



Fermi

Gamma-ray Space Telescope



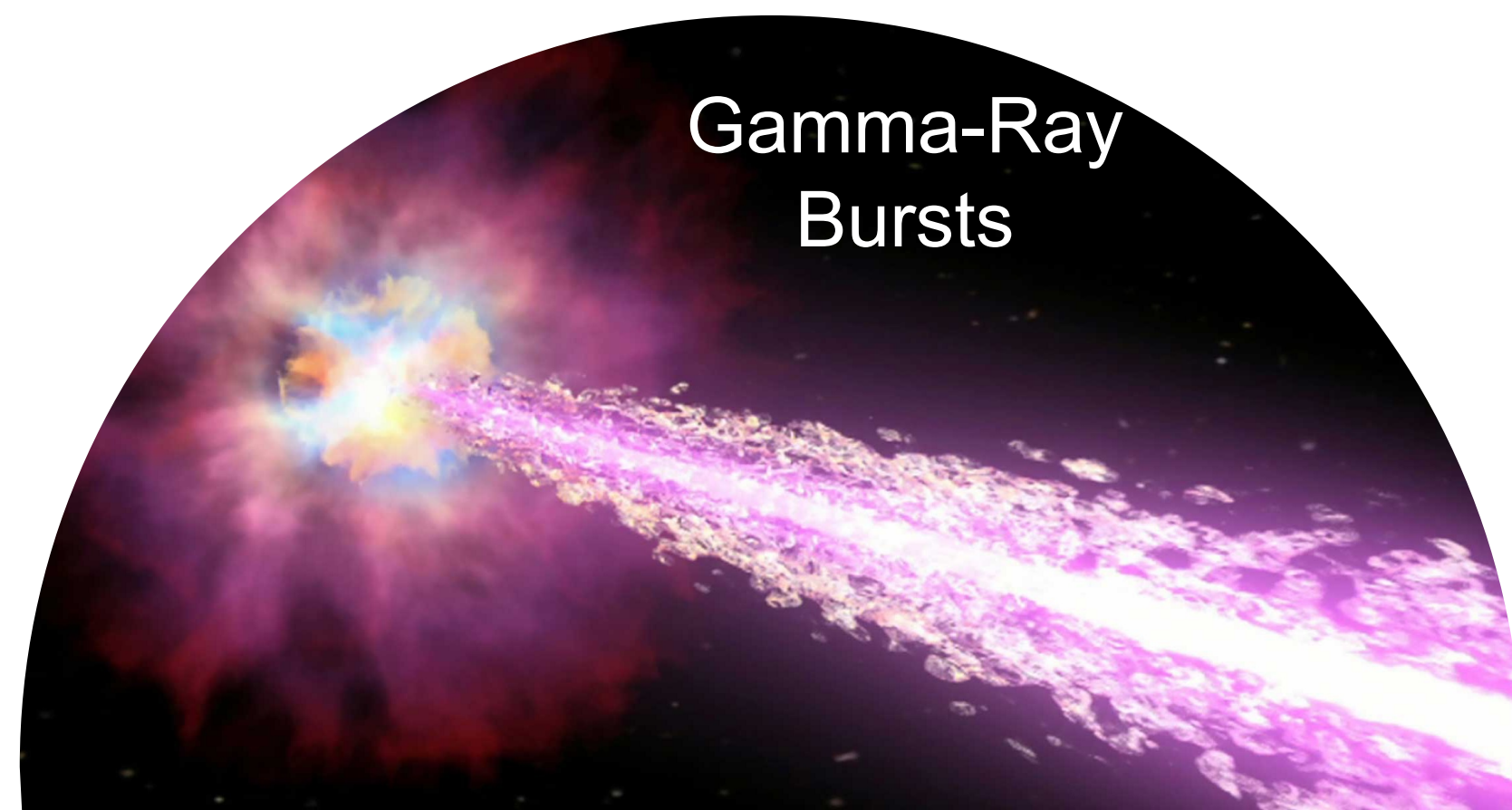
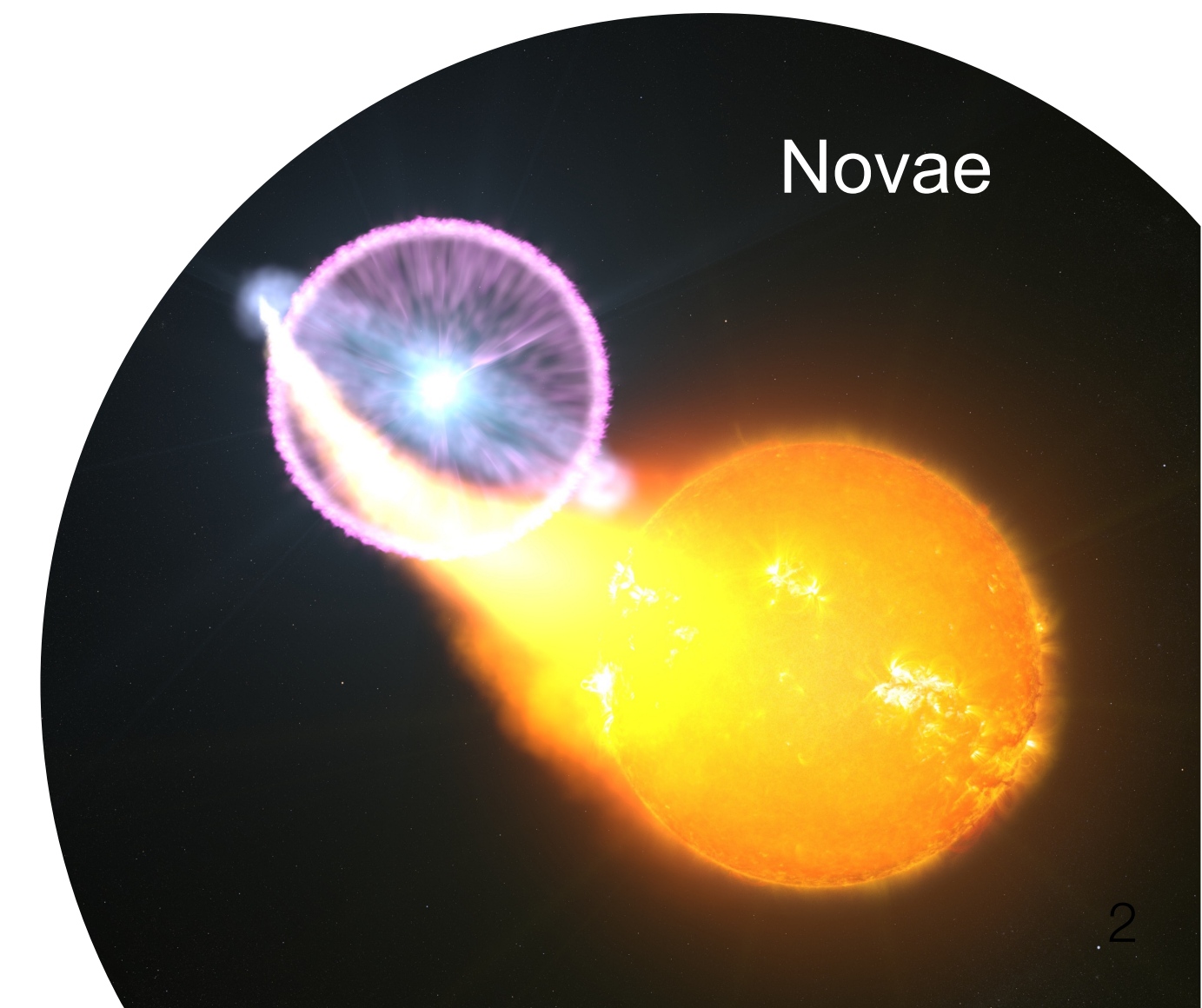
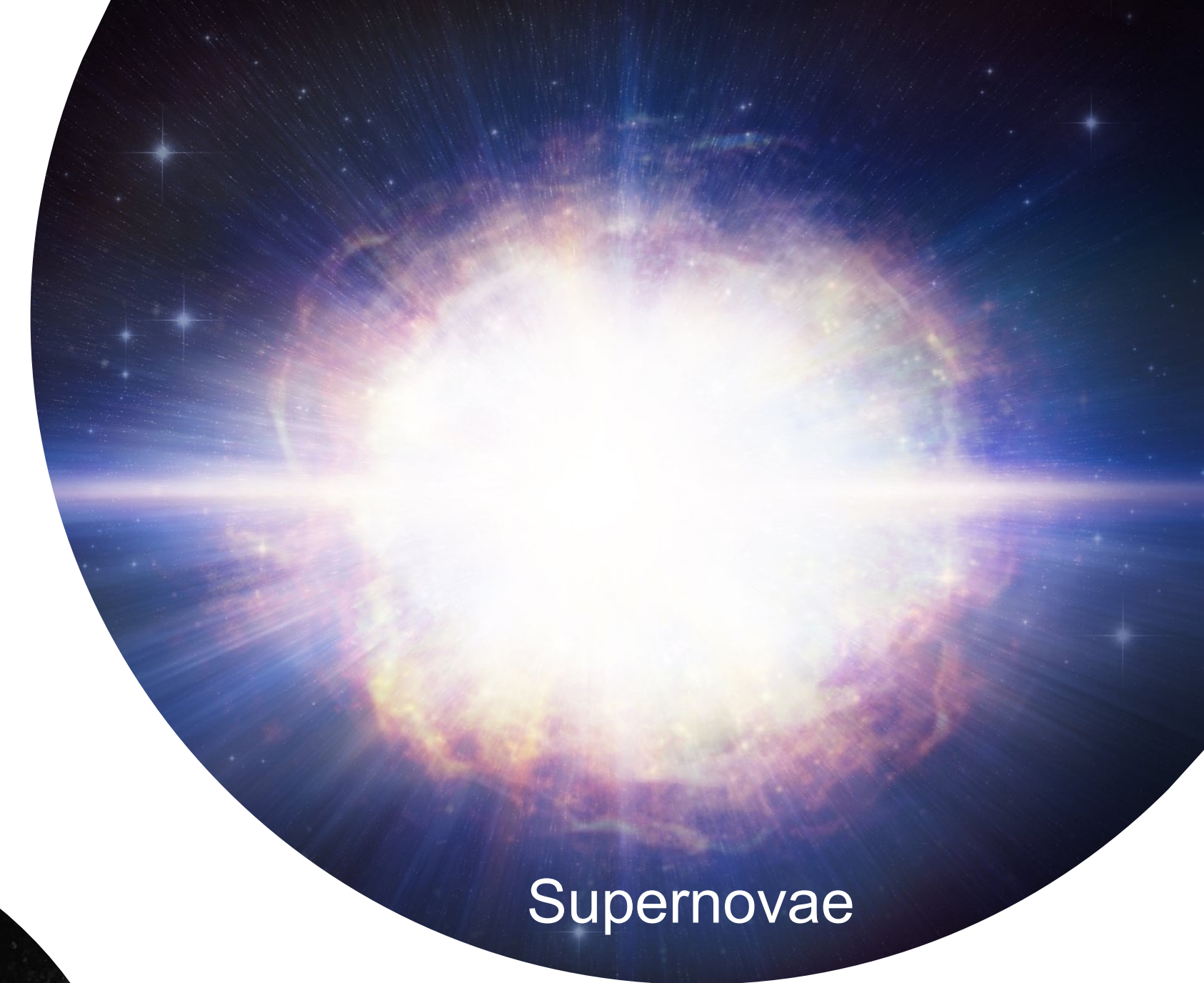
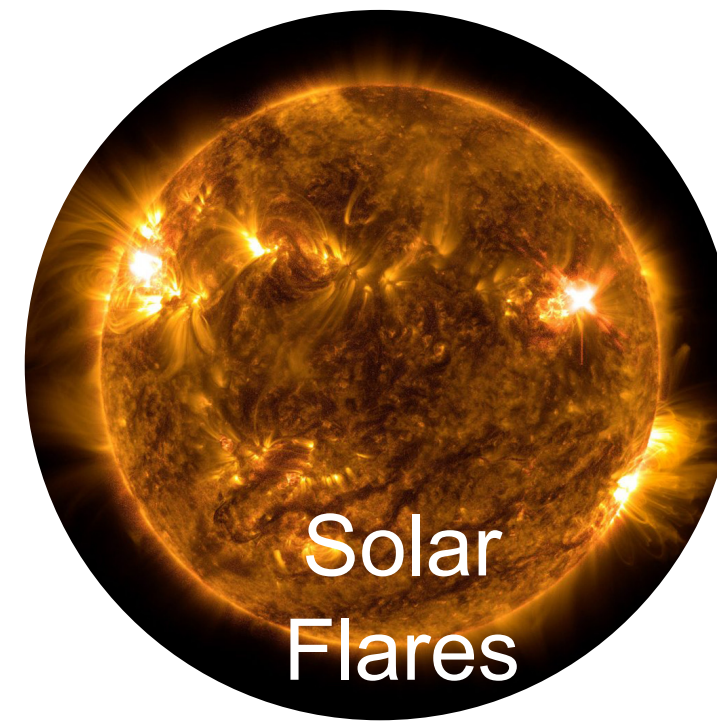
# Finding Information about High-Energy Transients

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(NASA/GSFC)**

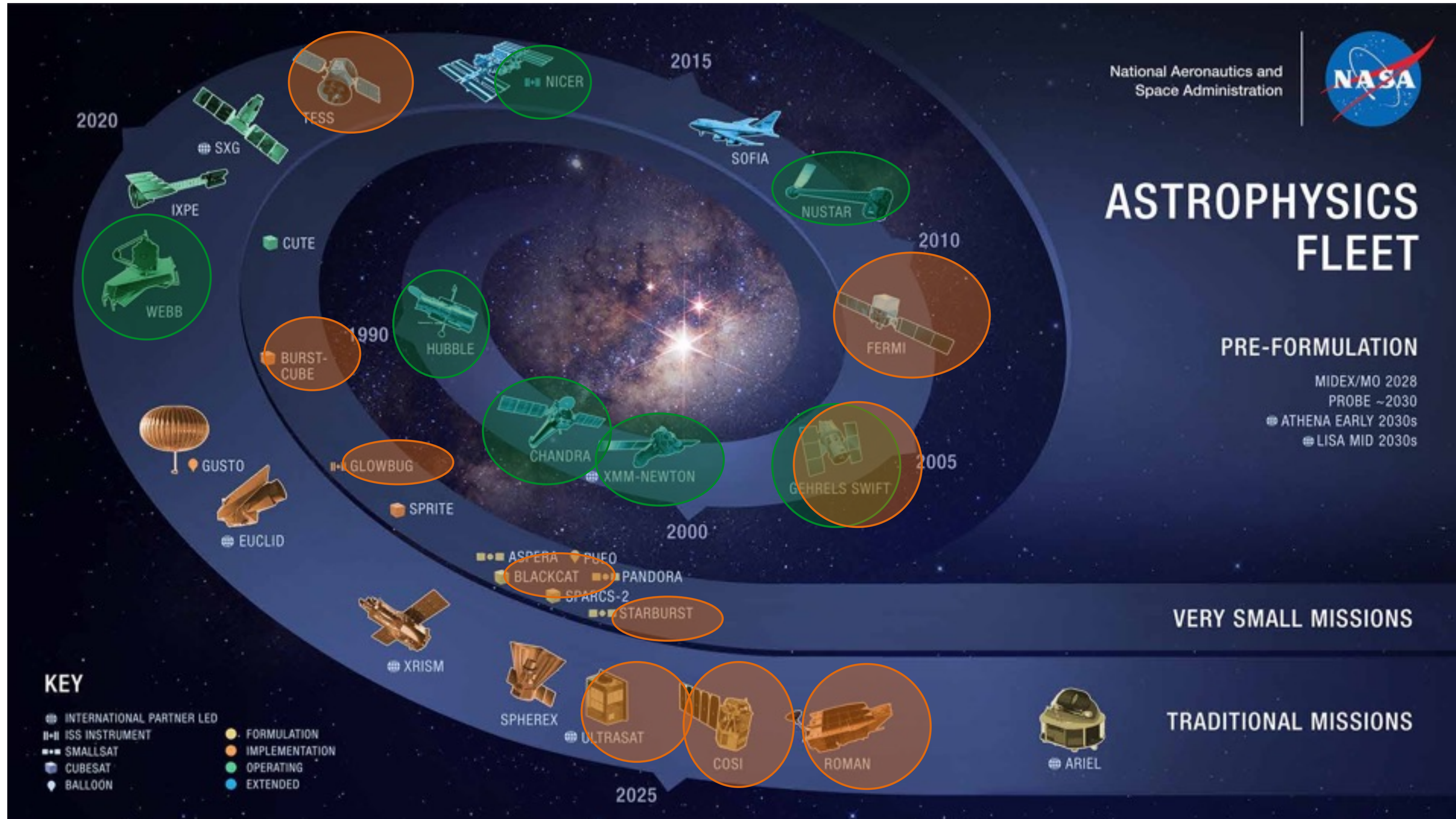
*Fermi Summer School, June 2023*

# Fast Astronomical Transients

- Regularly detected by ground- and space-based observatories
- Initially outburst on timescales of milliseconds to days
- Detection and follow-up observations across electromagnetic spectrum (radio to very high-energy gamma-ray)



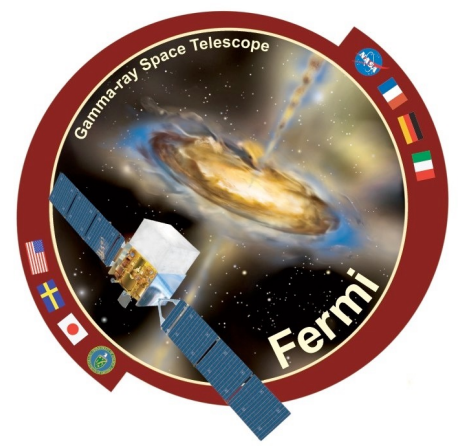
# NASA's Astrophysics Observatories



Transient Discoverers

Transient Follow-up Characterizers

# What kind of transients are you looking for?



<b>Transient Type</b>	<b>Where to find them?</b>	<b>Type of Information</b>
GRBs GWs Neutrinos AGN (LAT)	GCN <a href="https://gcn.nasa.gov">https://gcn.nasa.gov</a>	Machine-generated Notices Human-generated Circulars
Flaring Blazars Galactic Transients Neutrinos SNe	ATel <a href="https://www.astronomerstelegam.org">https://www.astronomerstelegam.org</a>	Human-generated Telegrams
Optical Transients	Transient Name Server <a href="https://www.wis-tns.org">https://www.wis-tns.org</a>	Transient Names AstroNotes
Optical Transients	Rubin/LSST Alert Brokers <a href="https://www.lsst.org/scientists/alert-brokers">https://www.lsst.org/scientists/alert-brokers</a>	Automated alert messages filtered and classified by brokers



# Fermi Transient Searches

Pipelines  
Timescale  
Transients

**Pipeline**  
Method  
Timescale  
Distribution  
Status

**LAT Transient Factor (LTF)**  
Likelihood Around GBM/BAT triggers  
seconds to orbits  
LAT Team - Results in GCNs  
Triggered + Blind Search

**Fermi All-sky Variability Analysis (FAVA)**  
Aperture Photometry, 1 week  
ATels, FAV catalogs

**Fermi LAT Light Curve Repository**  
Likelihood LAT Catalog Sources  
3 days, Weekly

**Fermi LAT Monitored Sources**  
Daily, Weekly above  $10^{-6} \text{ cm}^{-2}\text{s}^{-1}$

**GBM Targeted Search**  
ground search  
ms - s  
Temporal/Spatial Input

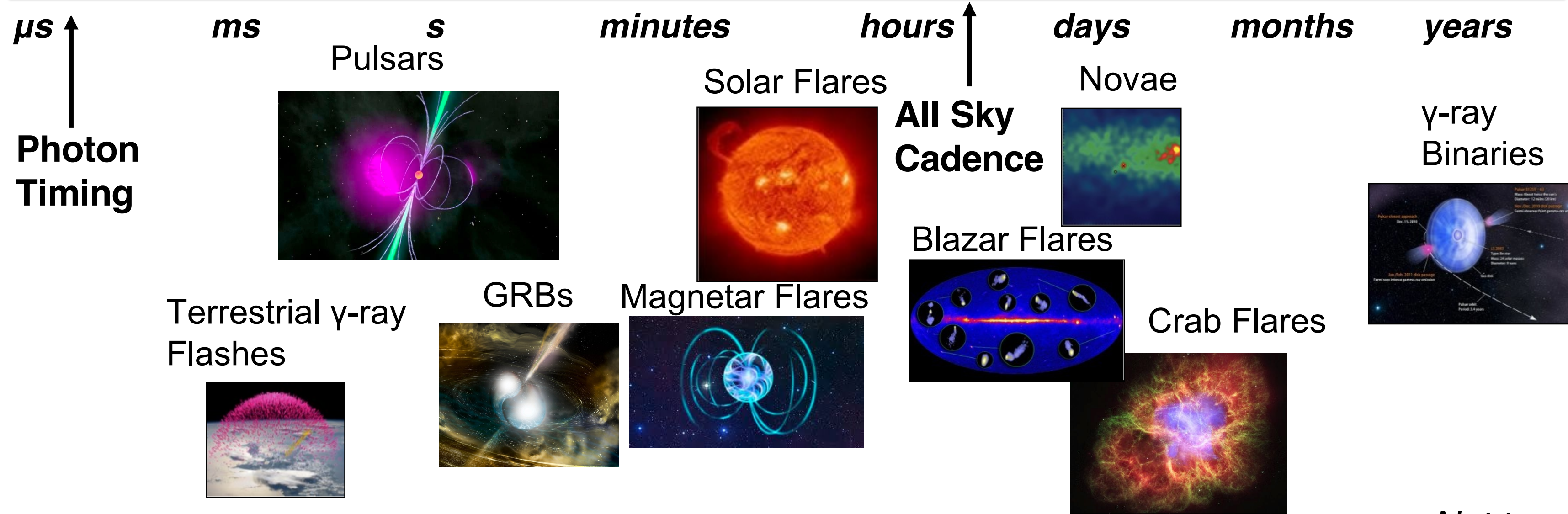
**LAT Burst Advocate Tool**  
Likelihood Around GBM/BAT triggers  
100 s, 1000 s  
LAT Team - Results in GCNs

**LAT Automated Science Processing (ASP) + Flare Advocates**  
Likelihood  
6 & 24 hour  
ATels, GCN notices (on AGN)

**LAT Catalogs**  
Likelihood, associations  
FGL, FHL, LAC, FLE, PSR


**GBM Untargeted Search**  
ground search  
ms - s  
GCN Notices


**GBM Onboard Triggers**  
rate triggers  
16 ms - minutes  
GCN Notices



Not to scale

- <https://fermi.gsfc.nasa.gov/ssc/data/access/lat/FAVA/>
- 1 week timescales
- binned data over a grid of regions on the sky
- searches for deviations from the expected flux based on the observed long-term average
- photometric approach advantages over a likelihood
  - independent of diffuse model
  - computationally inexpensive
  - no spectral shape assumptions


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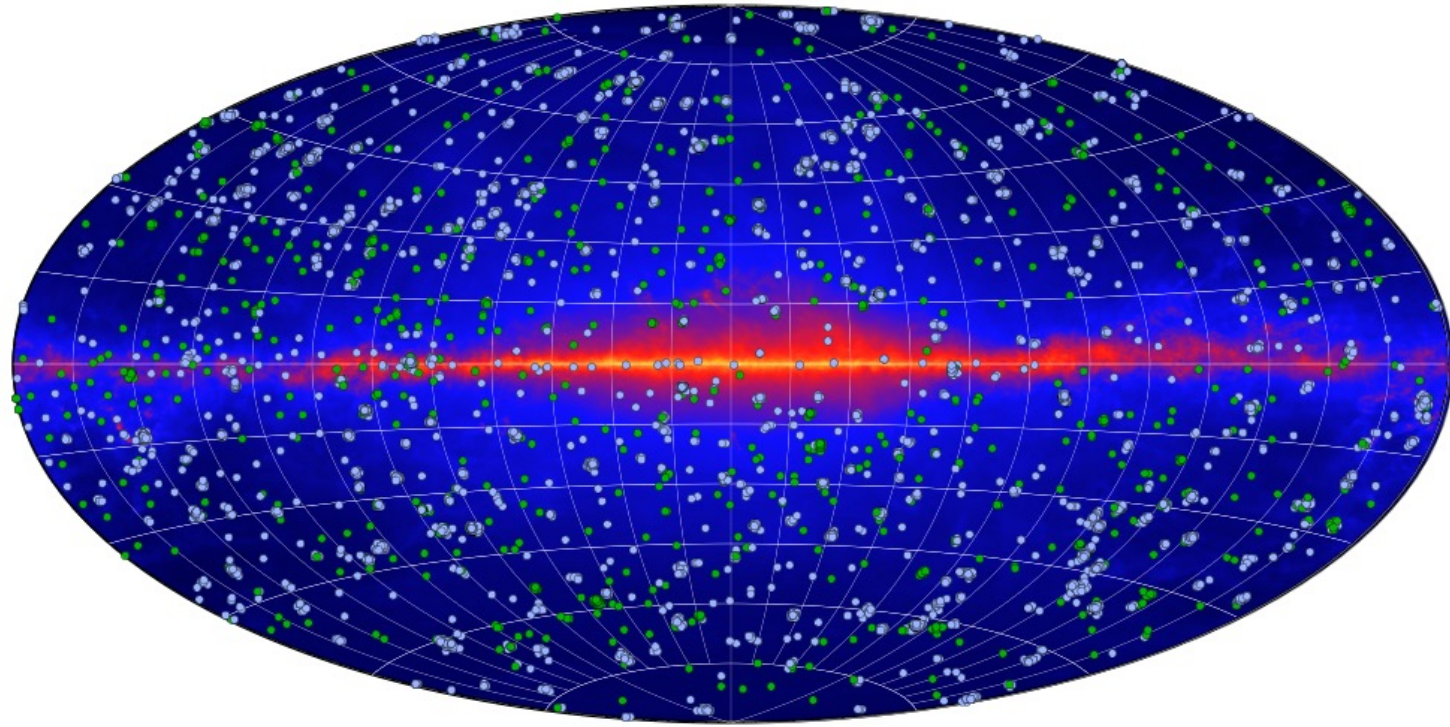

Fermi All-sky Variability Analysis (FAVA)

Light Curve Generator

RA:  
Dec:

[Submit](#)

FAVA Flare Map



FAVA Analysis Overview

Weeks Analyzed	766
FAVA Detections (>6σ)	8325
Associated Detections	7030
Unassociated Detections	1295

[FAVA Resources](#)  
[FAVA Weekly Flare List](#)  
[FAVA Light Curve Generator](#)  
[1st FAVA Catalog](#)  
[2nd FAVA Catalog](#)  
[About FAVA](#)


All analysis results presented here are preliminary unless otherwise stated. Please consult the about page for important details and caveats associated with this analysis.


Please reference Abdollahi et al. 2017 for any use of the presented results

Weekly FAVA Runs

Week Number	Start MET	Stop MET	Start Date	Stop Date
773	706463018	707067818	Mon 22 May 2023	Mon 29 May 2023
772	705858218	706463018	Mon 15 May 2023	Mon 22 May 2023
771	705253418	705858218	Mon 08 May 2023	Mon 15 May 2023
770	704648618	705253418	Mon 01 May 2023	Mon 08 May 2023
769	704043818	704648618	Mon 24 Apr 2023	Mon 01 May 2023
767	702834218	703439018	Mon 10 Apr 2023	Mon 17 Apr 2023
766	702229418	702834218	Mon 03 Apr 2023	Mon 10 Apr 2023
765	701624618	702229418	Mon 27 Mar 2023	Mon 03 Apr 2023
764	701019818	701624618	Mon 20 Mar 2023	Mon 27 Mar 2023
763	700415018	701019818	Mon 13 Mar 2023	Mon 20 Mar 2023
762	699810218	700415018	Mon 06 Mar 2023	Mon 13 Mar 2023
761	699205418	699810218	Mon 27 Feb 2023	Mon 06 Mar 2023
760	698600618	699205418	Mon 20 Feb 2023	Mon 27 Feb 2023
759	697995818	698600618	Mon 13 Feb 2023	Mon 20 Feb 2023
758	697391018	697995818	Mon 06 Feb 2023	Mon 13 Feb 2023
757	696786218	697391018	Mon 30 Jan 2023	Mon 06 Feb 2023
756	696181418	696786218	Mon 23 Jan 2023	Mon 30 Jan 2023
755	695576618	696181418	Mon 16 Jan 2023	Mon 23 Jan 2023
754	694971818	695576618	Mon 09 Jan 2023	Mon 16 Jan 2023

- <https://fermi.gsfc.nasa.gov/ssc/data/access/lat/LightCurveRepository/>
- 3 day, 1 week, 1 month likelihood analysis of catalog sources
- multi-cadence flux calibrated light curves for over 1500 sources deemed variable in the 10 year Fermi LAT point source (4FGL-DR2) catalog

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**Fermi LAT Light Curve Repository (LCR)**

**Catalog Search**

RA:  Dec:  Radius:

Keyword:

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**Map Options**

Coordinate System:

Celestial Projection:

**Coordinate Planes:**

Equatorial  Ecliptic

Galactic  Supergalactic

**Overlays:**

Source Info  Grid Lines

Constellations  Milky Way

Sun  Moon

**4FGL Marker Label:**

4FGL Name  Association

3FGL Assoc  Classification

**4FGL Marker Color:**

Hide Non-Variabile Sources

**4FGL Marker Size:**

Variability Index

Average Significance

Time-resolved Significance (3 day)

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**Data Overlays**

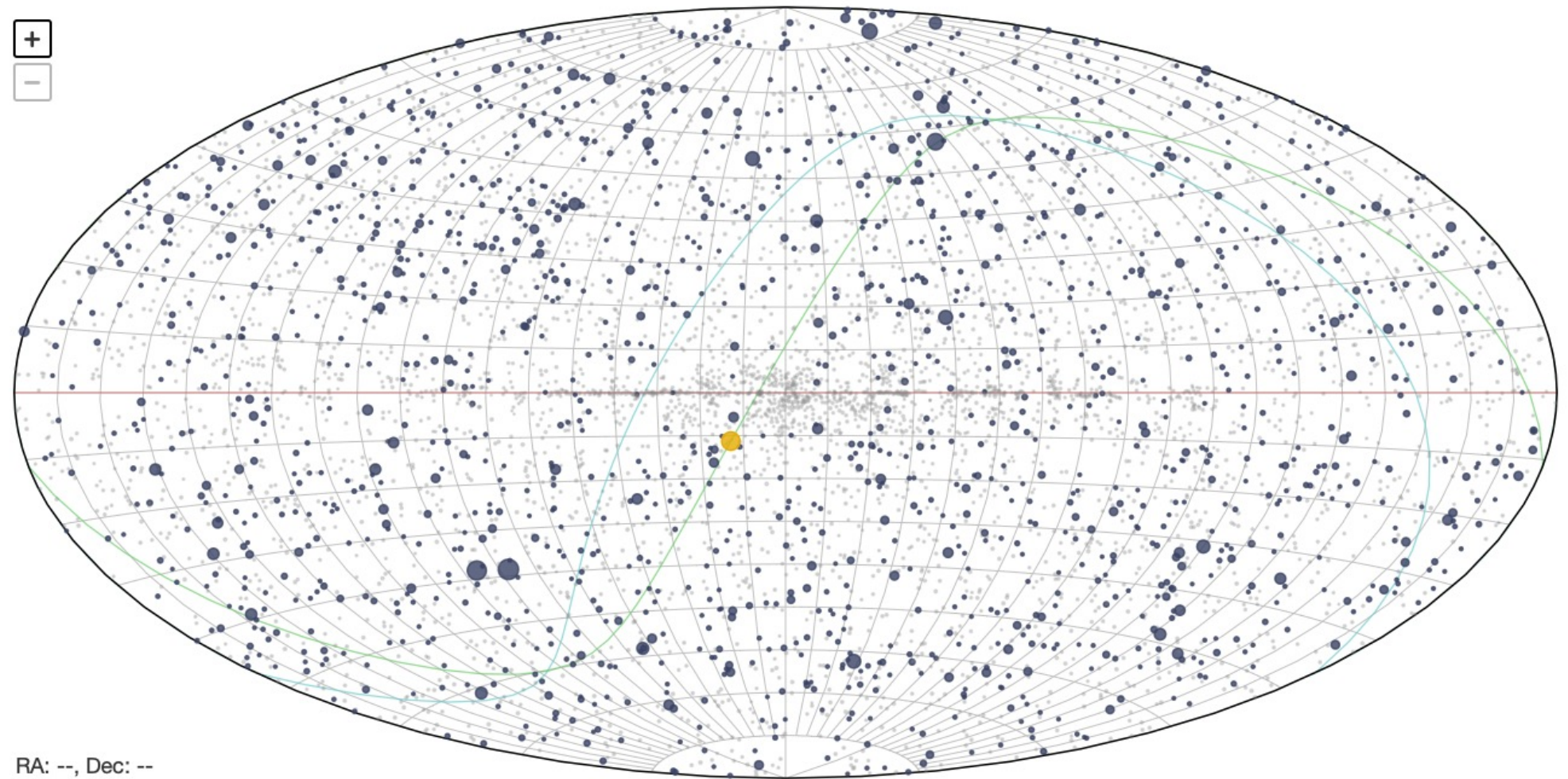
LAT Point Source Catalog (4FGL) [Abdollahi et al. 2020 - 5523 Sources](#)

2nd LAT GRB Catalog (2FLGC) [Ajello et al. 2019/GCN - 186 Detections](#)

IceCube Neutrino Alerts [GCN/AMON Notices](#)

FAVA Flare Catalog (2FAV) [Abdollahi et al. 2017 - 4309 Flares](#)

**Catalog Map**



RA: --, Dec: --

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**Catalog Sources**

4FGL

Source ID	RA	Dec	Gal l	Gal b	Association	Class	Variability Index	Photon Flux 1-100 GeV	Energy Flux 1-100 GeV	Average Significance	Spectrum Type	Spectral Index
4FGL J0000.3-7355	0.098	-73.922	307.709	-42.730			14.023	1.421e-10	1.622e-12	6.905	PowerLaw	2.194
4FGL J0000.5+0743	0.138	7.727	101.656	-53.029			17.717	1.730e-10	2.272e-12	5.369	PowerLaw	2.393
4FGL J0001.2+4741	0.313	47.686	114.250	-14.338	B3 2358+474	bcu	20.019	1.216e-10	1.407e-12	4.092	PowerLaw	2.222
<a href="#">4FGL J0001.2-0747</a>	0.315	-7.797	89.033	-67.305	PMN J0001-0746	bll	33.229	8.232e-10	9.171e-12	23.369	PowerLaw	2.105
<a href="#">4FGL J0001.5+2113</a>	0.382	21.218	107.649	-40.168	TXS 2358+209	fsrq	1564.418	1.359e-9	2.614e-11	44.135	LogParabola	2.548
4FGL J0001.6-4156	0.416	-41.943	334.226	-72.029	2MASS J00013275-4155252	bcu	16.149	3.049e-10	3.913e-12	15.611	PowerLaw	1.756
4FGL J0002.1-6728	0.538	-67.475	310.085	-48.963	SUMSS J000215-672653	bcu	13.479	2.417e-10	2.888e-12	13.141	PowerLaw	1.846
4FGL 0.542 67.358 118.203 4.939	0.542	67.358	118.203	4.939	1RXS	unk	8.473	6.618e-10	6.159e-12	7.332	LogParabola	2.615