

Geek² Geek event

Thursday, Jan. 25

5-7 p.m.

Jackson Center Pub



Presenting Sponsor:

AEgis
TECHNICAL COLLEGE

Authors:

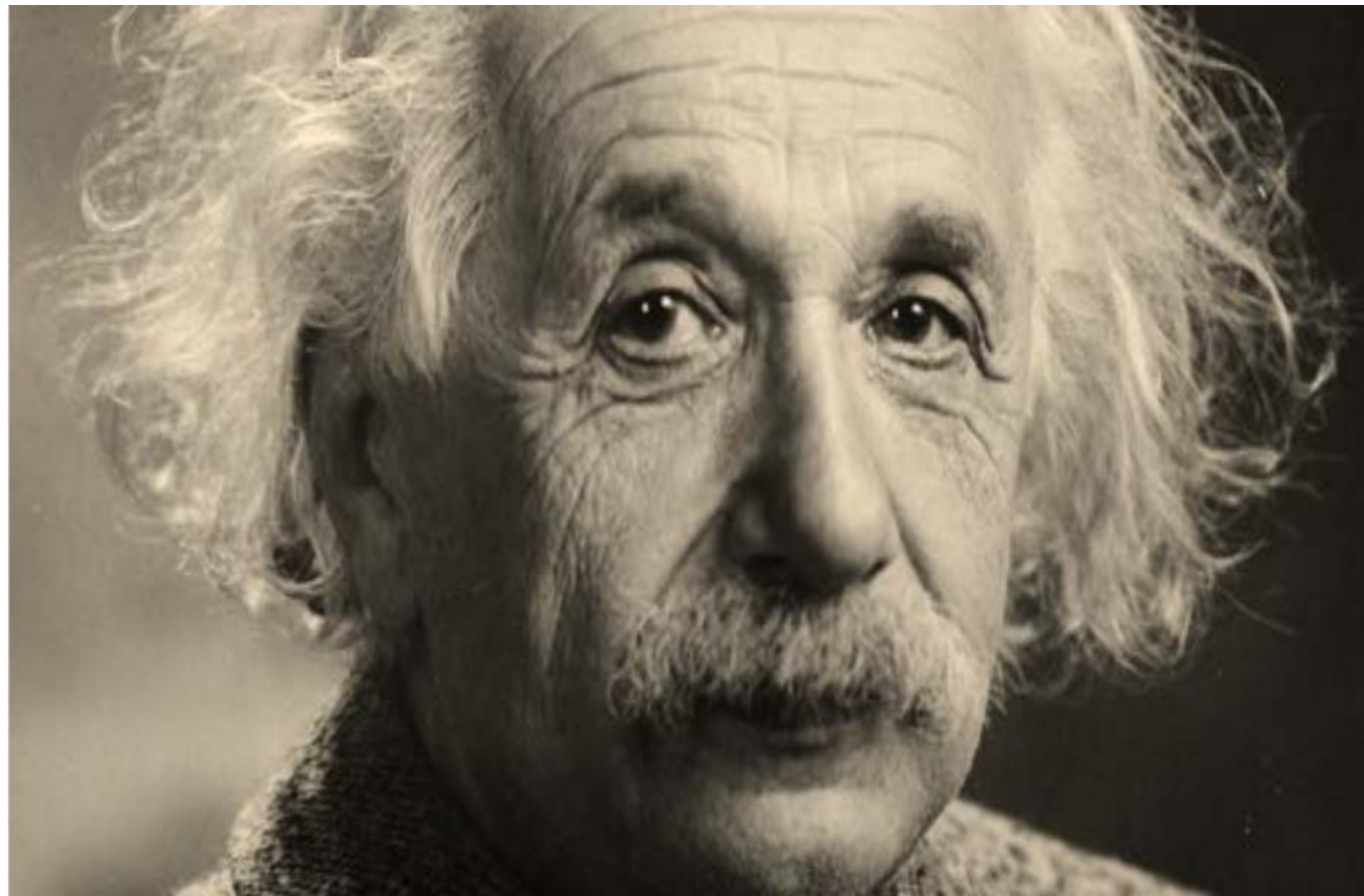
Dr. Tyson Littenberg

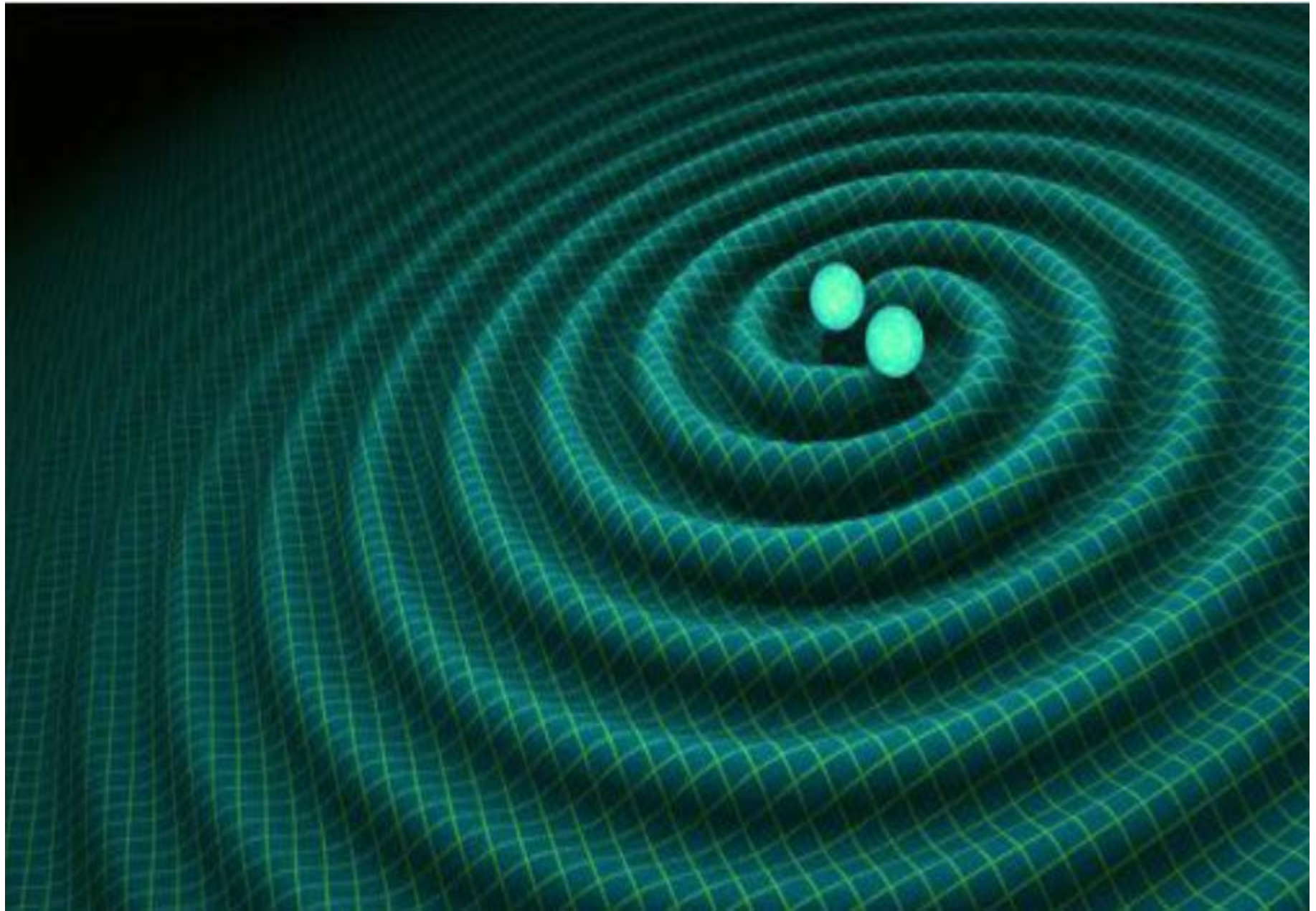
Dr. Colleen Wilson-Hodge

Dr. Michael Briggs

Dr. Adam Goldstein

Ms. Rachel Hamburg



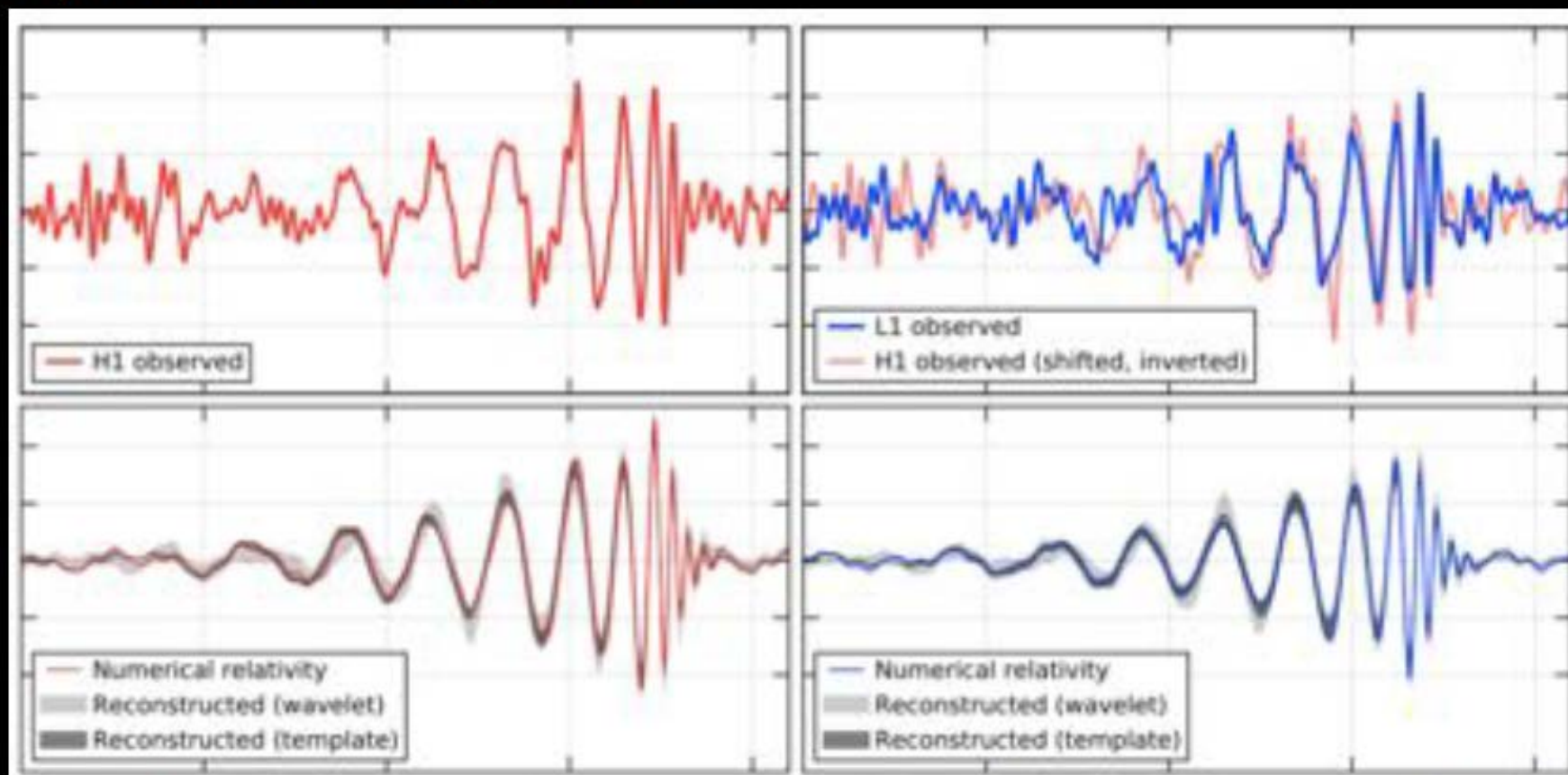


An aerial photograph of the LIGO facility, showing a large, modern building with a white roof and blue accents, surrounded by a lush green forest. A long, straight road or path runs alongside the building. The sky is clear and blue. The right side of the image is overlaid with a black diagonal shape containing the text.

**LASER
INTERFEROMETER
GRAVITATIONAL-WAVE
OBSERVATORY**

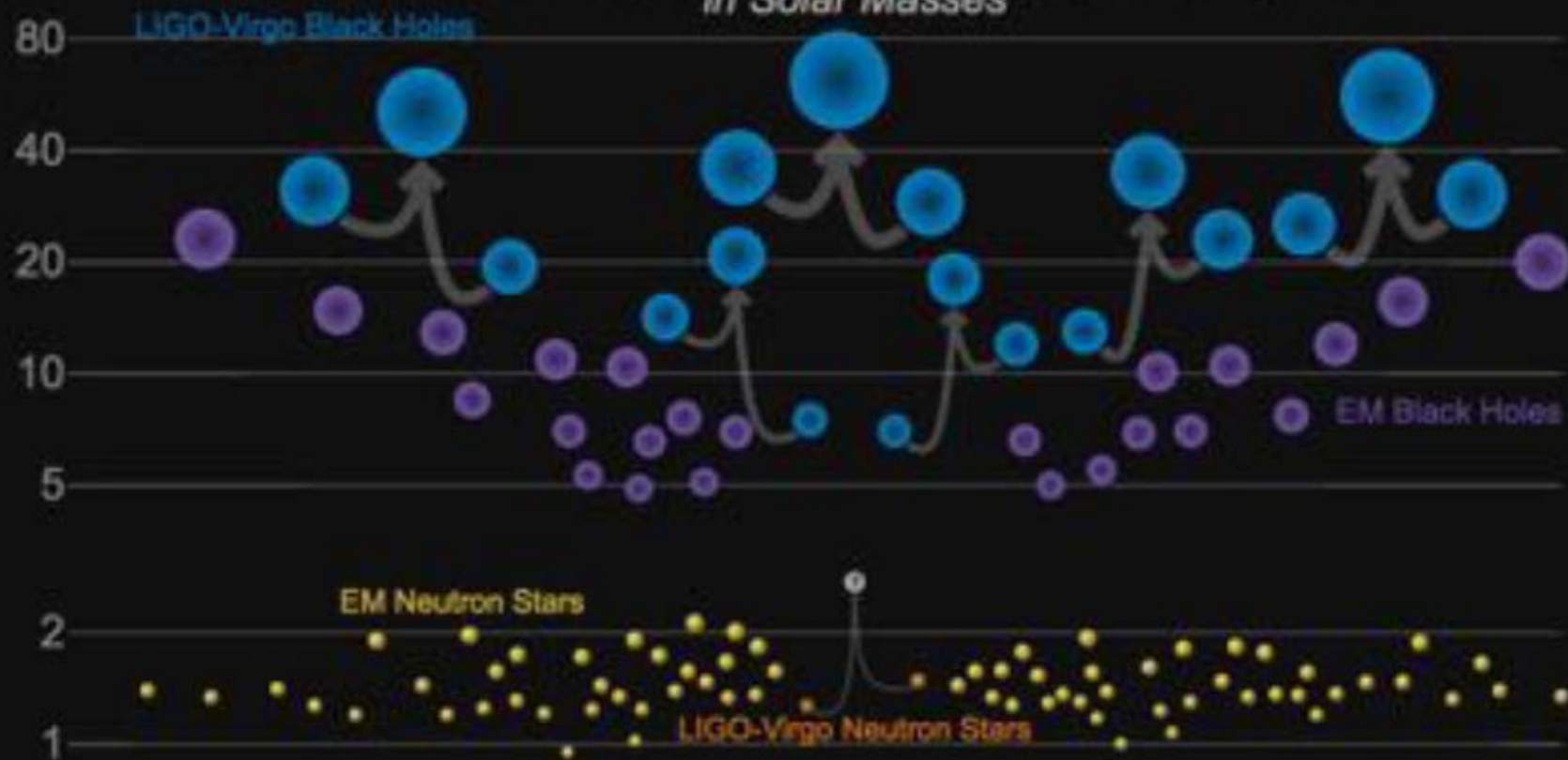


September 14, 2015

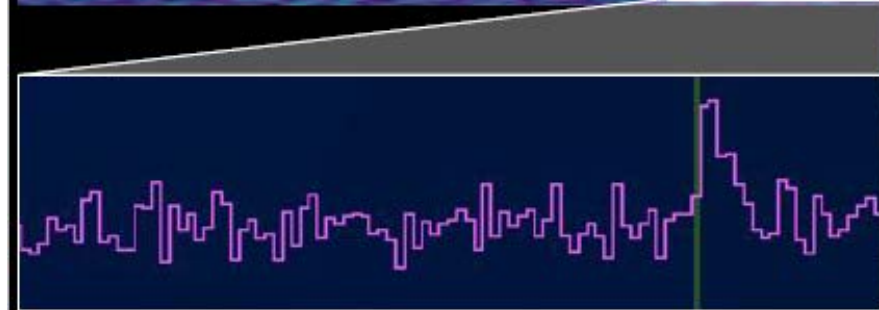
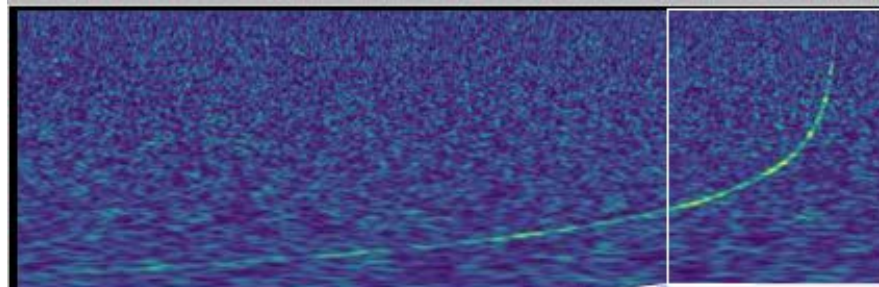


Masses in the Stellar Graveyard

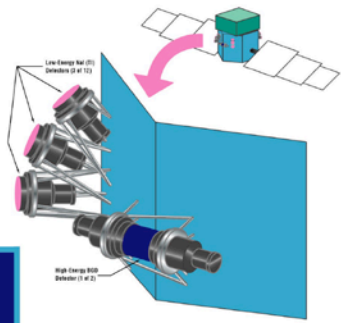
in Solar Masses



August 17, 2017







GLAST Burst Monitor

A Proposal to NASA for a Burst Monitor (GBM) for the GLAST Mission

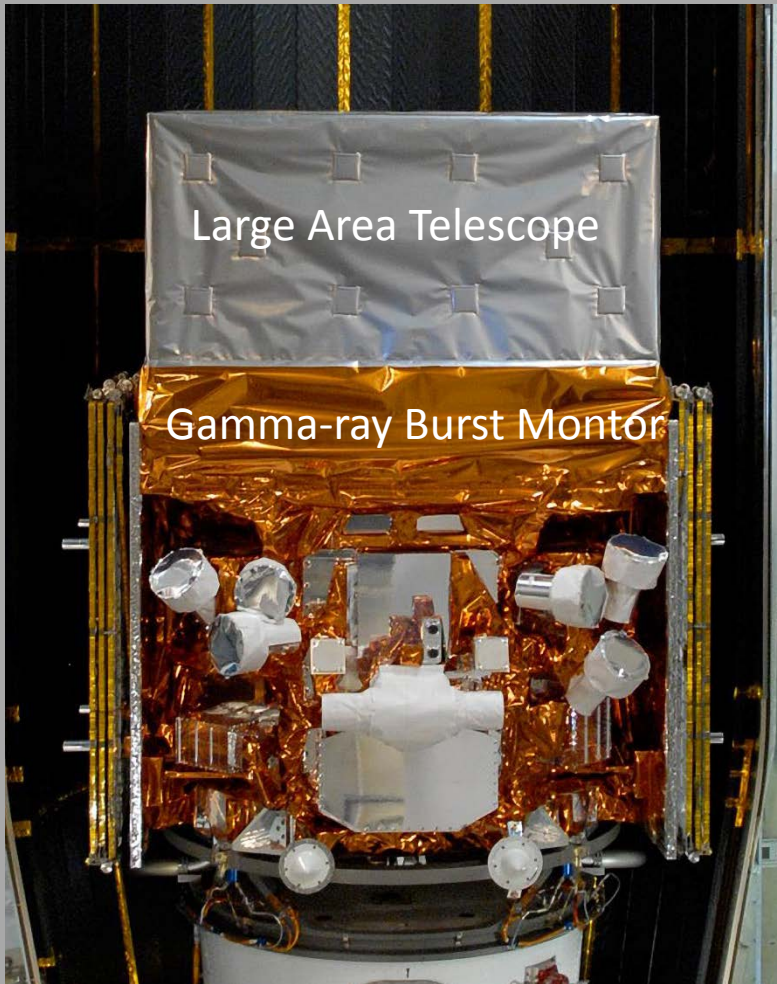
Volume I.
Science Investigation and Technical Description

Version 2
March 20, 2000

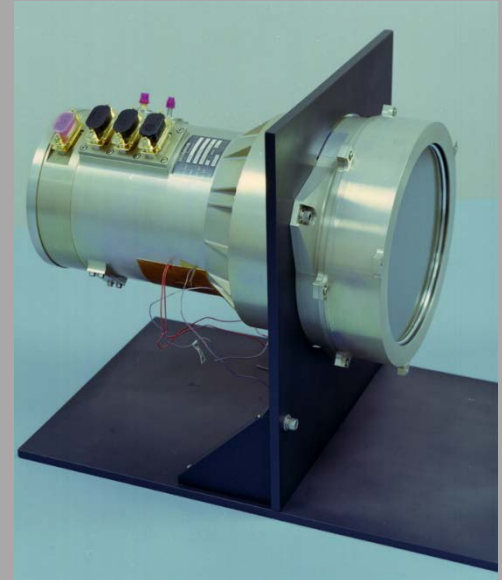
Submitted by
Space Science Department
Science Directorate
Marshall Space Flight Center
Alabama 35812





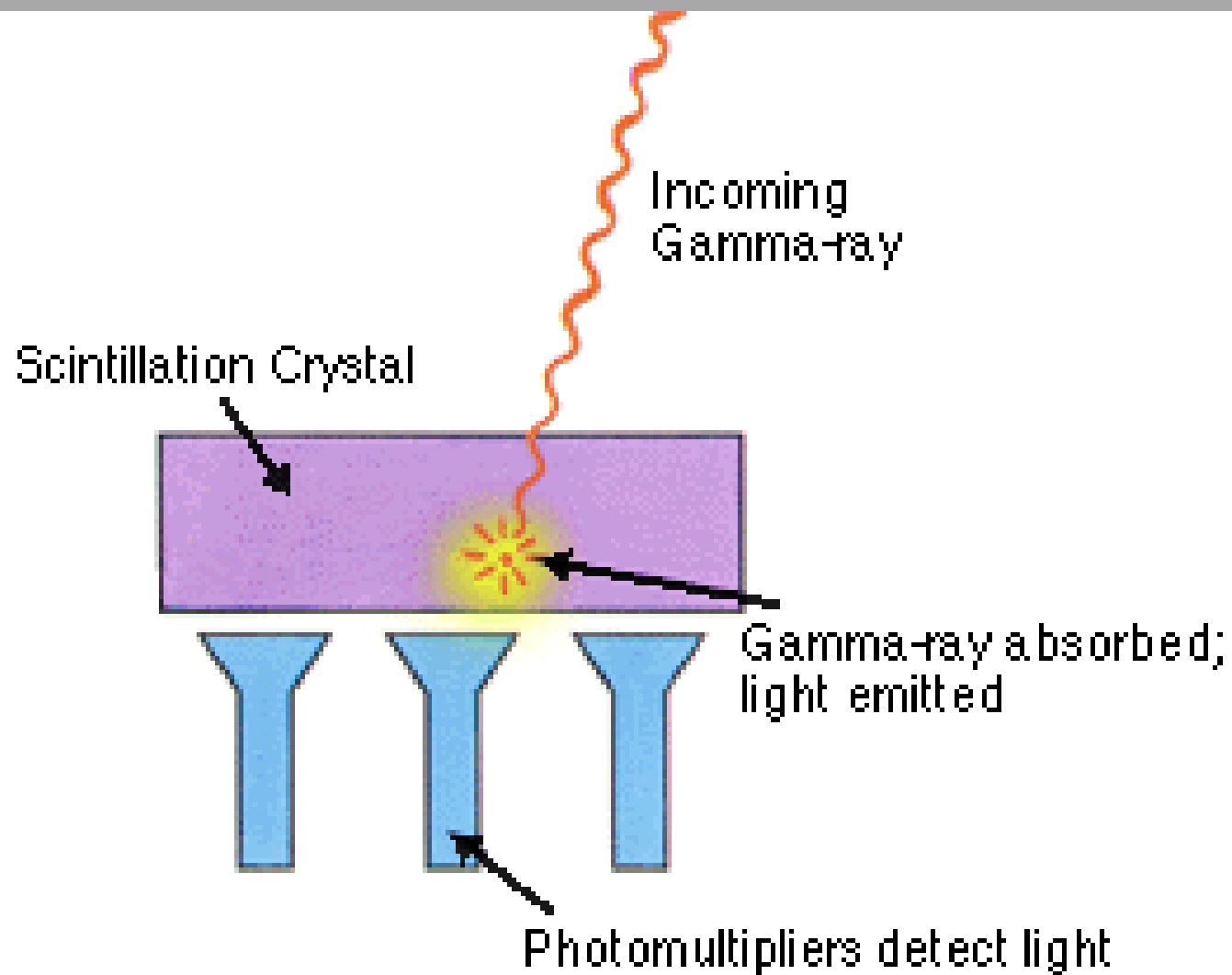


Nal Detector
8 keV-1 MeV



BGO Detector
200 keV-40 MeV



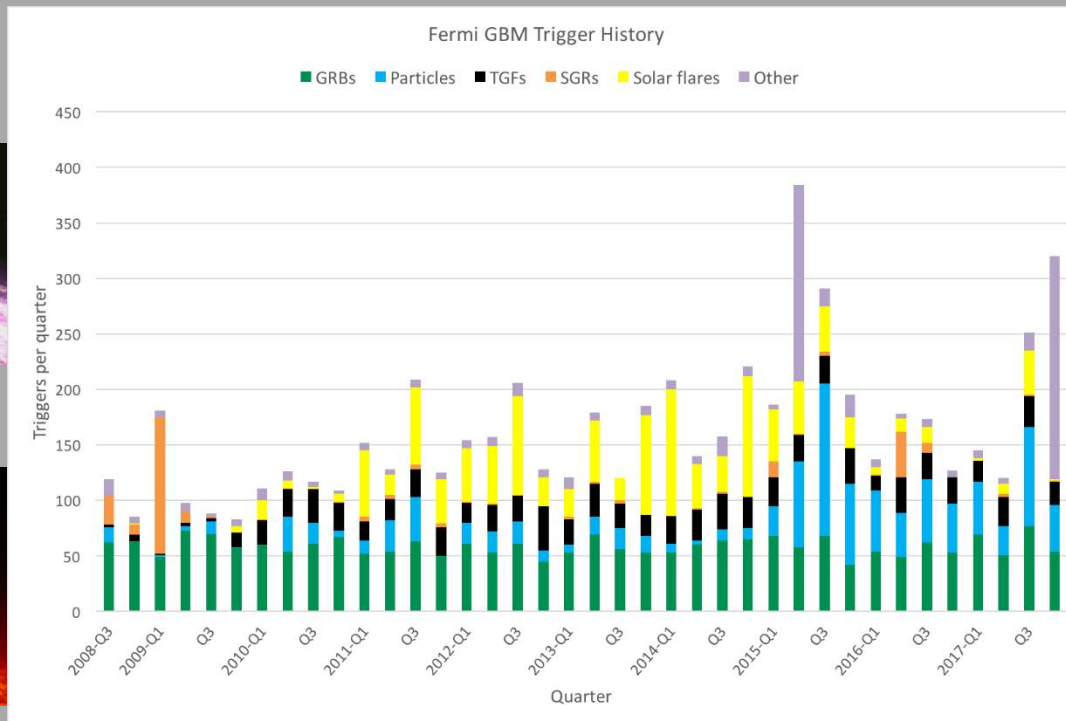


6222 Fermi GBM triggers

2238 GRBs



1176 Solar Flares



275 Magnetars

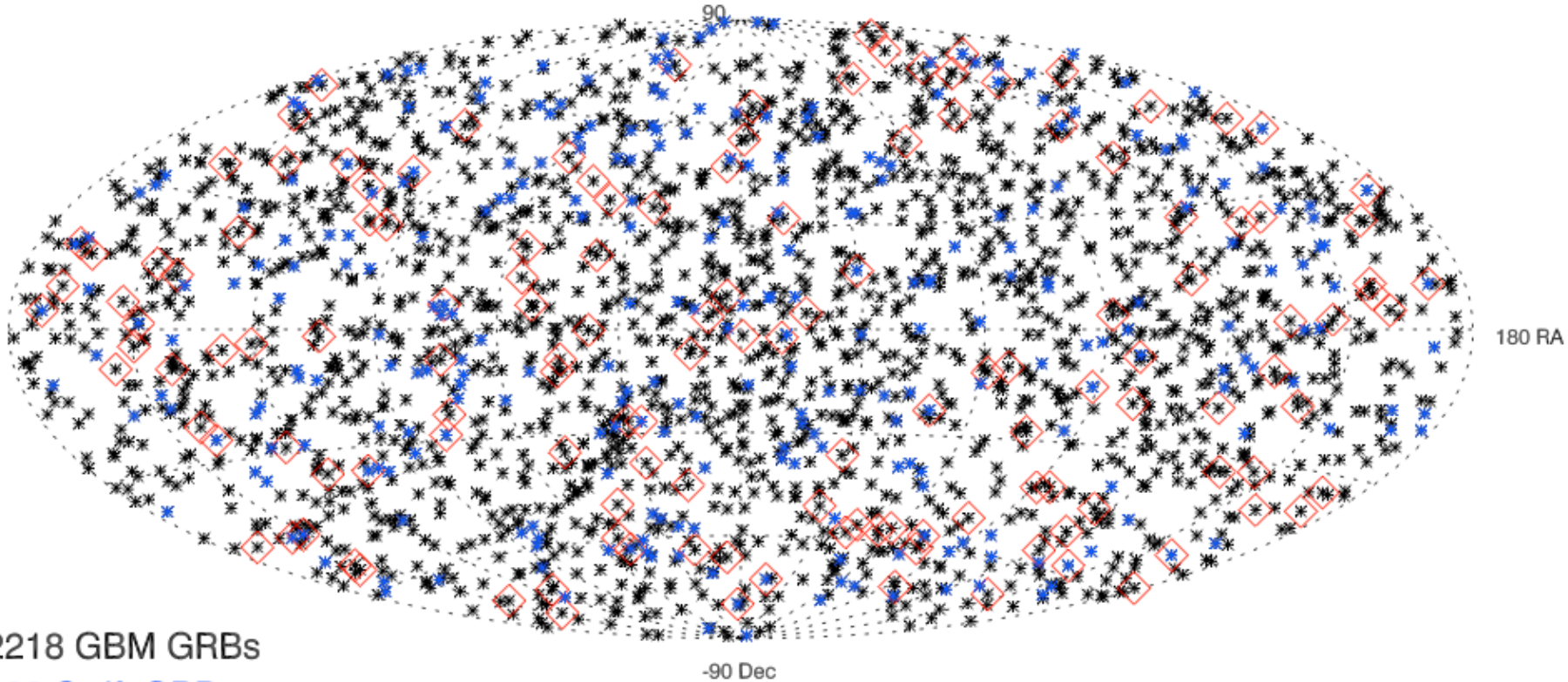


875 TGFs



668 Others, including 189 from Swift J0243.6+6124 and 169 from V404 Cyg;
1041 particles

GBM Triggered GRBs



2218 GBM GRBs

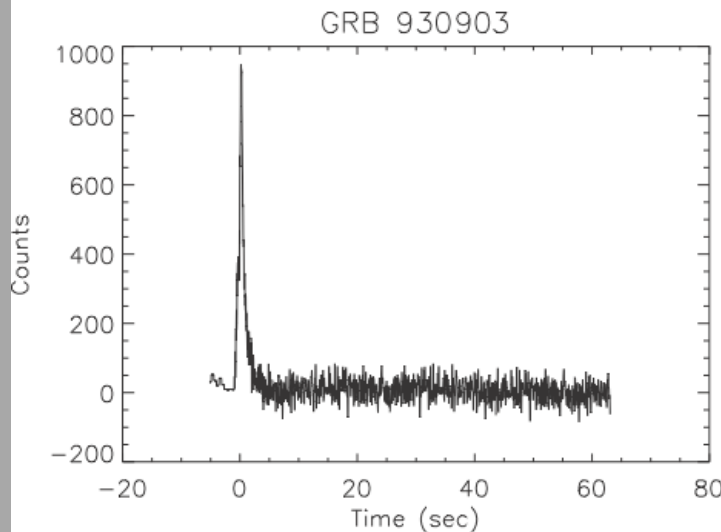
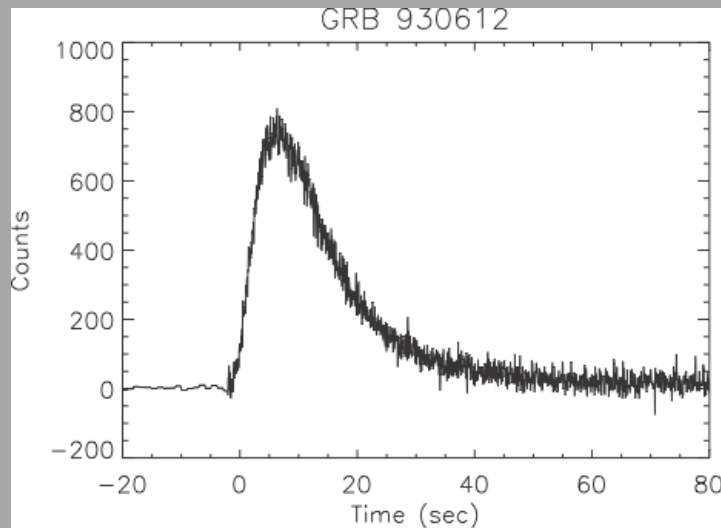
293 Swift GRBs

139 LAT GRBs

Types of GRBs

Long GRBs

- 200 per year triggered with GBM

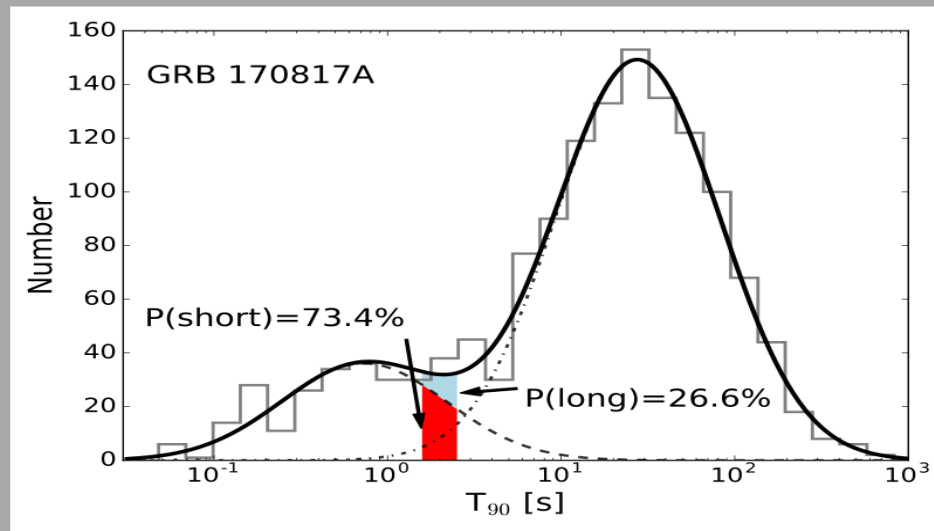


Short GRBs

- 40 per year triggered with GBM
- >80 per year found in searches for weak GRBs



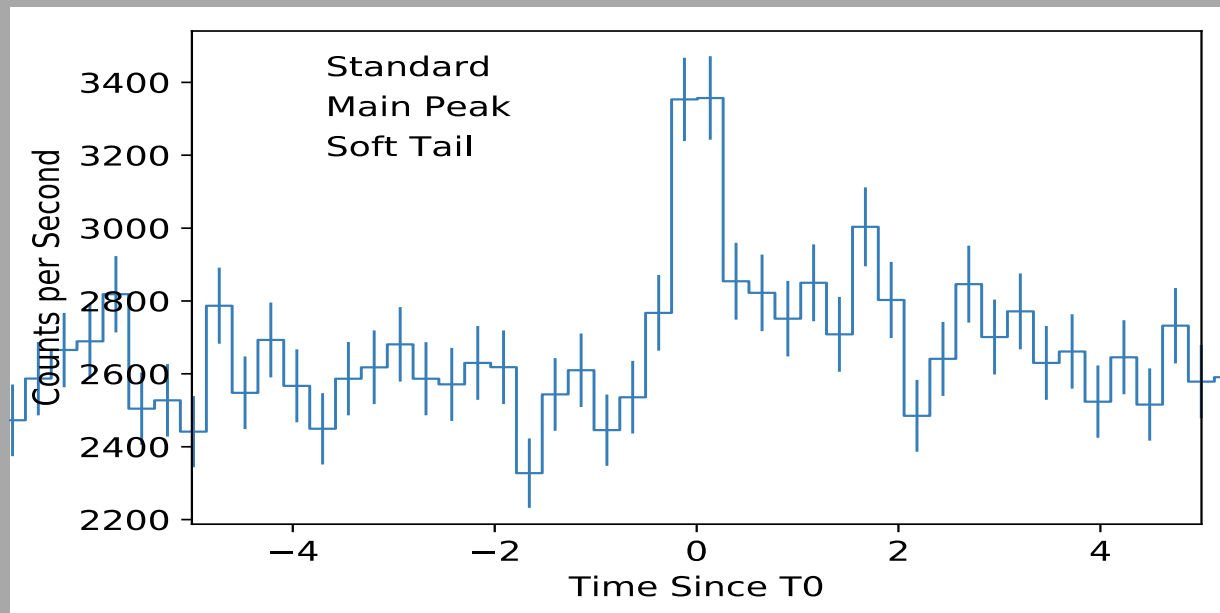
GRB 170817A: a short GRB



- GRB 170817A is a short GRB—
predicted to originate from mergers

GRB 170817A:

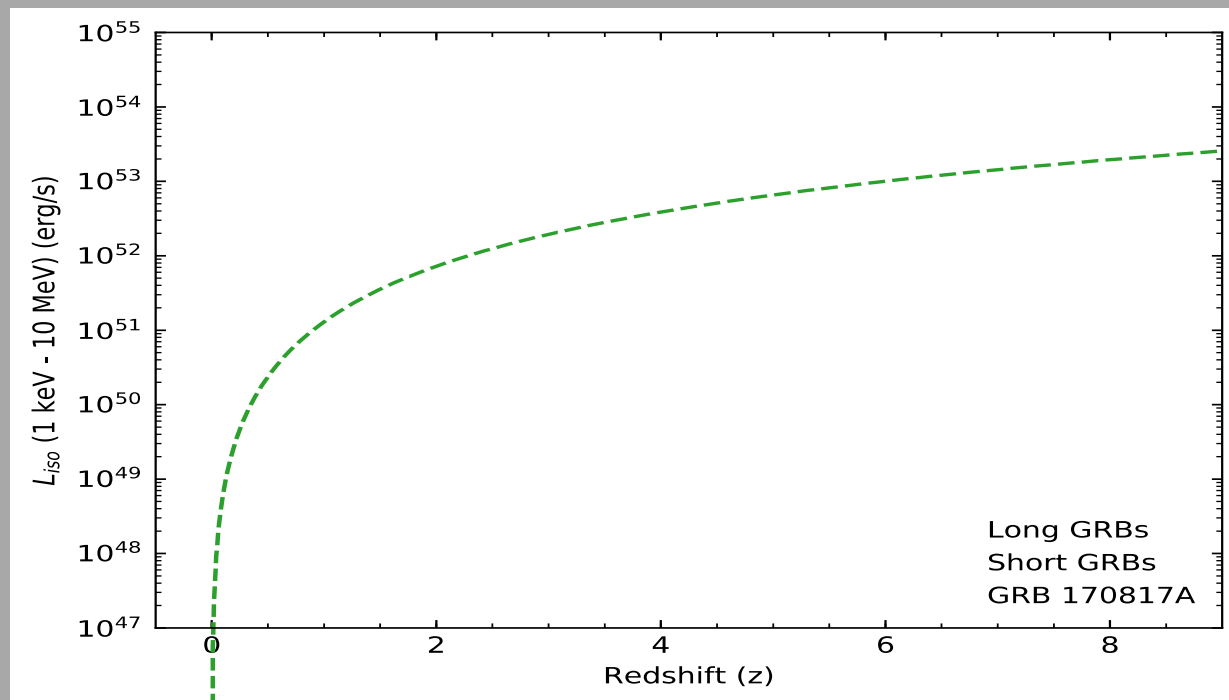
A short GRB with a weak low-energy tail



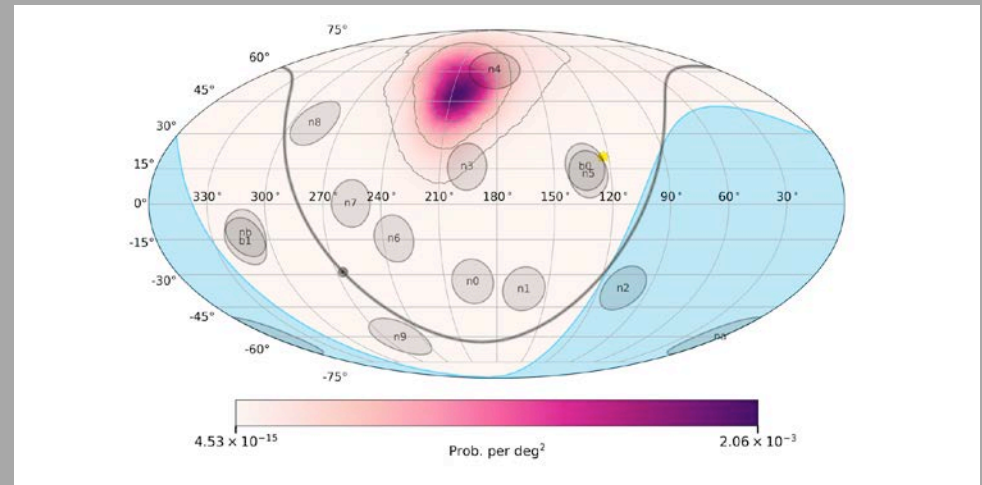
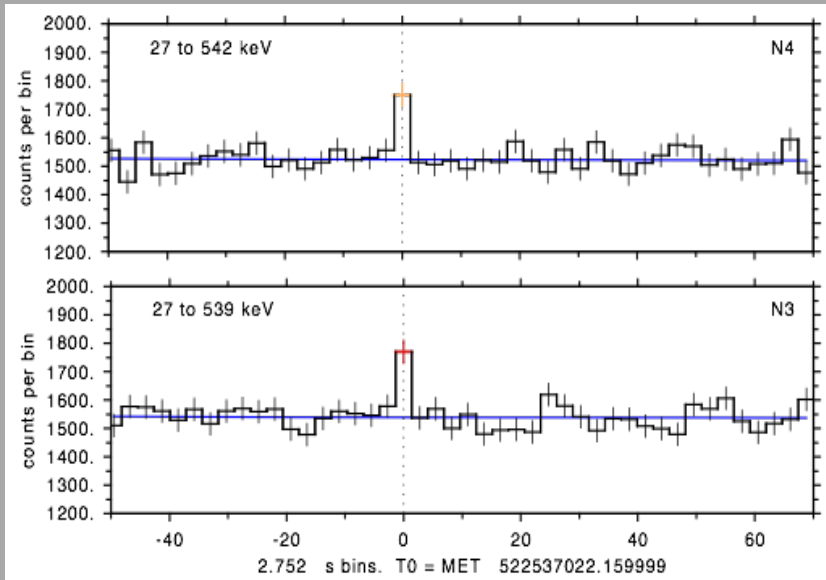
traditional “spike” but also a weak lower-energy tail

Goldstein et al. 2017, ApJ, 848, L14; Abbot et al. 2017, ApJ, 848, L13

GRB 170817A: Faintest GRB with known distance



Other weak short GRBs in GBM data

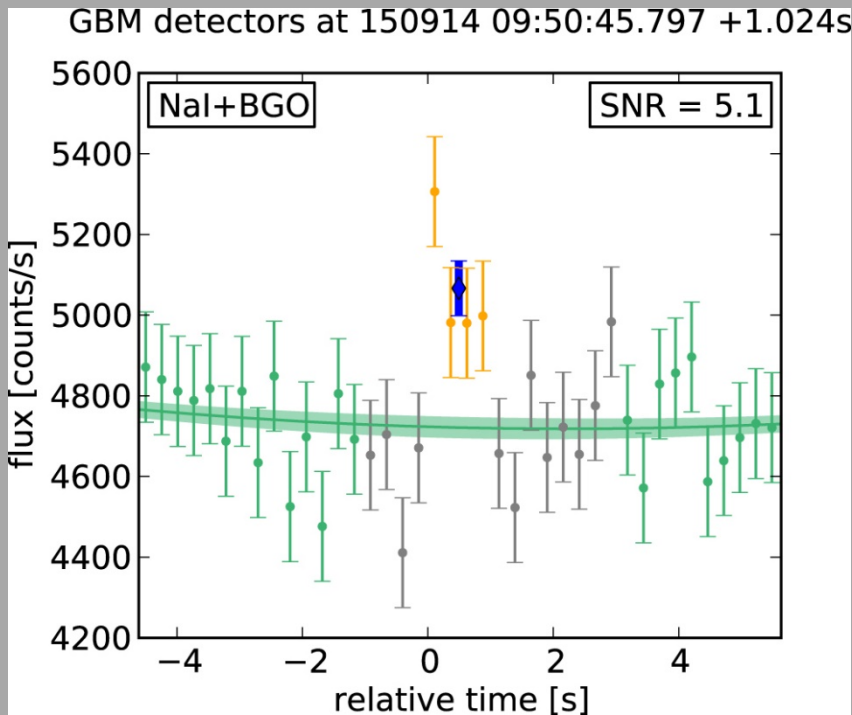


80 weak short GRBs per year

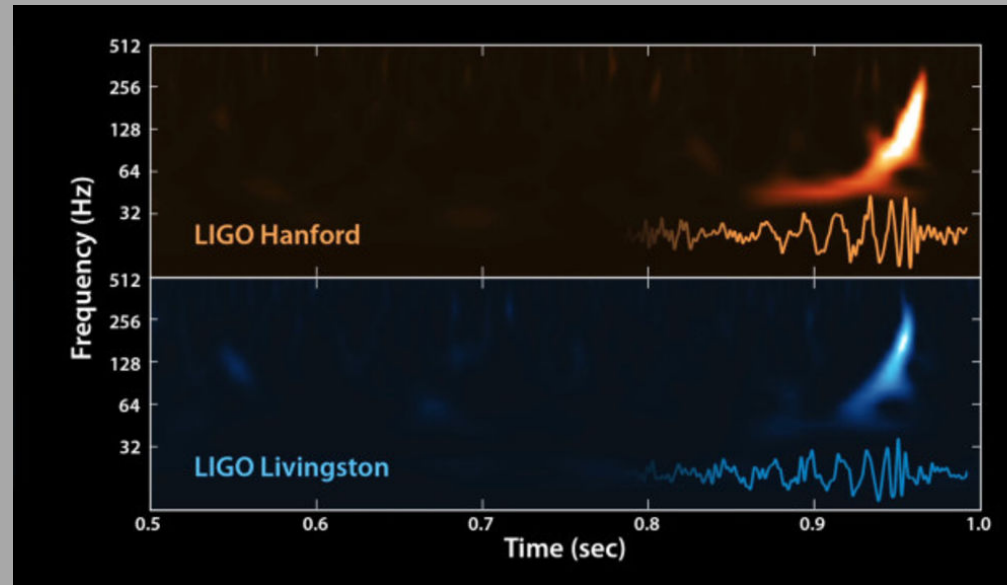
GBM could see GRB 170817A twice as far away

Expect to see about ~1 coincident event per year when LIGO/Virgo reaches design sensitivity

Counterpart to a Black hole merger?

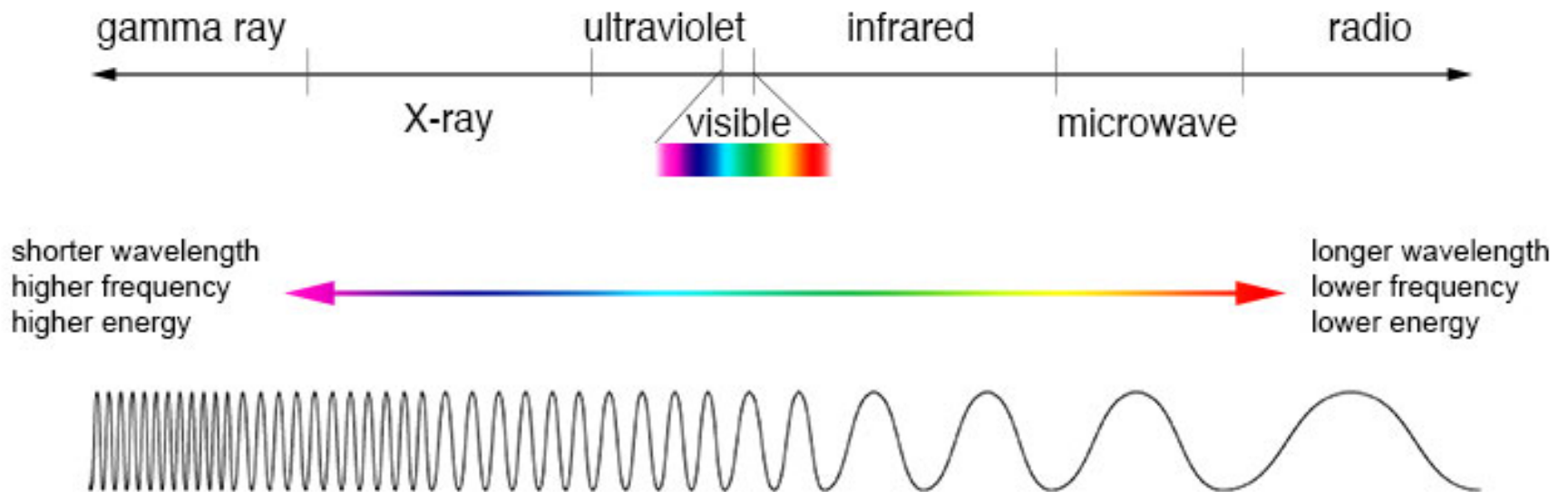


GW150914

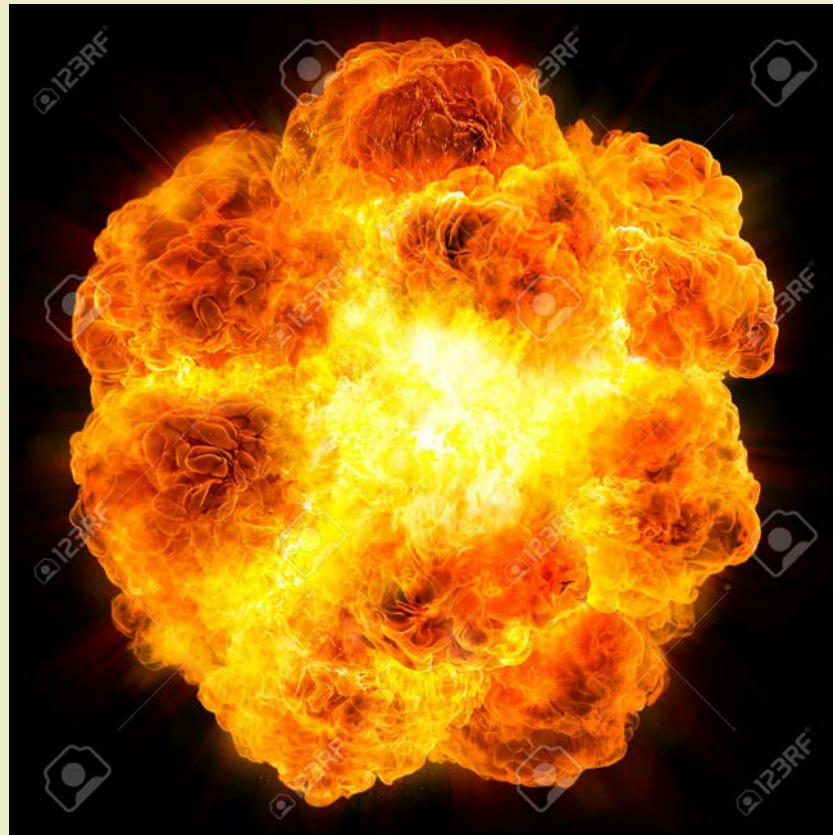




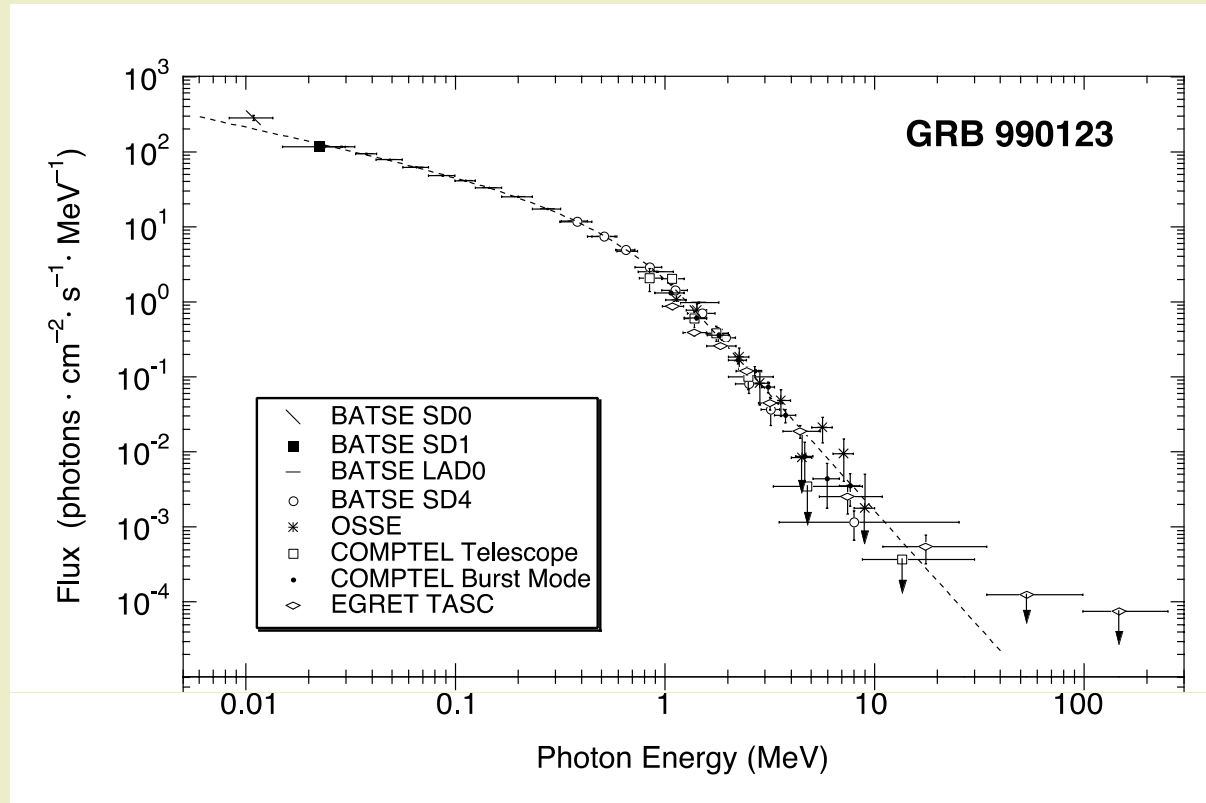
gamma rays



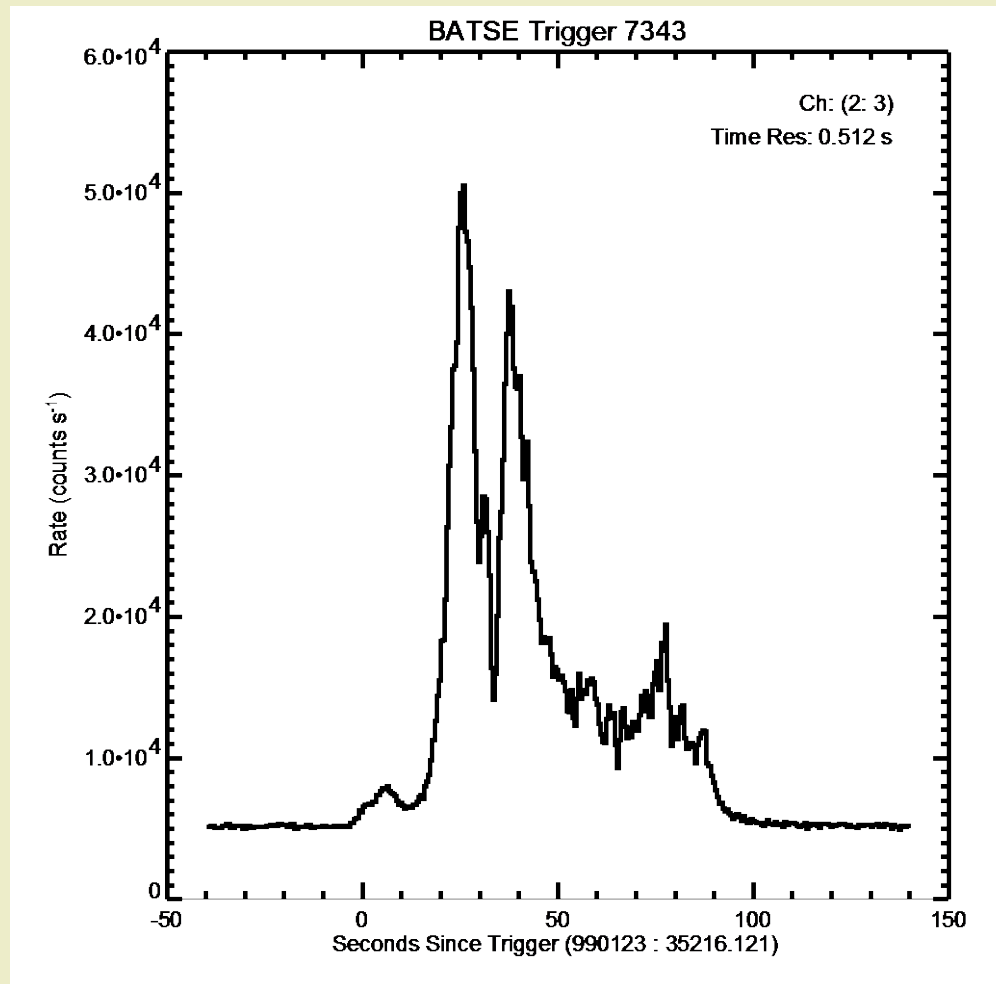
Gamma-Ray Bursts



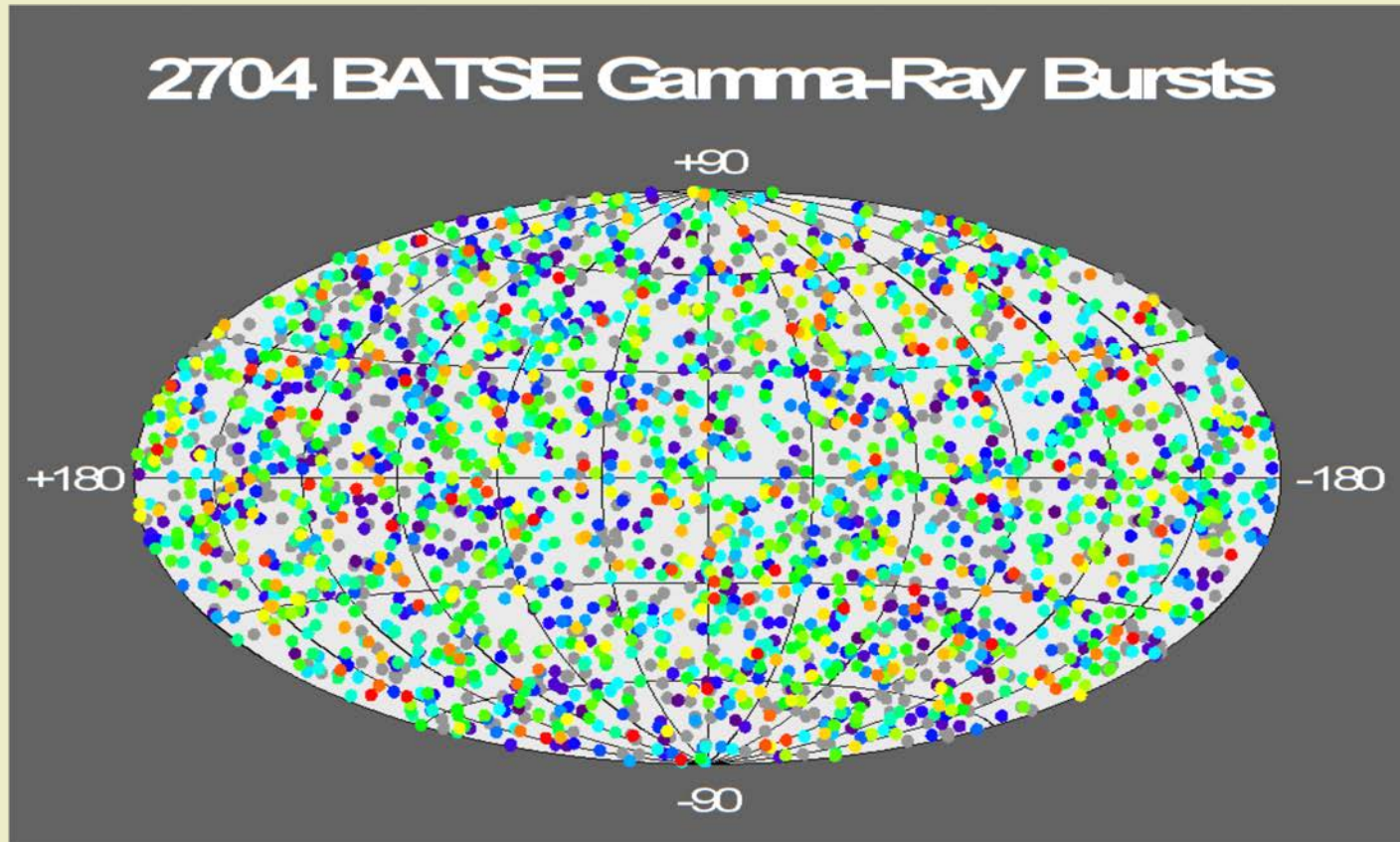
Example Spectrum



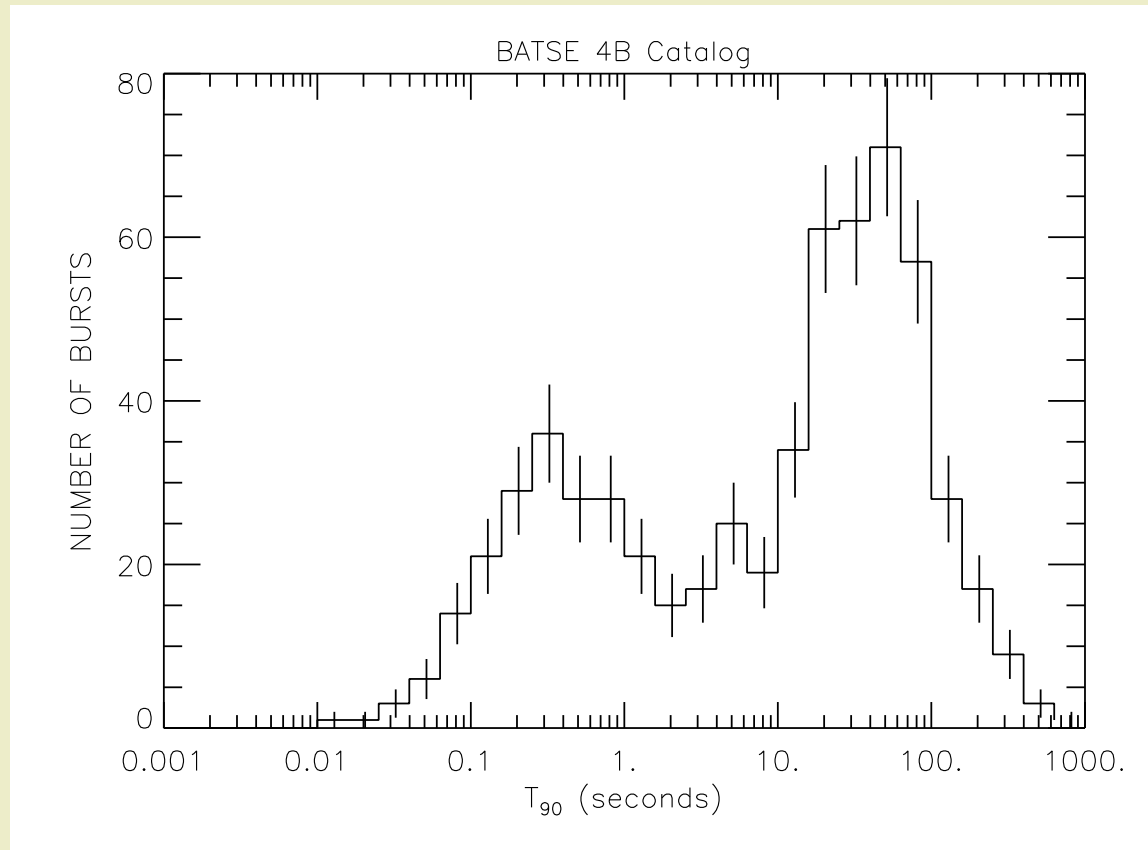
Example Time History

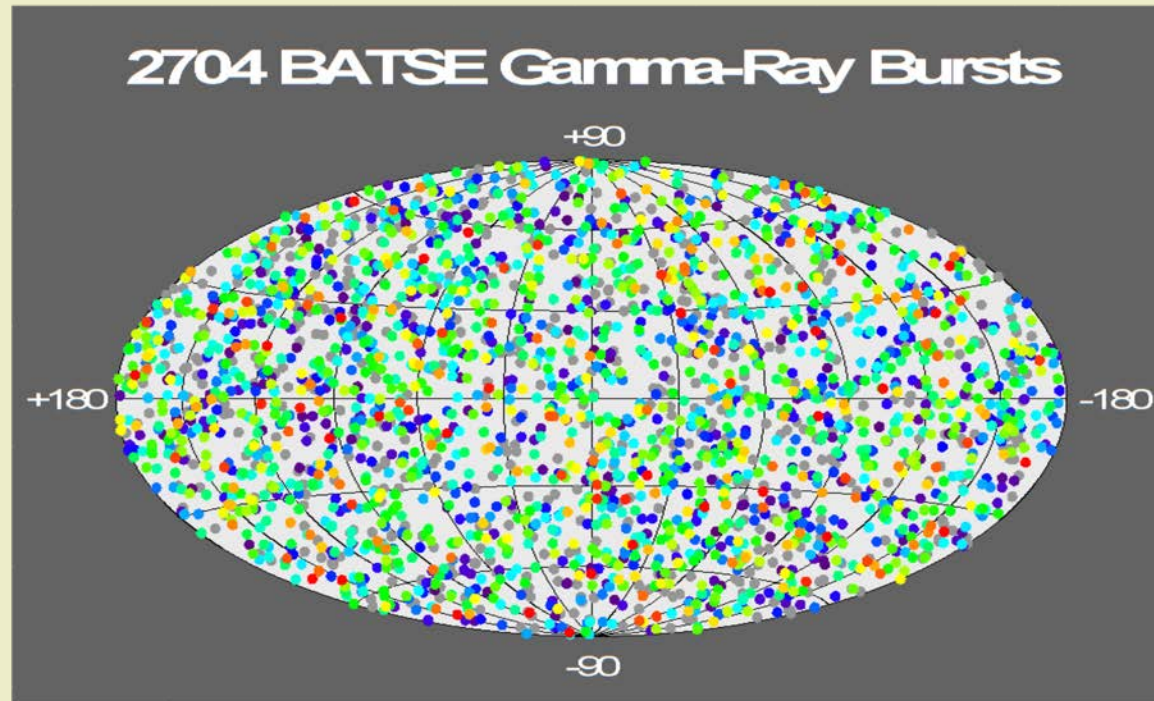


Where & When



Duration Distribution





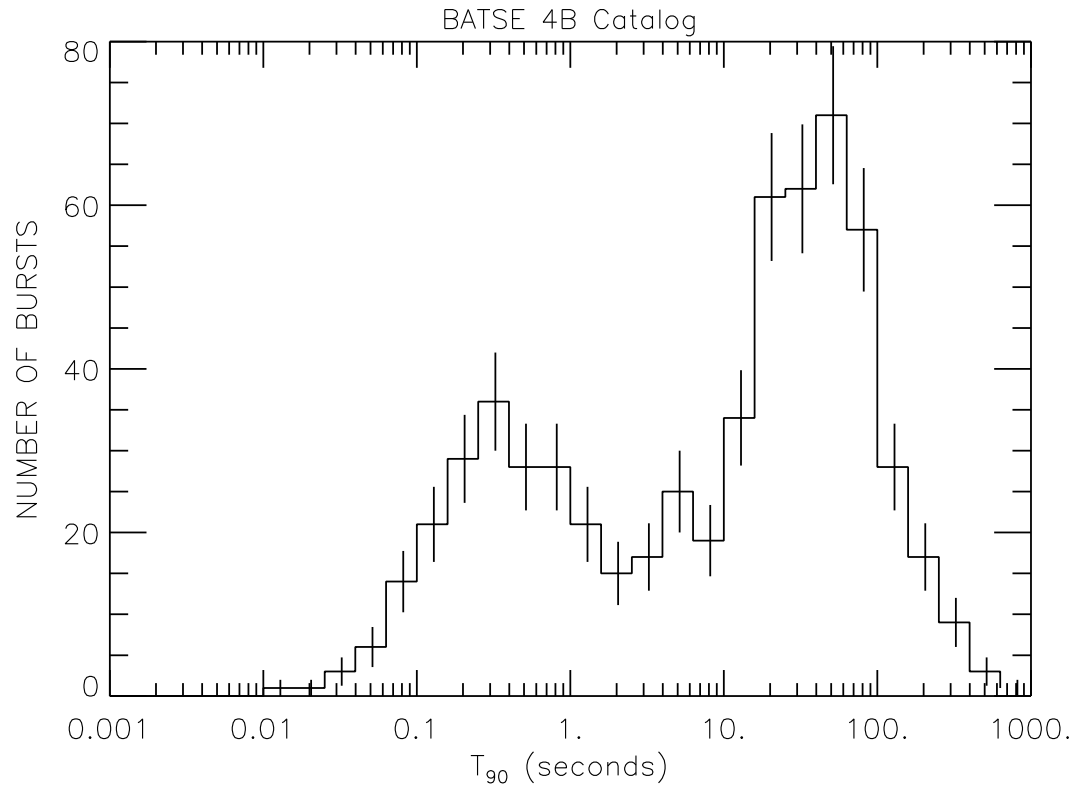
No Milky Way band:

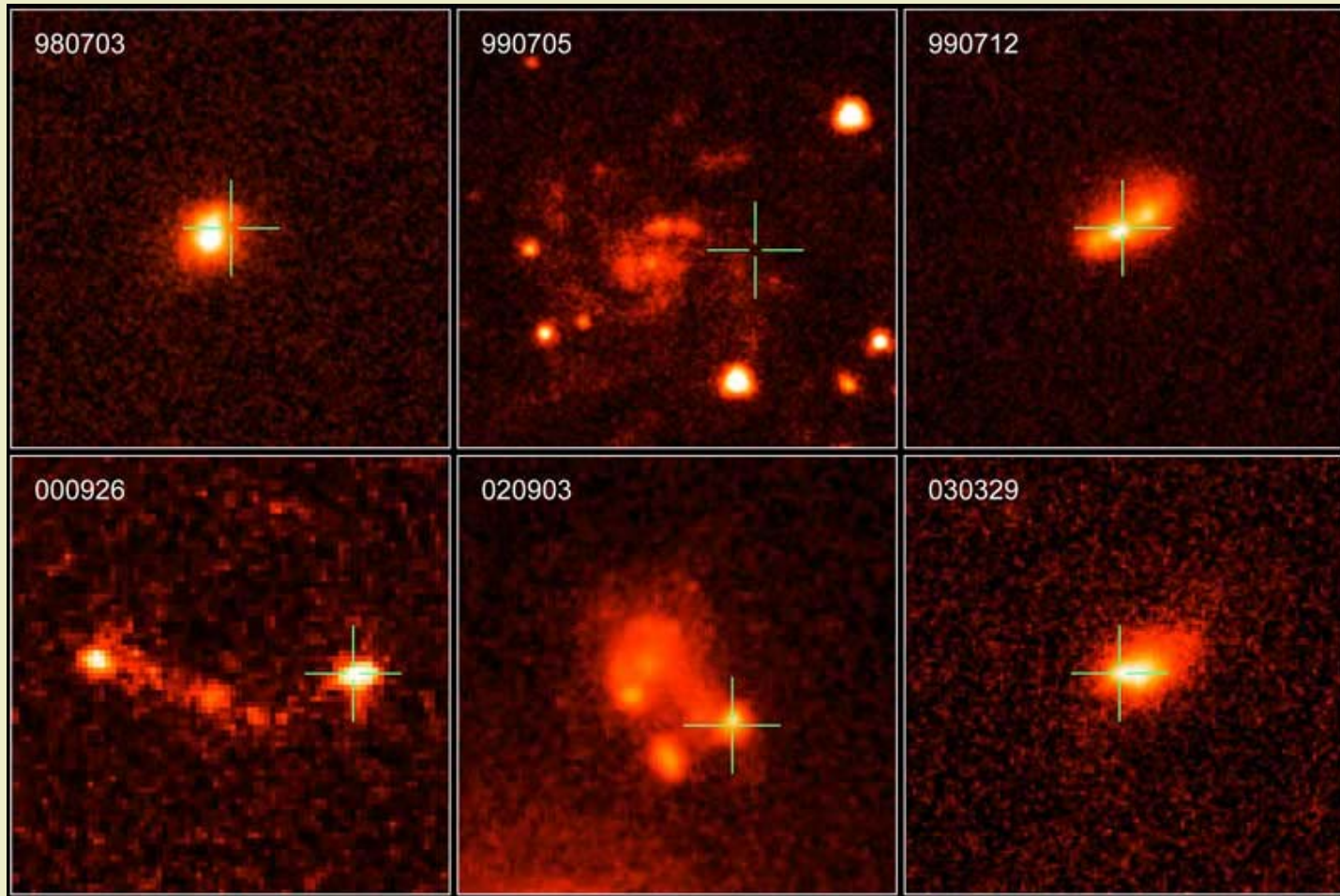
- ➔ GRBs farther away than our Galaxy
- ➔ Extremely high energies
- ➔ Due to energy and source size (from variability), gamma rays should self absorb, but ...

Solution: Relativistic Jet



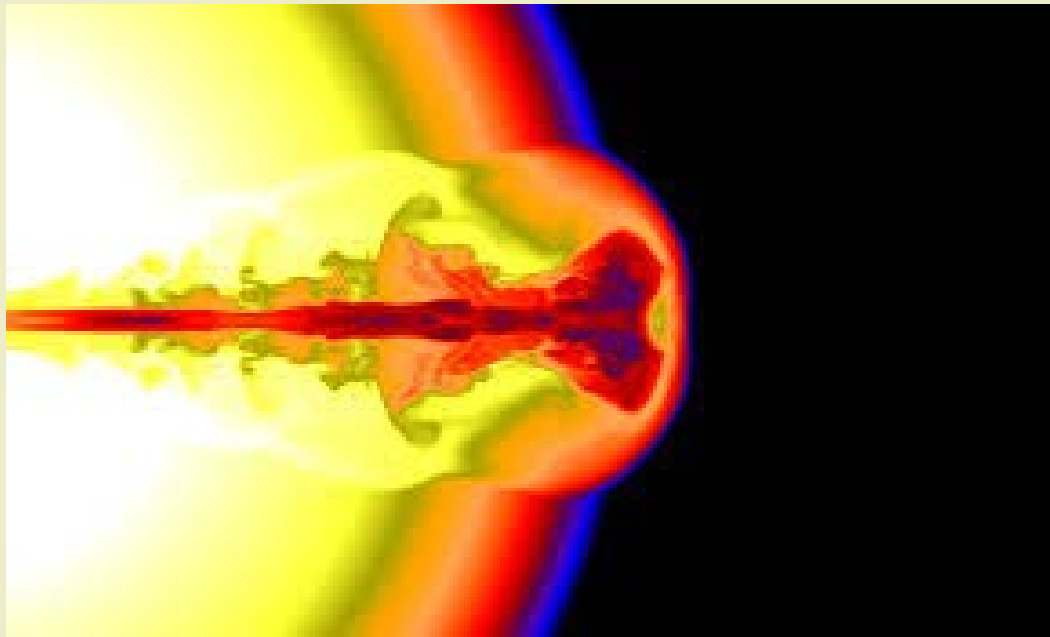
Two origins?





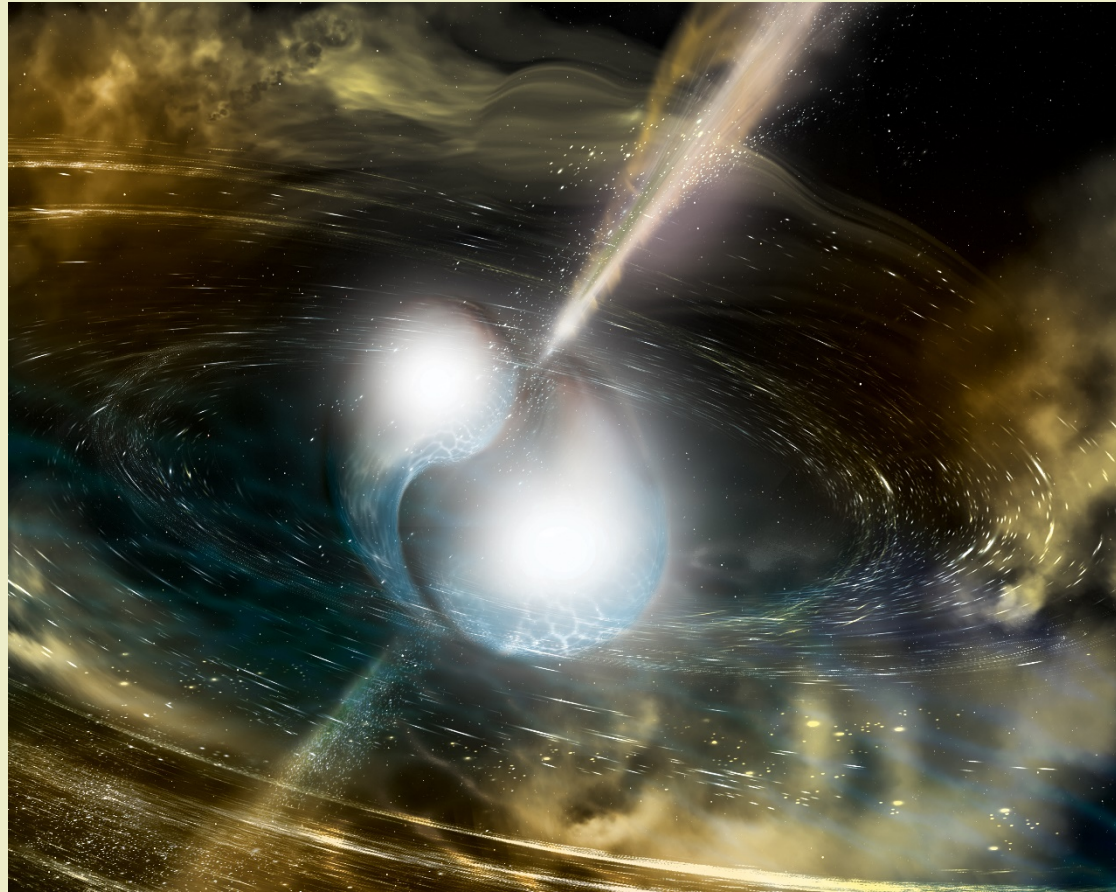
Hubble images of host galaxies of long GRBs (Andrew Fruchter, STScI)

Long GRBs: Collapsar: Jet Breakout



simulation: Woosley and Zhang,
Lawrence Berkeley Laboratory

Short GRBs: Merger of Binary Neutron Stars



Questions

Are there more than two origins for GRBs?

The rate of GRBs varies with cosmic distance (age) and heavy element abundance. How common (rare) are GRBs near to us?

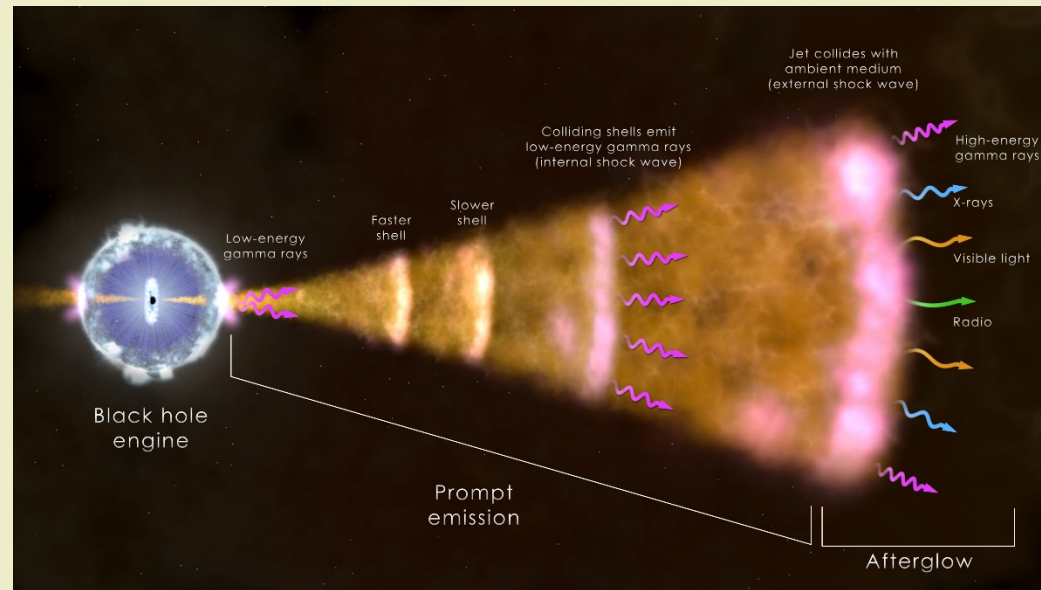
Questions

Can we fully explain the spectra of GRBs?

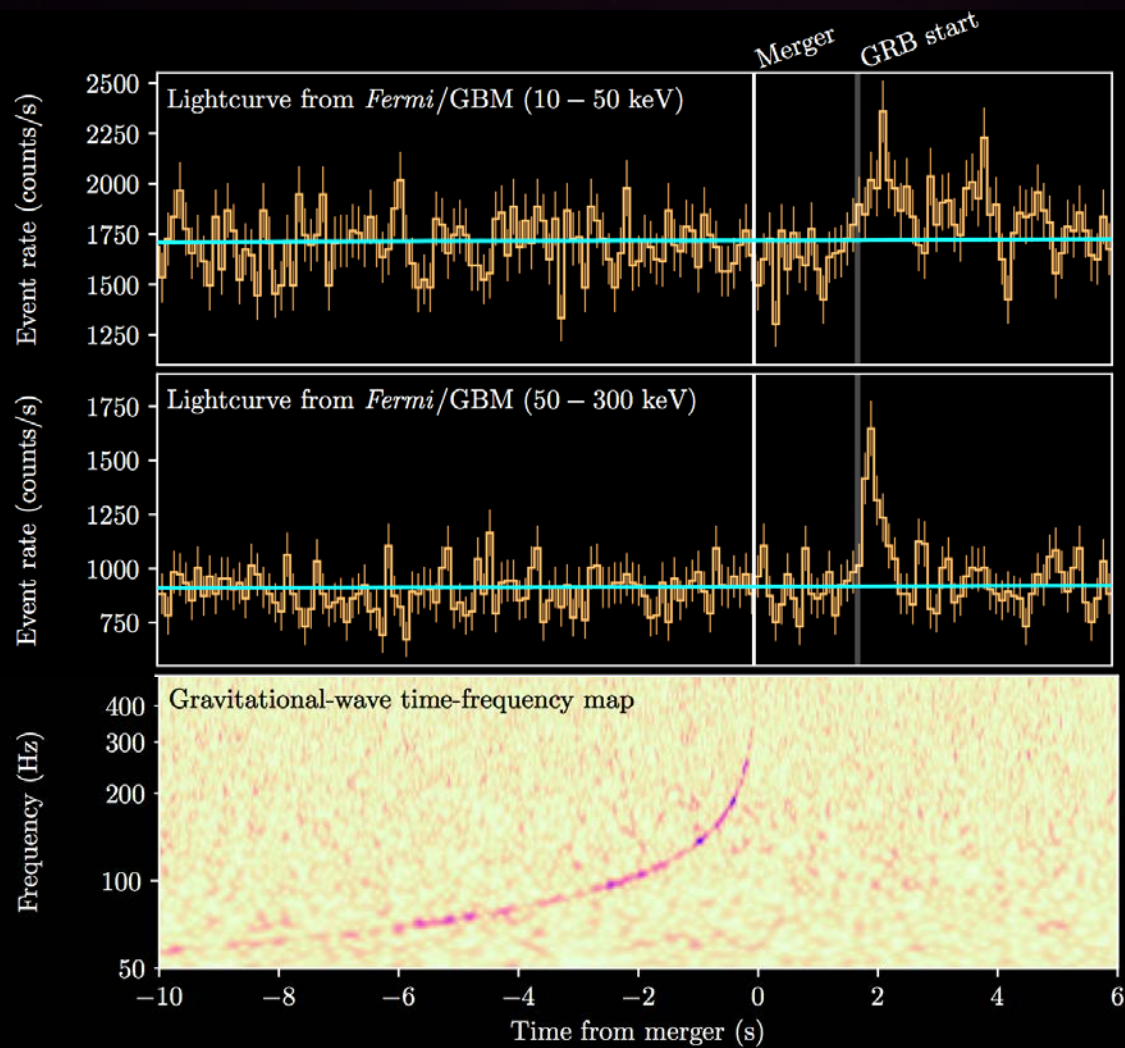
Especially for short GRBs:

what are the opening angles of the jet beams?

And thus, what are their true energies?



T0+0 s



T0+16 s

<https://gcn.gsfc.nasa.gov/other/524666471.fermi>

////////////////////////////////////

TITLE: GCN/FERMI NOTICE

NOTICE_DATE: Thu 17 Aug 17 12:41:20 UT

NOTICE_TYPE: Fermi-GBM Alert

RECORD_NUM: 1

TRIGGER_NUM: 524666471

GRB_DATE: 17982 TJD; 229 DOY; 17/08/17

GRB_TIME: 45666.47 SOD {12:41:06.47} UT

TRIGGER_SIGNIF: 4.8 [sigma]

TRIGGER_DUR: 0.256 [sec]

E_RANGE: 3-4 [chan] 47-291 [keV]

ALGORITHM: 8

DETECTORS: 0,1,1, 0,0,1, 0,0,0, 0,0,0, 0,0,

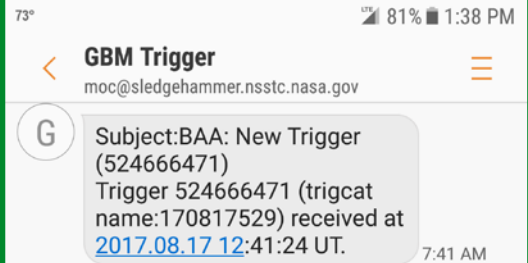
LC_URL:

http://heasarc.gsfc.nasa.gov/FTP/fermi/data/gbm/triggers/2017/bn170817529/quicklook/glg_lc_medres34_bn170817529.gif

COMMENTS: Fermi-GBM Trigger Alert.

COMMENTS: This trigger occurred at longitude,latitude = 321.53,3.90 [deg].

COMMENTS: The LC_URL file will not be created until ~15 min after the trigger.



T0+27 s

First On-board Localization
and classification

Automate
d On-
ground
Localizati
on

T0+40 s



T0+40 min

LIGO Report on GW Trigger Coincident with GRB

Subject:[gbm+ligo] WAKE UP

Date:Thu, 17 Aug 2017 13:23:13 +0000

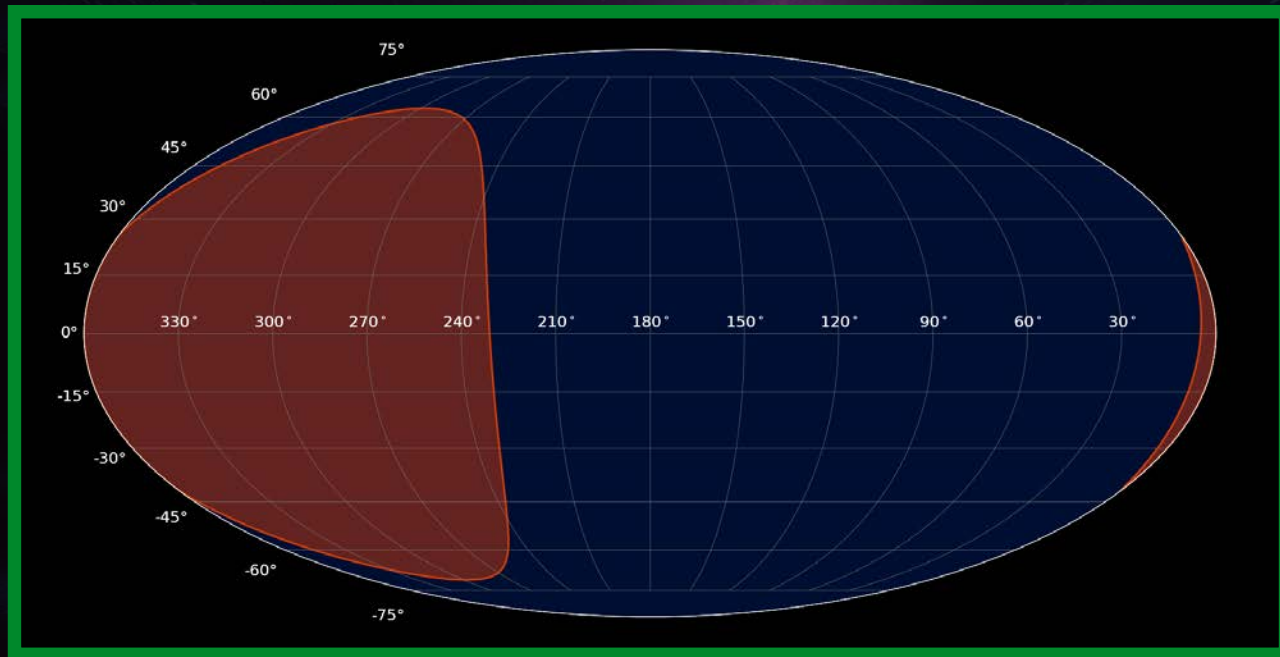
From:Littenberg, Tyson B. (MSFC-ST12) <[REDACTED]>

To:GBM+LIGO <[REDACTED]>

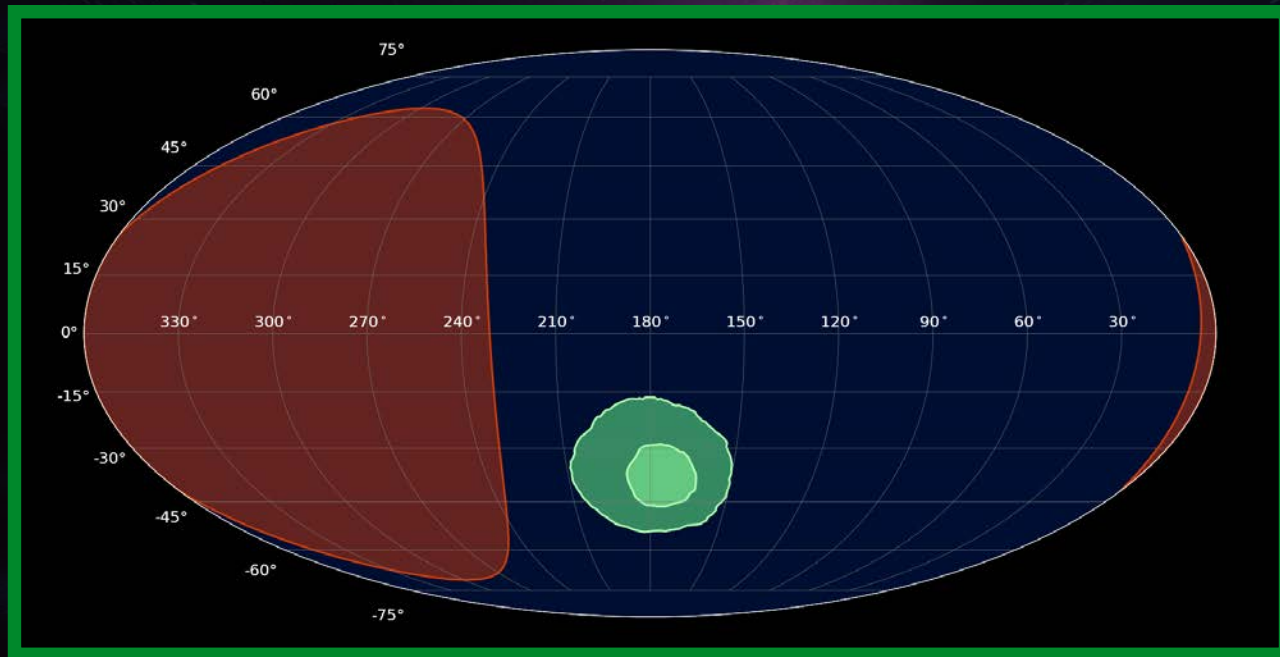
[ivo://nasa.gsfc.gcn/Fermi#GBM_Gnd_Pos_2017-08-17T12:41:06.47_524666471_57-431](https://nasa.gsfc.gcn/Fermi#GBM_Gnd_Pos_2017-08-17T12:41:06.47_524666471_57-431)

this morning's GBM trigger has a friend....

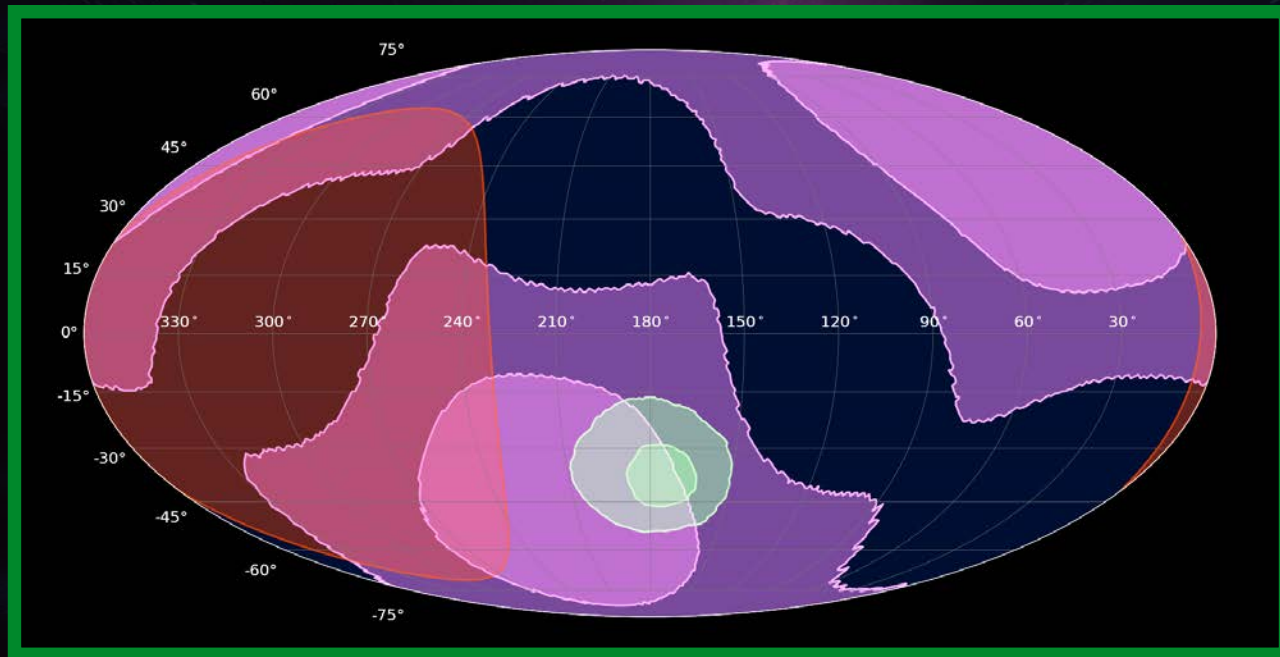
T0+45 min



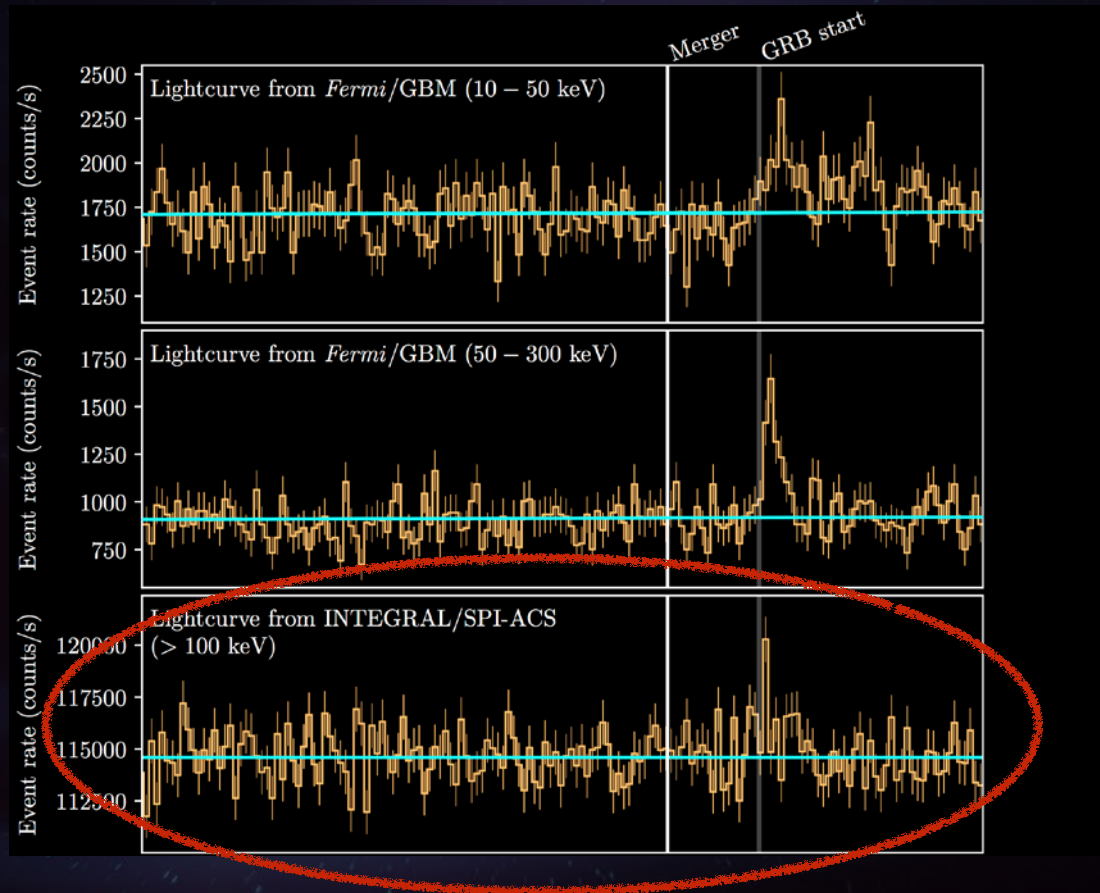
T0+45 min



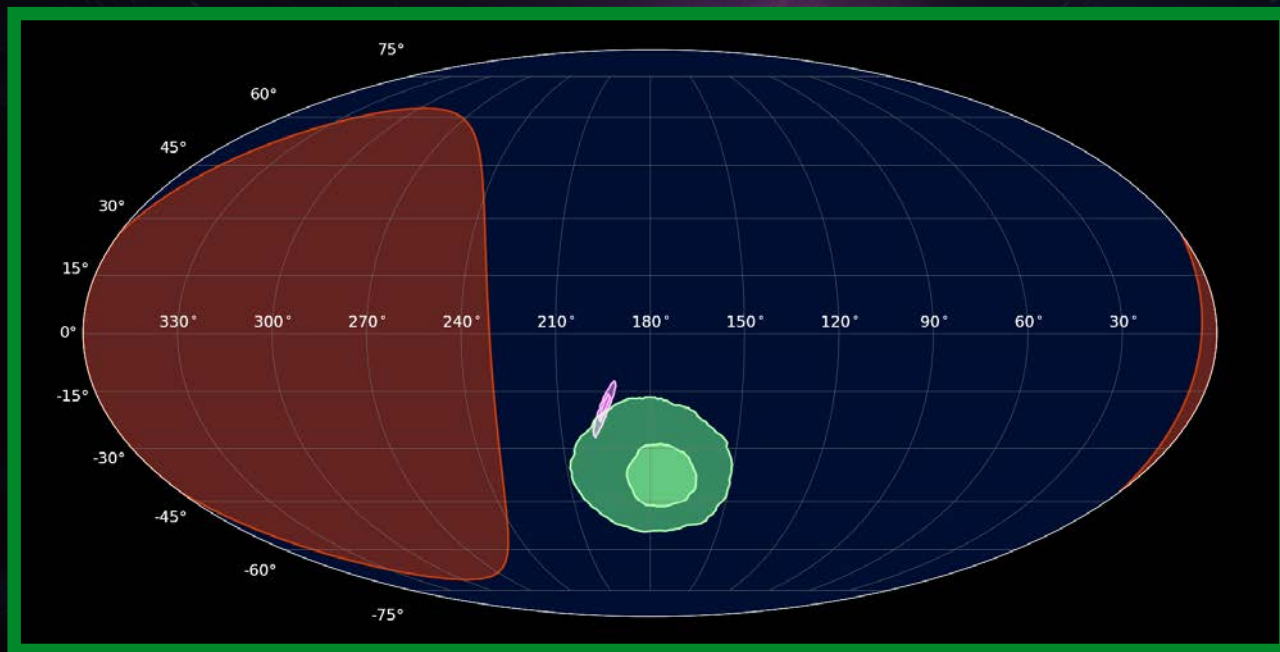
T0+45 min



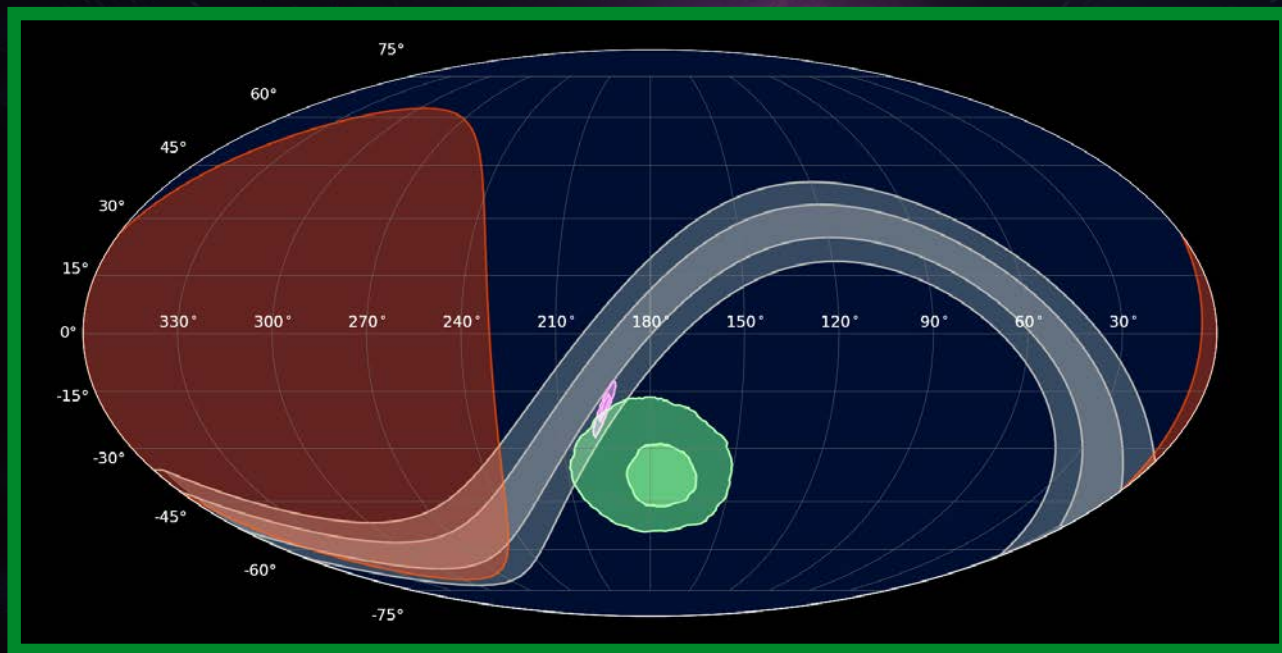
T0+77 min



T0+5 hr



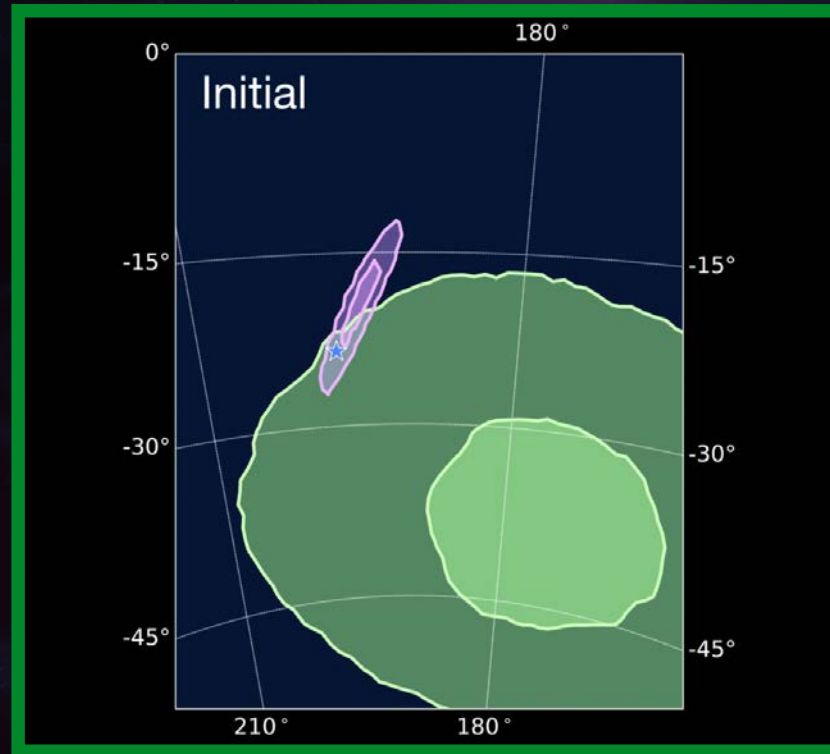
T0+6 hr



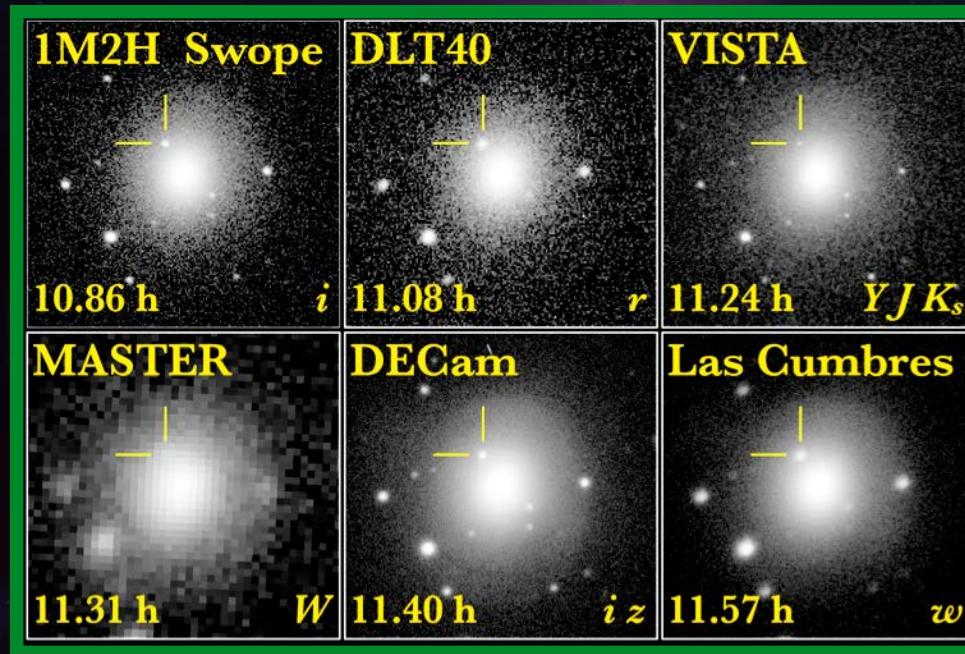
T0+7 hr

TITLE: GCN CIRCULAR
NUMBER: 21520
SUBJECT: GRB 170817A: Fermi GBM detection
DATE: 17/08/17 20:00:07 GMT
FROM: Andreas von Kienlin at MPE <azk@mpe.mpg.de>

T0+11 hr



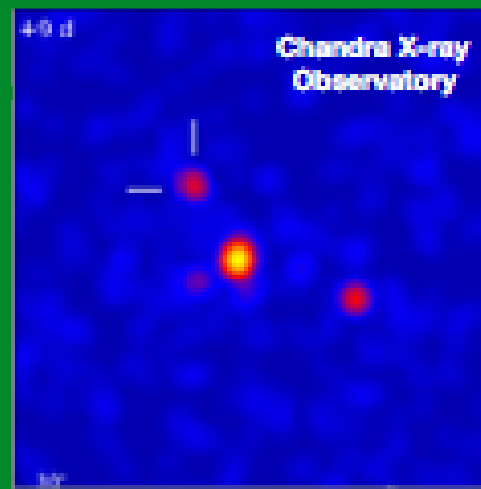
T0+12 hr



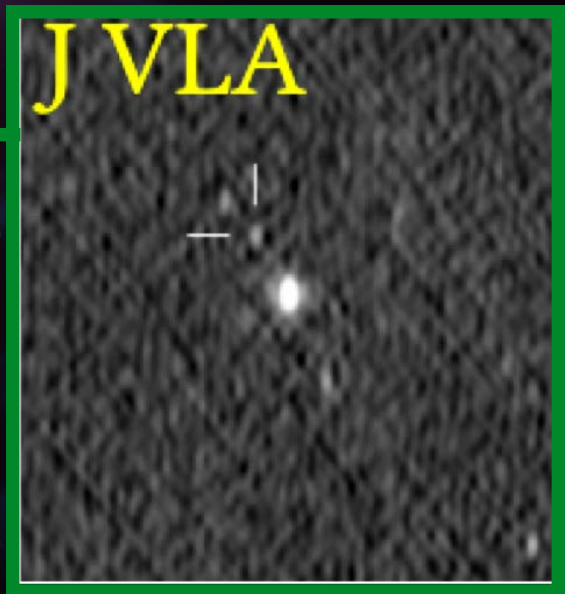
Overnight...



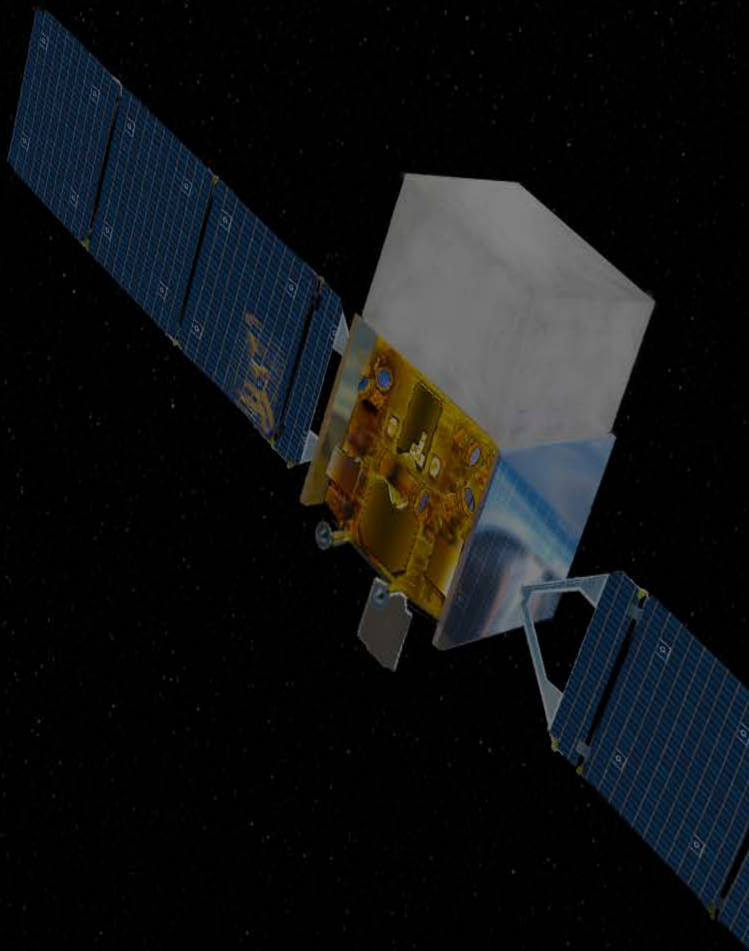
T0+13 days

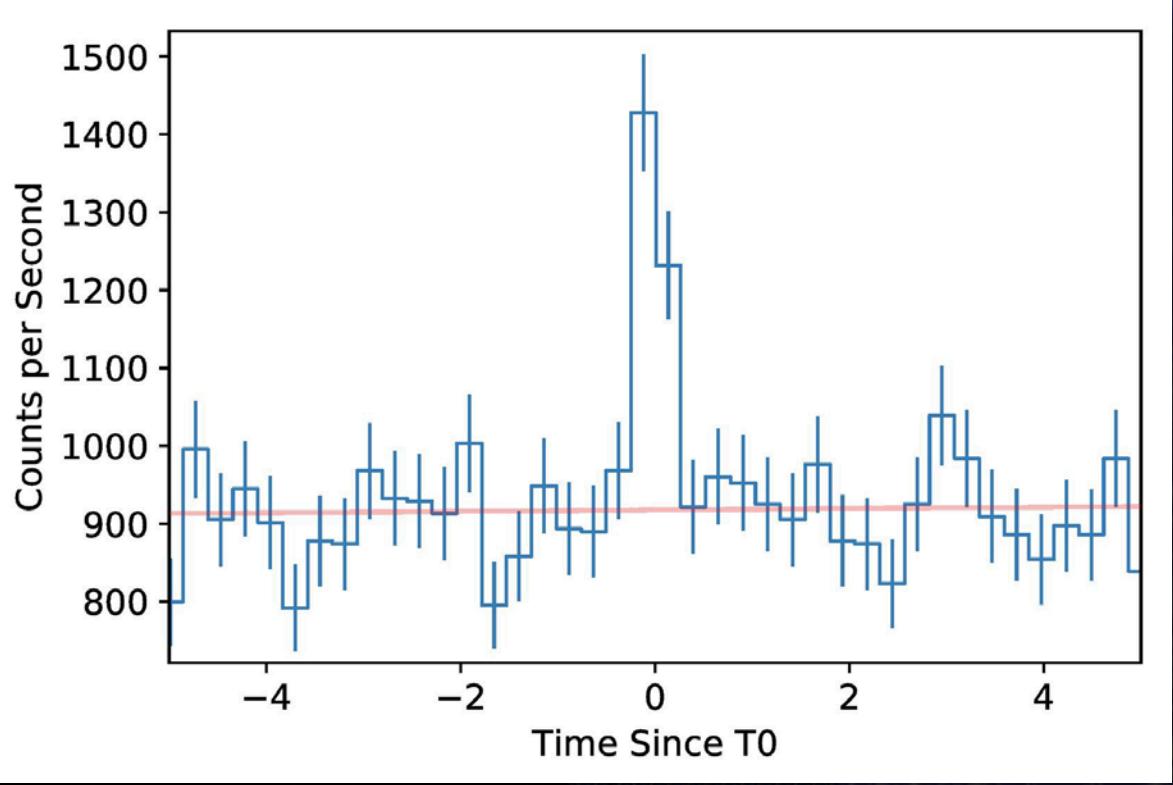


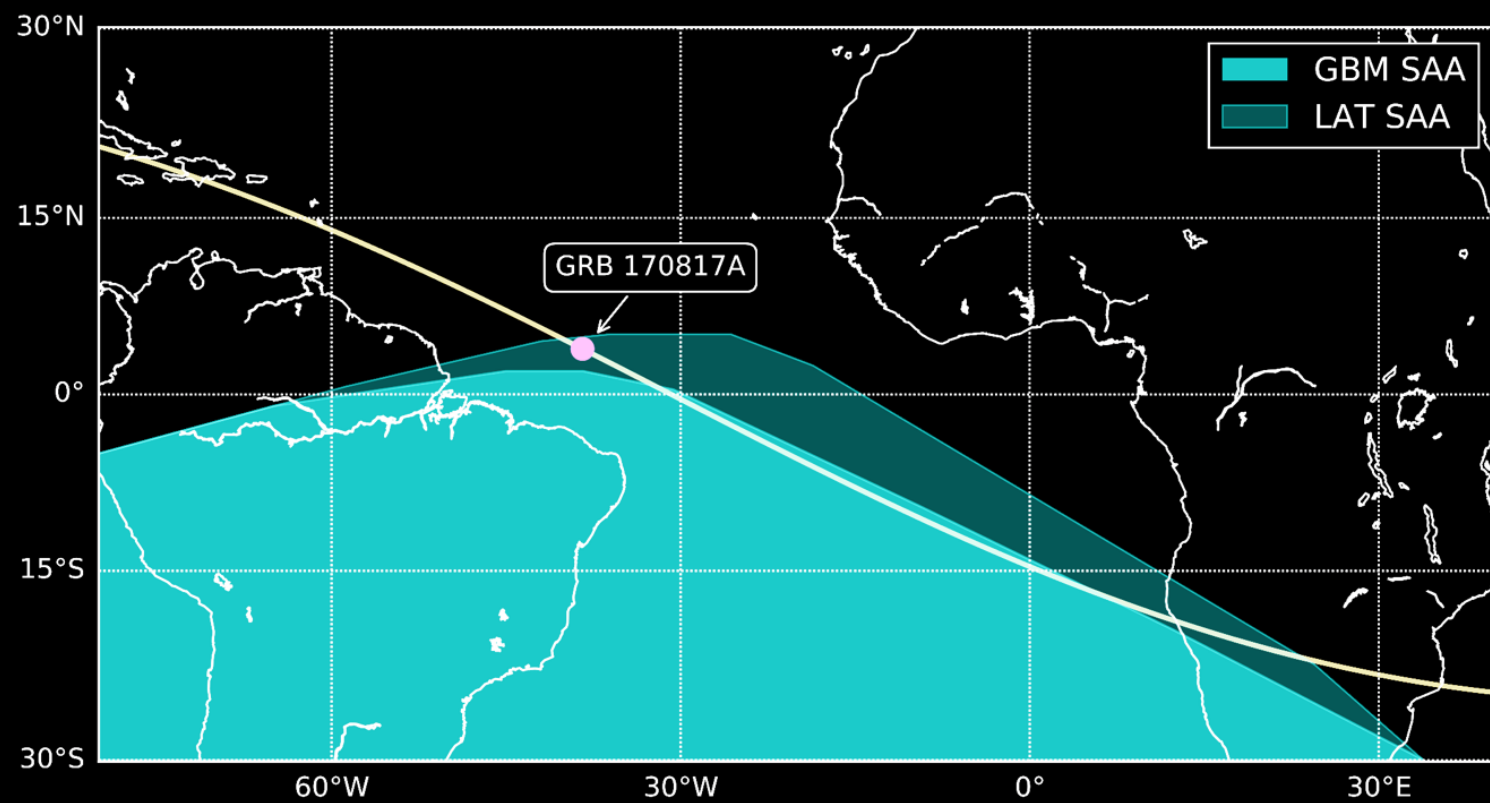
T0+18.5 days

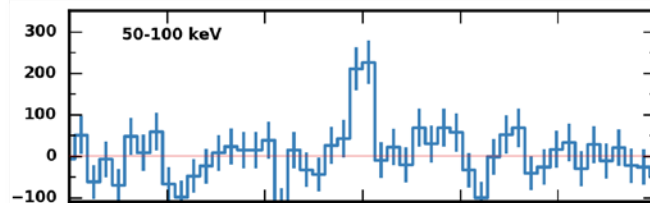
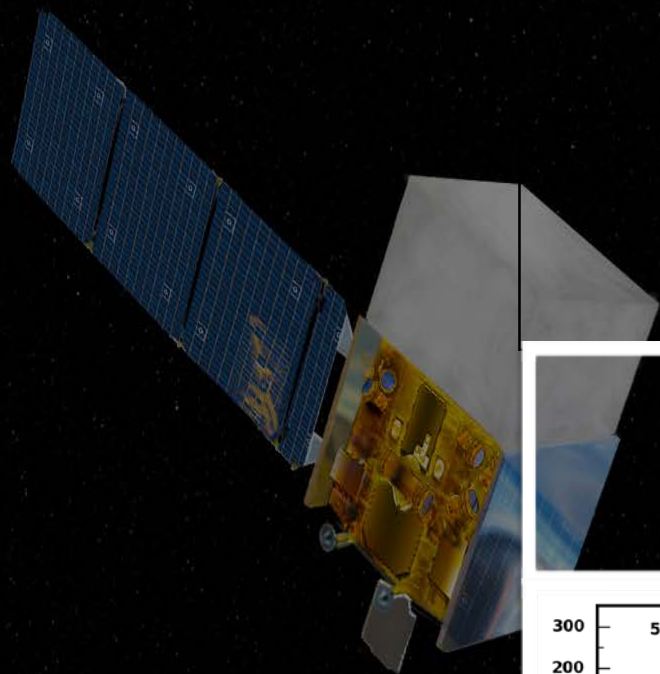












Time since GRB170817A

Earth

Space



THE ASTROPHYSICAL JOURNAL LETTERS

Focus on the Electromagnetic Counterpart of the Neutron Star Binary Merger GW170817

OPEN ACCESS

Multi-messenger Observations of a Binary Neutron Star Merger

B. P. Abbott *et al.* 2017 *ApJL* **848** L12

[+ View abstract](#)

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[PDF](#)

OPEN ACCESS

Gravitational Waves and Gamma-Rays from a Binary Neutron Star Merger: GW170817 and GRB 170817A

B. P. Abbott *et al.* 2017 *ApJL* **848** L13

[+ View abstract](#)

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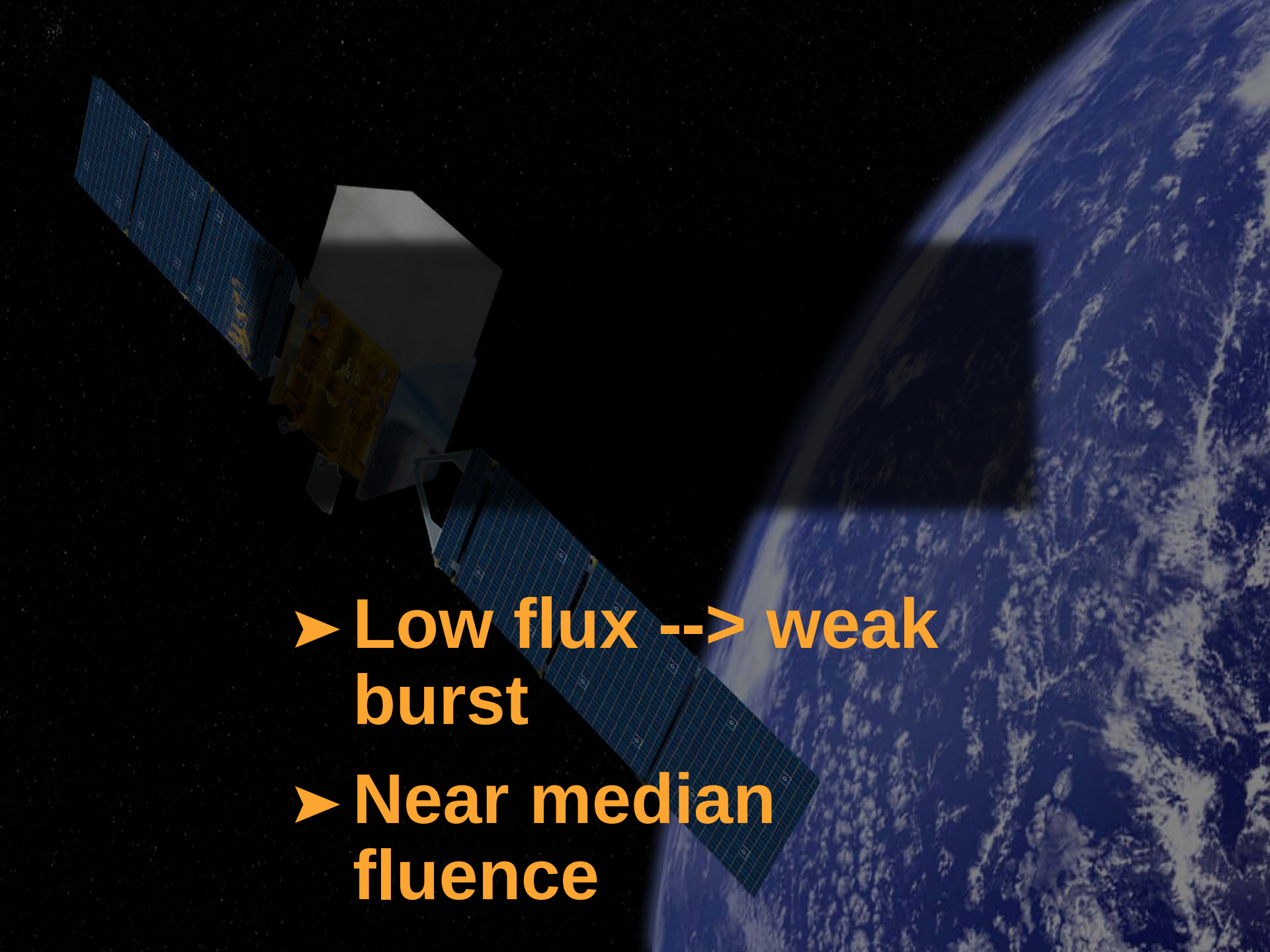
An Ordinary Short Gamma-Ray Burst with Extraordinary Implications: *Fermi*-GBM Detection of GRB 170817A

A. Goldstein *et al.* 2017 *ApJL* **848** L14

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[PDF](#)

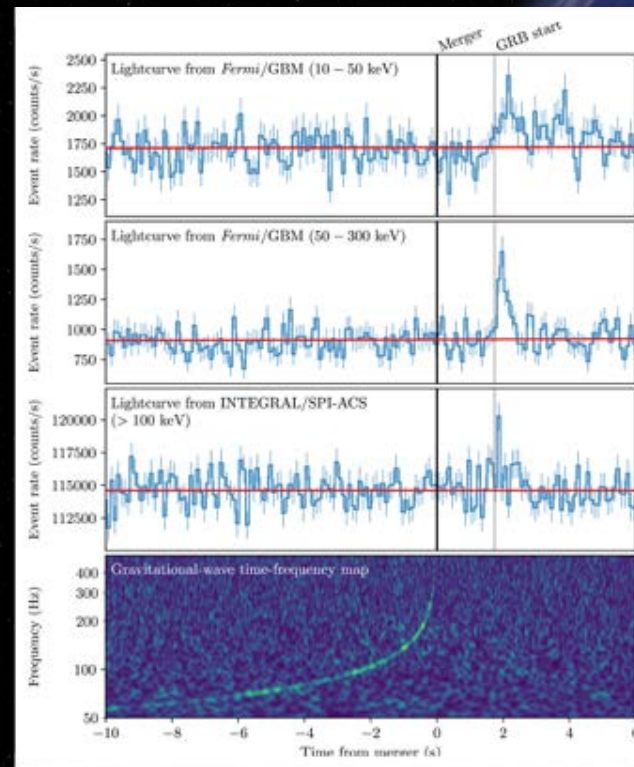
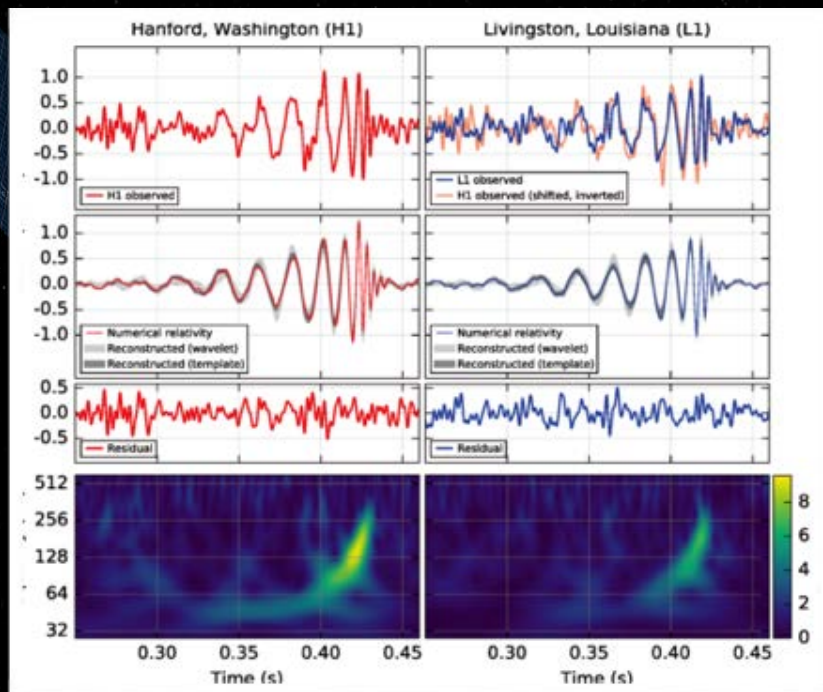
- 
- A satellite with two large solar panel arrays is shown in space. The Earth's blue and white cloud-covered surface is visible in the background on the right side of the frame. The satellite's body is white and gold, with various instruments and antennas visible.
- Low flux --> weak burst
 - Near median fluence

GW170817 / GRB 170817A Upper Limits on Gamma-ray Flux



Table 4
3 σ 24 hr Flux Upper Limits (Units of 10^{-9} erg s $^{-1}$ cm $^{-2}$) Over the HLV Map

Energy (keV)	Min	Max	Median
12–27	0.84	2.06	1.31
27–50	0.93	2.28	1.42
50–100	1.58	3.95	2.37
100–300	3.34	8.73	5.14
300–500	7.29	20.6	11.4
12–100	1.45	1.80	1.59



?

JOINT SUB- THRESHOLD ► On-call Burst SEARCHES Advocate

TITLE: GCN CIRCULAR
NUMBER: 21505
SUBJECT: LIGO/Virgo G298048: Fermi GBM trigger 524666471/170817529:
LIGO/Virgo Identification of a possible gravitational-wave counterpart
DATE: 17/08/17 13:21:42 GMT
FROM: Reed Clasey Essick at MIT <ressick@mit.edu>

The LIGO Scientific Collaboration and the Virgo Collaboration report:

The online CBC pipeline (gstlal) has made a preliminary identification of a GW candidate associated with the time of Fermi GBM trigger 524666471/170817529 at gps time 1187008884.47 (Thu Aug 17 12:41:06 GMT 2017) with RA=186.62deg Dec=-48.84deg and an error radius of 17.45deg.

The candidate is consistent with a neutron star binary coalescence with False Alarm Rate of $\sim 1/10,000$ years.

An offline analysis is ongoing. Any significant updates will be provided by a new Circular.

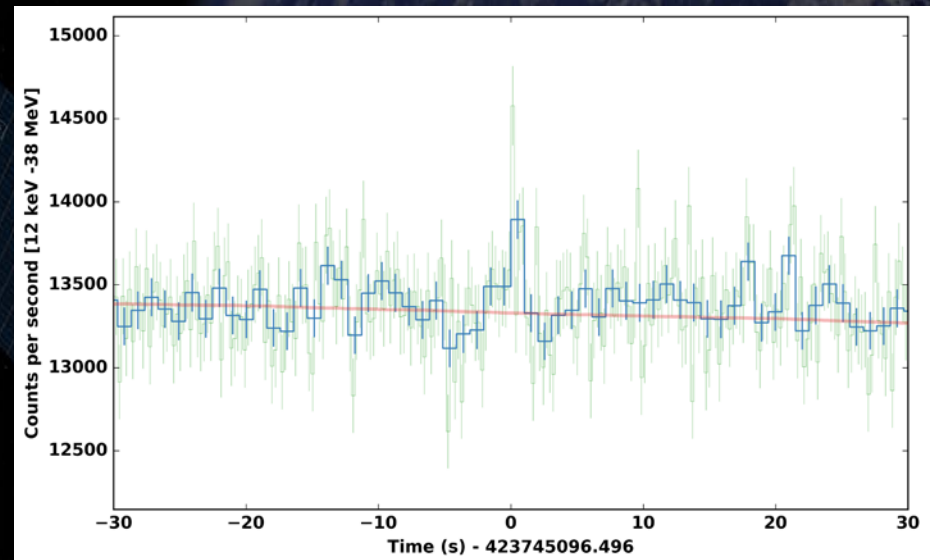
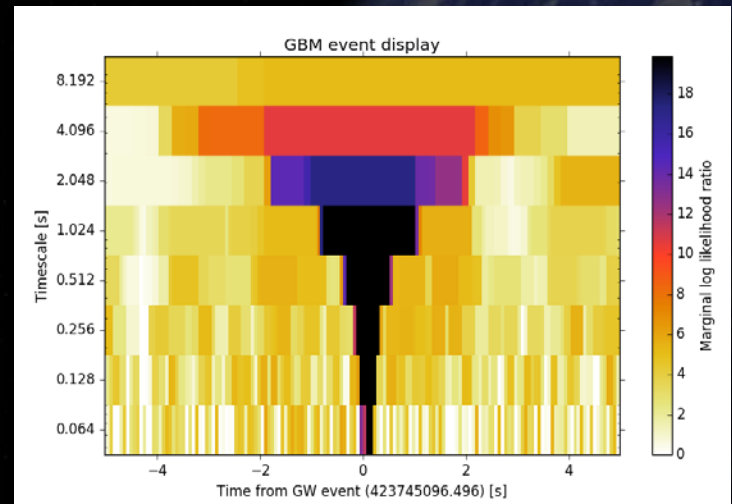
[GCN OPS NOTE(17aug17): Per author's request, the LIGO/VIRGO ID was added to the beginning of the Subject-line.]

JOINT SUB-

THRESHOLD

► On-call Burst
SEARCHES
Advocate

► Targeted search



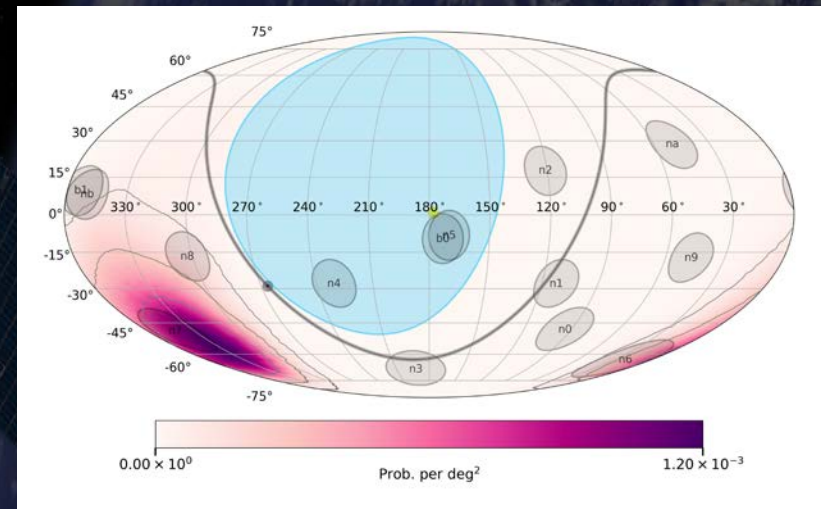
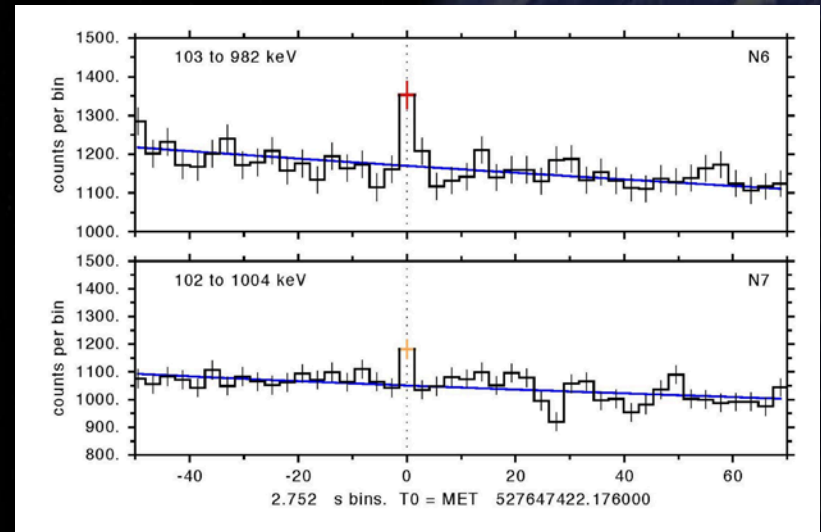
JOINT SUB-

THRESHOLD

➤ On-call Burst
SEARCHES
Advocate

➤ Targeted search

➤ Untargeted search



SO MANY QUESTIONS...

- How do we explain the soft tail of GRB 170817A?
- Do all short GRBs come ~ 2 s later?
- How wide are GRB jets?
- Neutrinos?

The image shows the Fermi Gamma-ray Space Telescope in orbit above Earth. The satellite is a cube-shaped spacecraft with two large, rectangular solar panel arrays extended from its sides. The panels are covered in a grid of blue solar cells. The central body of the satellite is white and gold, with various instruments and antennas visible. The Earth's blue and white cloud-covered surface is visible in the background, curving along the horizon. The text "Happy 10th, Fermi!@nasafermi" is overlaid on the right side of the image in a bold, orange, sans-serif font.

***Happy 10th,
Fermi!@nasafermi***