High Energy Transients

Neil Gehrels
NASA-GSFC

Royal Society
April 23, 2012
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Early discoveries of γ-ray transients

Categories of transients

Fermi unexpected transients

Swift unexpected transients

The future

Swift operations
First GRB Detection

(Klebesadel, Strong & Olson 1973)

Vela Satellites - Los Alamos
First Solar Flare $\gamma$-Ray Detection

OSO-7 Detector

OSO-7 Dec 20, 1972

X-rays

Time

Counts s$^{-1}$

$\gamma$-rays

RHESSI July 23, 2002

Counts cm$^{-2}$ s$^{-1}$ keV$^{-1}$

Energy (keV)
Early Supernova $\gamma$-Ray Detection

GRIS Team – Alice Springs 1987

SN87A
847 keV Line

Teegarden, Tueller et al. 1988
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<th>Duration</th>
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<tr>
<td>GRB</td>
<td>msec - mins</td>
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<td>SGR</td>
<td>msec - sec</td>
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<tr>
<td>TDE</td>
<td>day - yrs</td>
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<tr>
<td>solar flare</td>
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Fermi LAT Sky $>10$ GeV
LAT Galactic transient – V407 Cyg

February 2010

10 March 2010

Nova: white dwarf + giant star symbiotic binary
673 Gamma Ray Bursts

http://grb.sonoma.edu/
673 GRB as of this yesterday
85% with X-ray detections
~60% with optical detection
201 with redshift (41 prior to Swift)
65 short GRBs localized (0 prior to Swift)
GRB 061121 = brightest long GRB

GRB 061210 = brightest short GRB

Short GRB
Oddball Events (1)

- **Short "GRB" 050925**: near galactic plane with soft spectrum and $T_{90}=0.07$ s. Galactic source or SGR? (Markwardt et al. 2005)

- **SN GRBs 060218**: nearby ($z \sim 0.033$), underluminous ($E_{\text{iso}} \sim \text{few } 10^9$), very long ($T_{90} = 35$ minutes) GRB with SN 2006aj

- **RS Oph 2006**: bright 60-day XRT outburst with super-soft state from recurrent nova. Such SSS CVs are thought to be precursors of SNe Ia. (Osborne et al. 2011)
Oddball Events (2)

- **GRBs 060505 & 060614**: nearby \((z \sim 0.1)\) GRBs with \(T_{90} >> 2s\) and no supernovae detected to deep limits. (~10 papers)

- **Hostless GRB 070125**: \(z < 1.5\) with no spectral absorption features and no host detected. Compact-star-forming cluster far from a galaxy?? (Cenko et al. 2008)
Oddball Events (3)

- Galactic "GRB" 070610: Galactic transient. Possibly a new class of BH binary fast X-ray nova. (Kasliwal et al. 2008)

Oddball Events (4)

- **EV Lac superflare**: 25 Apr 2008 hard X-ray superflare from dMe star triggers BAT (Osten et al. 2005)

- **Pulsing GRB 090709**: 8 s pulsations in prompt emission (Markwardt et al. 2009). Host galaxy indicating extragalactic origin (Perley et al. 2010)

- **GRB 101225 "Christmas burst"**: bizarre transient, either He star - NS merger GRB or galactic NS capturing an asteroid (Thöne et al. 2011; Campana et al. 2011)

- **TDE Sw J1644+57**: tidal disruption of a star by $10^6 M_\odot$ black hole at center of galaxy at $z=0.35$ (Bloom et al.; Levan et al.: Burrows et al.; Berger et al.)
The Future
Lobster Explorer Proposal

Wide Field Imager (WFI)
- Microchannel optic
- CCD detectors
- Wide-field, focusing optic (0.5 sr = 1600 sq deg)
- 0.2 – 5 keV
- Sky coverage: 50% of sky every 3 hours

InfraRed Telescope (IRT)
- Mirror diameter: 40 cm
- HgCdTe detector
- Wavelength range: 0.6 – 2.1 microns
- Multiband photometry, R=30 slit spectroscopy

Rapidly-slewing, autonomous spacecraft

GSFC
MIT
U. Arizona
U. Leicester
Italy
+ 100 scientists
Transient Science

![Graph showing the relationship between timescale (s) and X-ray flux (erg cm$^{-2}$ s$^{-1}$) for different transient phenomena.]

- SGR Flares
- LGRBs
- Thermonuclear Bursts
- SGRBs
- Sub-Luminous GRBs
- SN Ibc/II Breakout
- SN Ia Breakout
- Flare Stars
- SFXT
- Classical Novae
- Tidal Disruption
- Blazars
- AGN

**WFI Detectability**

**WFI Sensitivity**