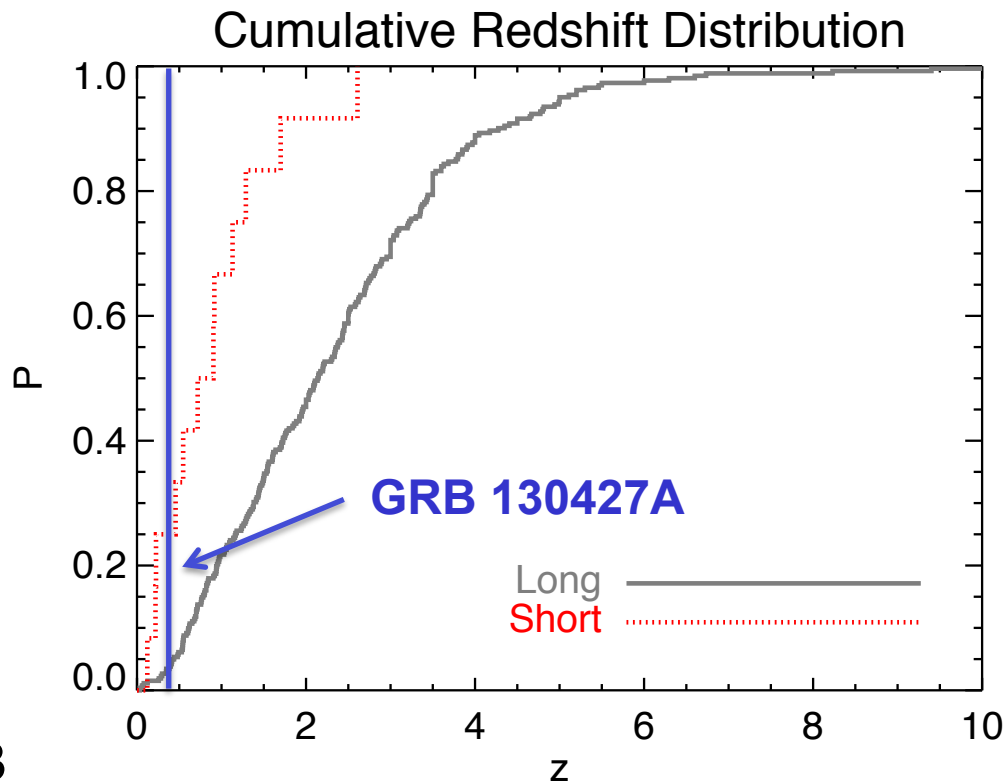
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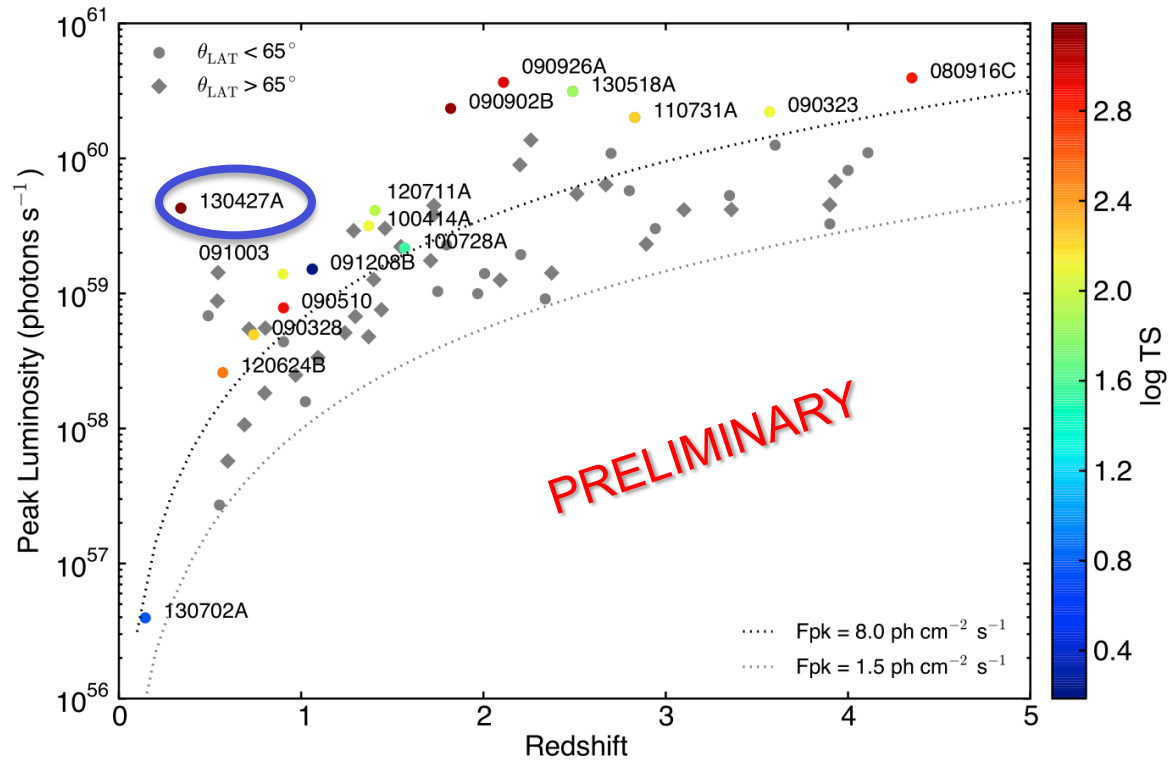


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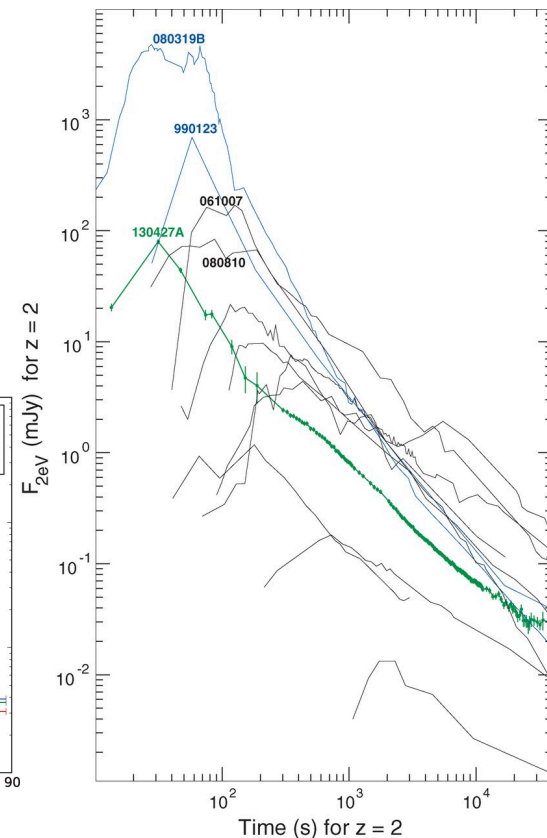
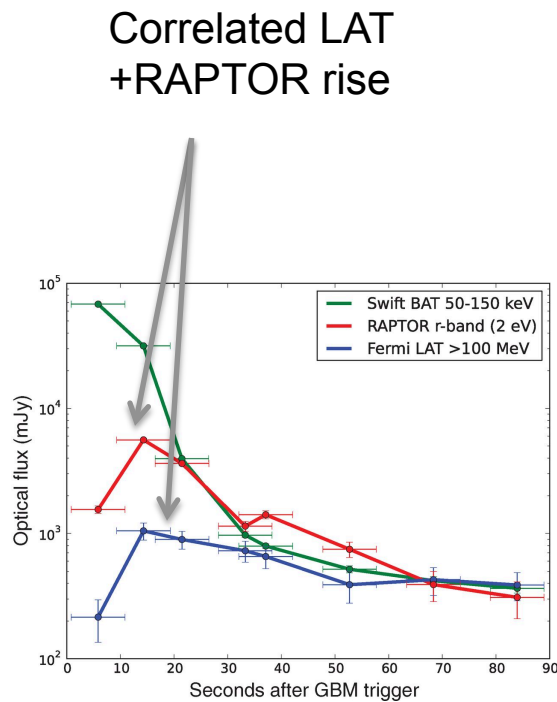
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Not under-luminous like most nearby GRBs



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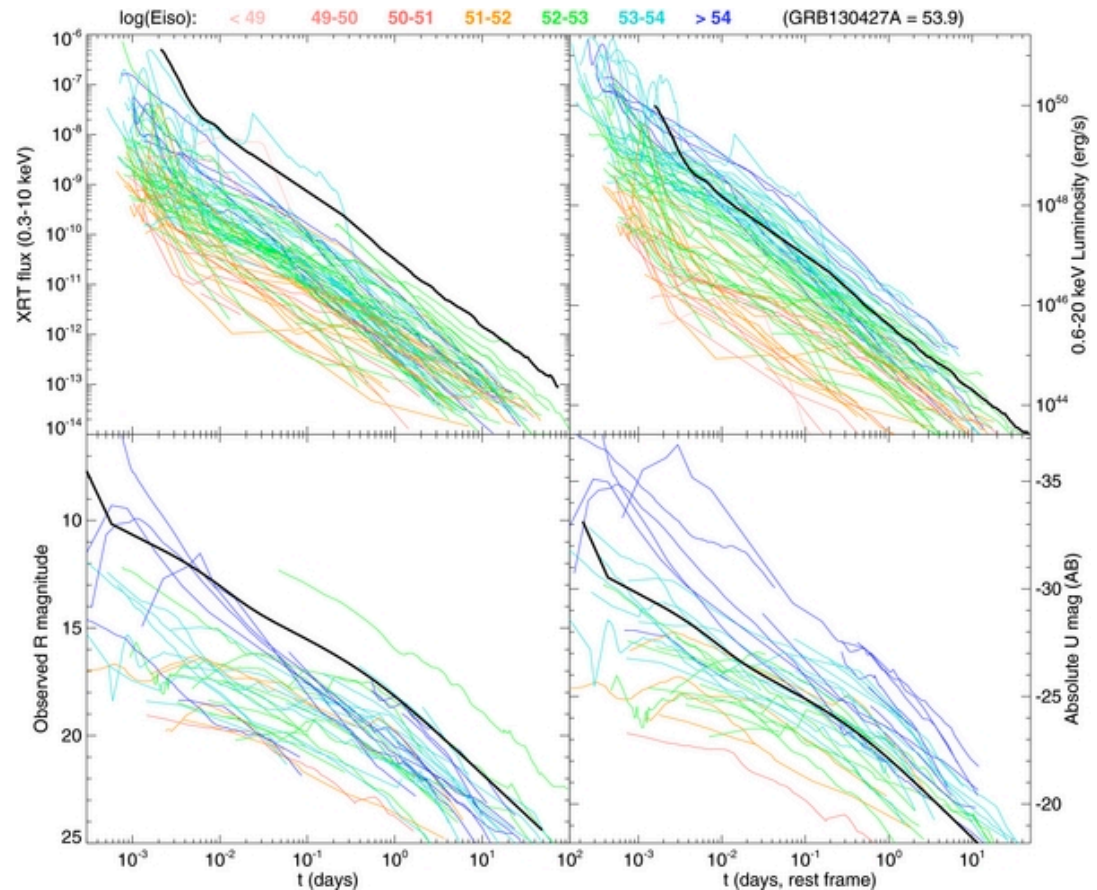


Vestrand et al. 2013, Science

7<sup>th</sup> magnitude optical flash (2<sup>nd</sup> brightest ever recorded)

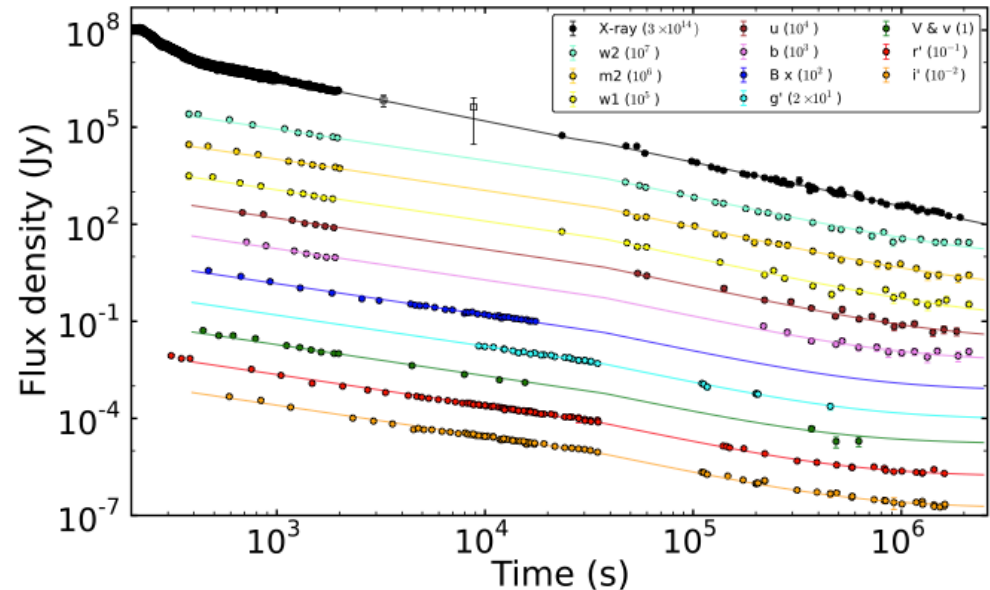


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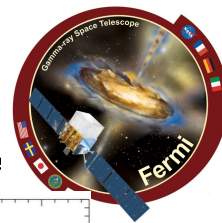
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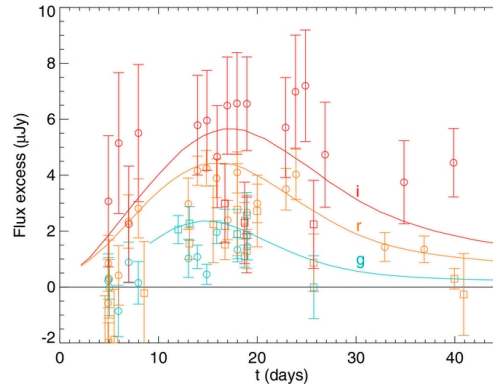
Maselli et al. 2013, Science

Follow-up observations by many ground- and space-based observatories including Swift-UVOT, RAPTOR, Liverpool Telescope, P60, RATIR, Gemini-N, Faulkes-N, MITSuME, HST, Chandra, NuSTAR, VLA, CARMA...

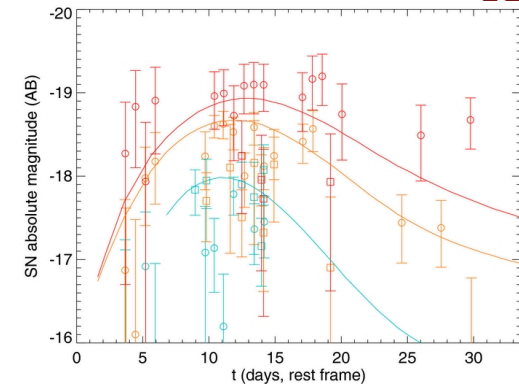
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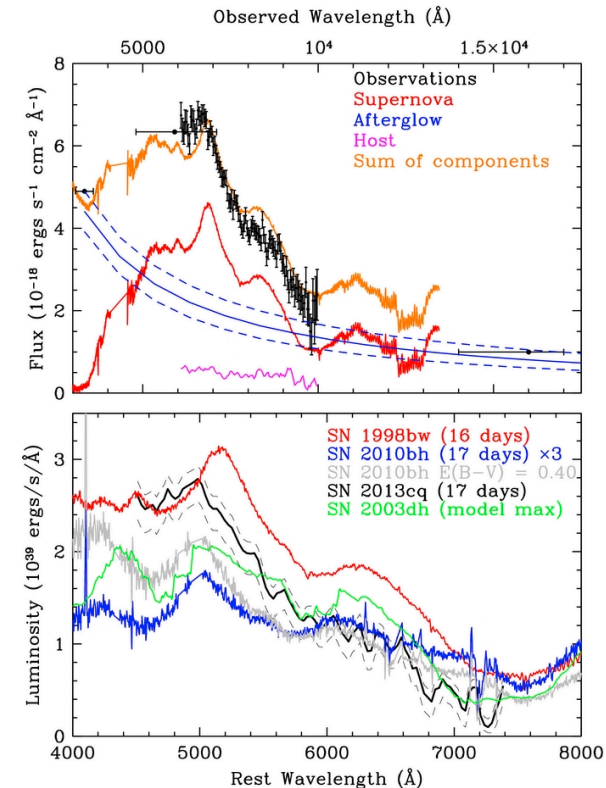
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Perley et al. 2014



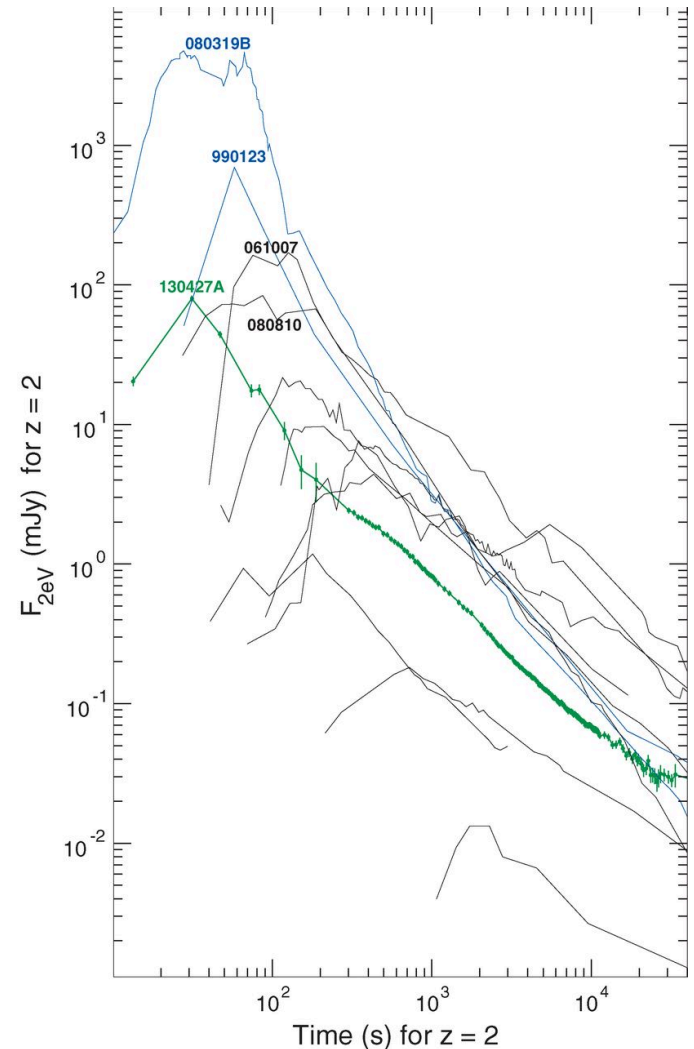
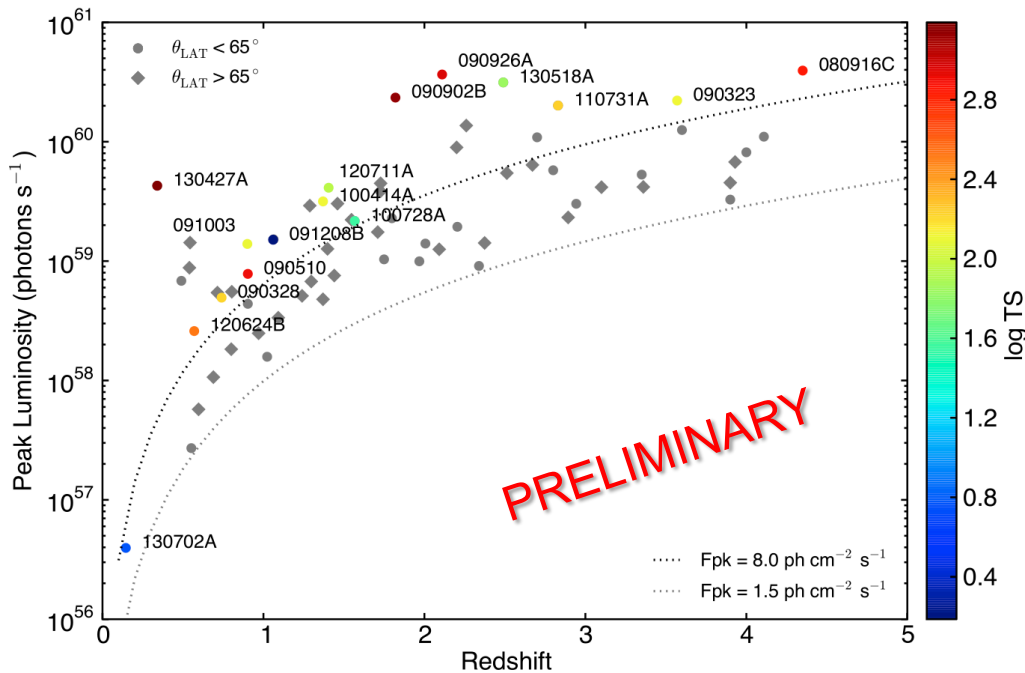
Similarity between SNe associated with most and least luminous GRBs suggests similar progenitor star



Levan et al. 2014



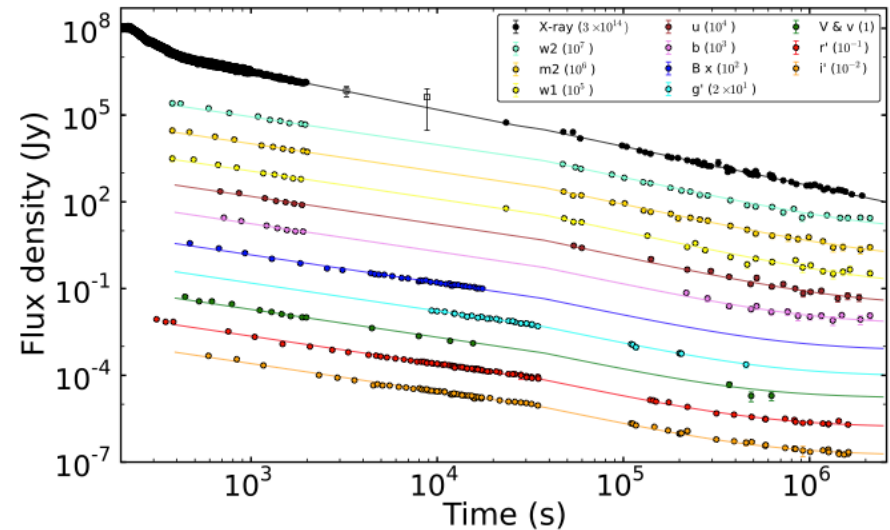
- **Nearby**
  - **But not subluminal**
  - **Similar to cosmological cousins**
- **Once in a decade (or more) sort of event**



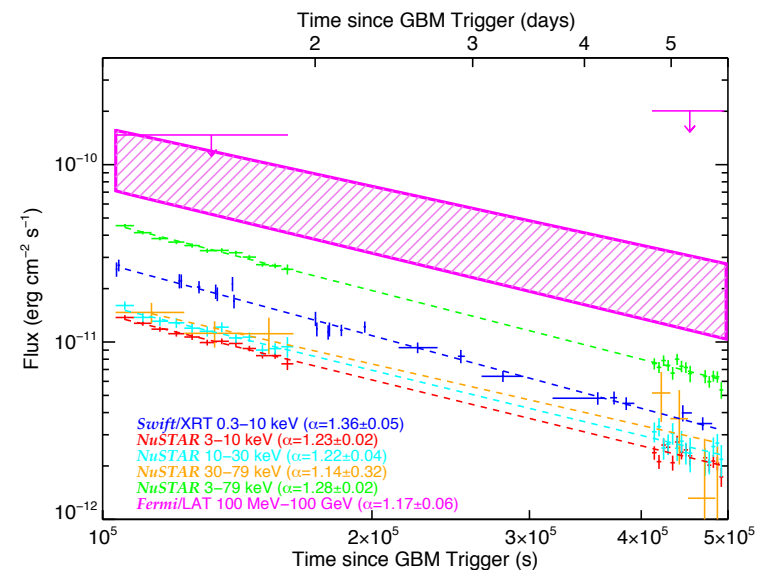
Vestrand et al. 2013, Science



- **Similar afterglow power-law decay slopes from Optical-X-ray-GeV**
- **Same component?**
  - **Synchrotron forward shock (Perley et al. 2014, Kouveliotou et al. 2014, Ackermann et al. 2013)**
  - **Additional inverse Compton component (Fan et al. 2013, Liu et al. 2013)**

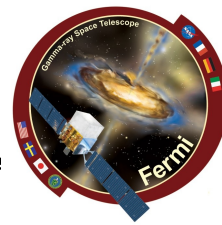


Maselli et al. 2013, Science



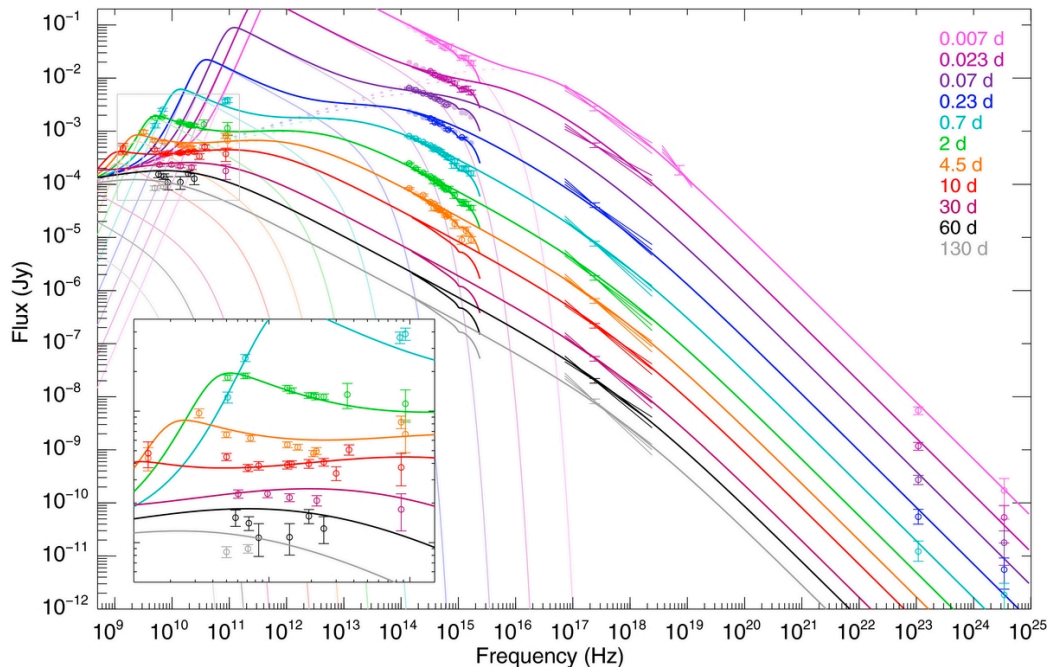
Kouveliotou et al. 2013





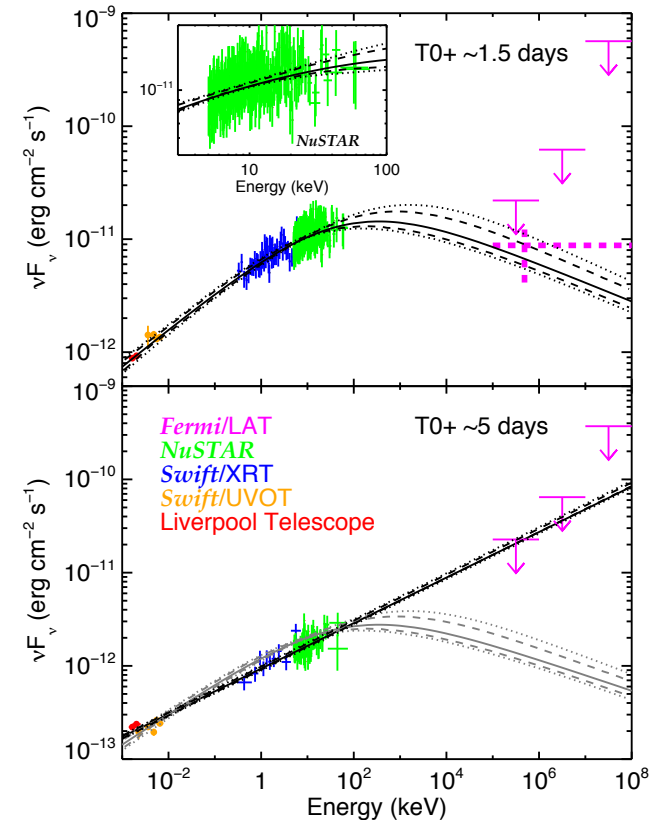
## Broadband Modeling

- Wind-like environment, or somewhere between constant density ISM and Wind
- Appears to be a single component



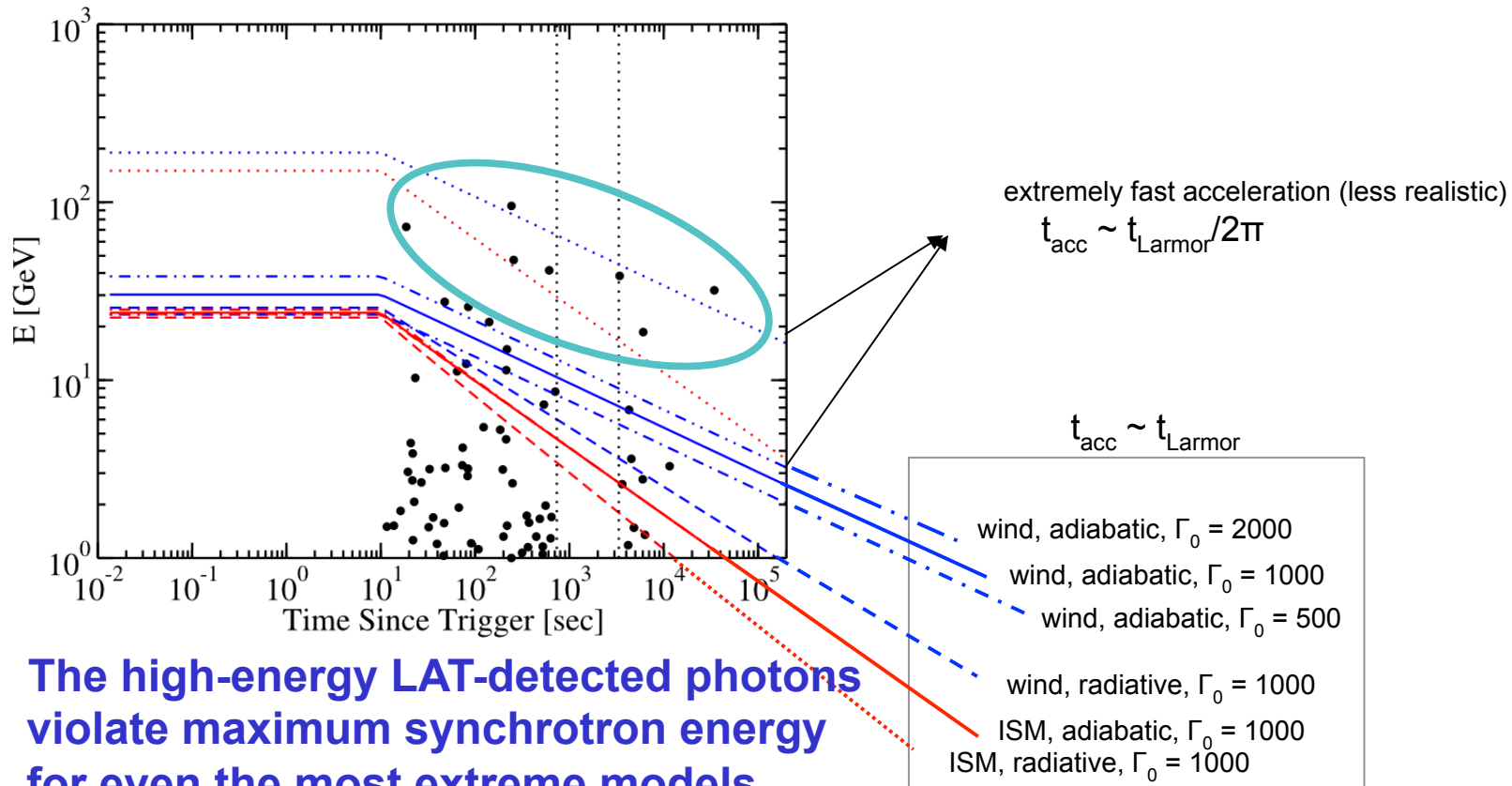
Perley et al. 2014

- First late-time hard X-ray (3-80 keV) afterglow ever observed
- Single smoothly broken power law from optical - GeV



Kouveliotou et al. 2013

# GRB 130427A Challenges Synchrotron Shock Physics?



- **The high-energy LAT-detected photons violate maximum synchrotron energy for even the most extreme models**
- **Requires modifications to standard Synchrotron shock physics or alternative model (Non-uniform magnetic field, Diffusive shock acceleration, magnetic reconnection, Electromagnetic cascades)**
- **See poster #9.08 by Jeremy Perkins on limits set by VERITAS TeV observations of GRB 130427A**



- **GRB 130427A was a rare and well-observed event that is teaching us about GRB emission mechanisms and shock physics**
- **Pass 8 adds ~30% more photons (source class), including several new high energy photons with  $E > 10$  GeV**
- **Future TeV observations could help solve solve Synchrotron puzzle**
  - **HAWC has limits on GRB 130427A (Abeysekara et al., arXiv: 1410:1536), but will be more constraining with the full array**
- **Current array of observatories (ground and space-based) are ideal for studying these rare and bright objects**

