

TIME-DOMAIN ASTRONOMY

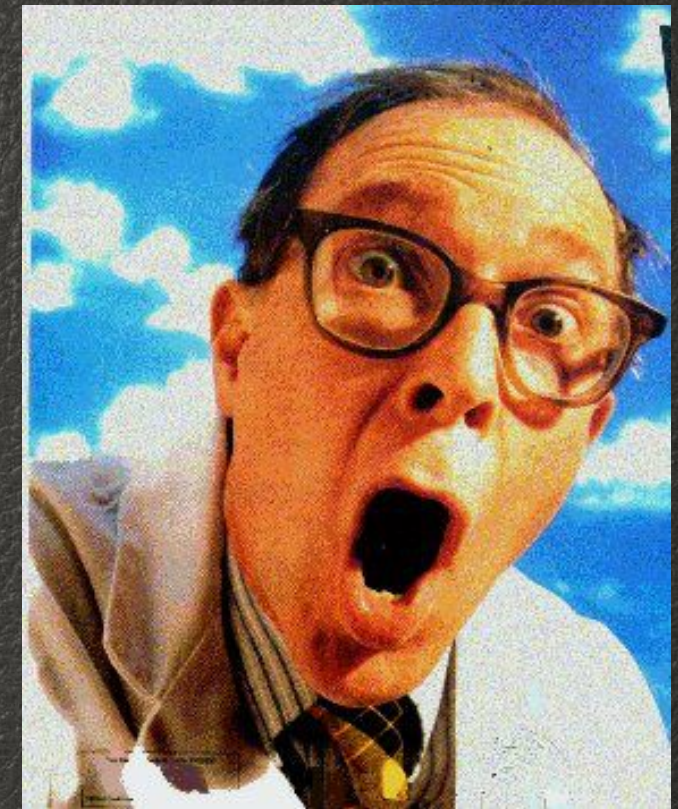
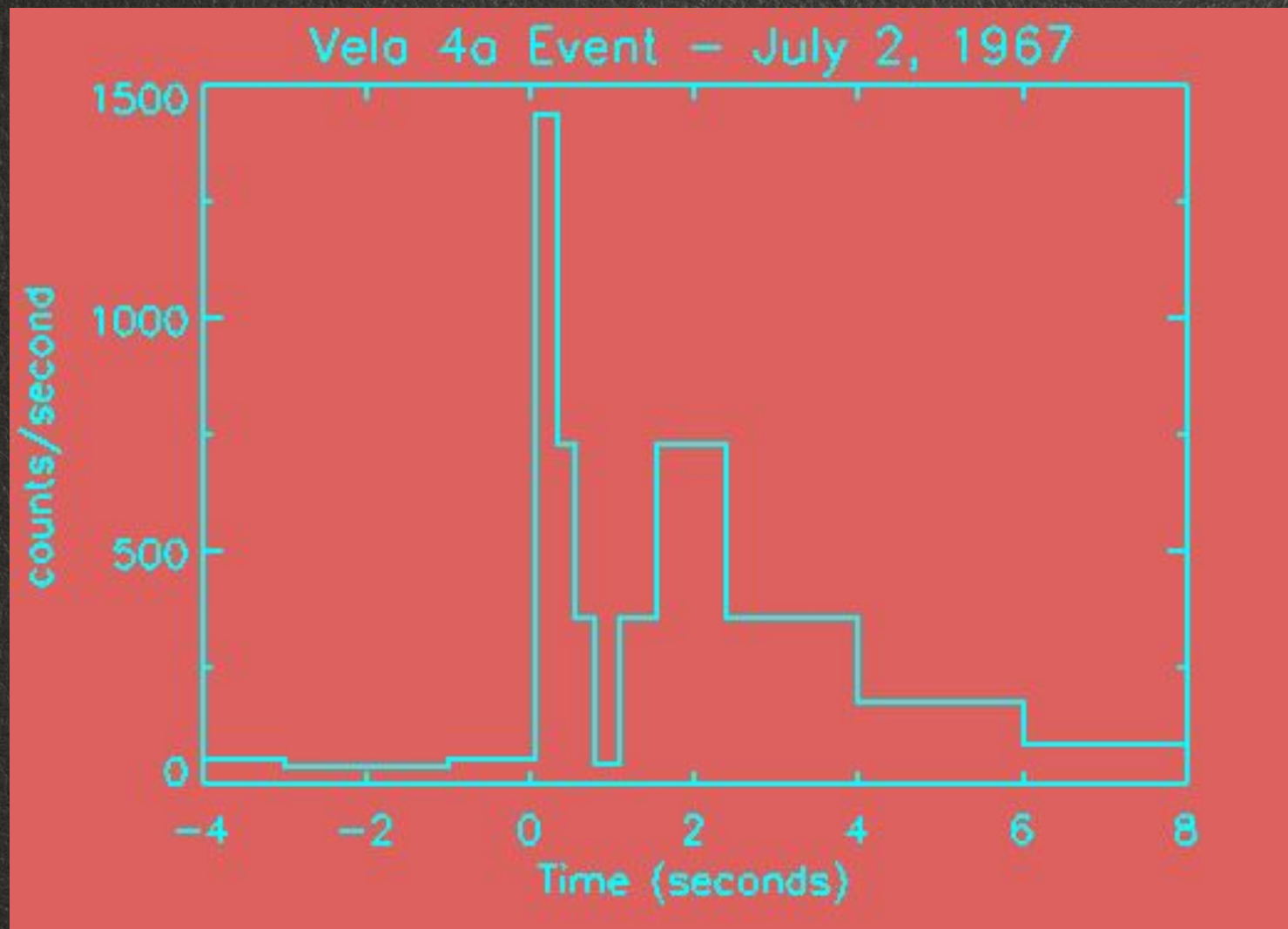
Science Case 6: Gamma-Ray Bursts

Stefano Covino

INAF / Brera Astronomical Observatory



The first GRB ever observed!



Results published only 6 years after

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OBSERVATIONS OF GAMMA-RAY BURSTS OF COSMIC ORIGIN

RAY W. KLEBESADEL, IAN B. STRONG, AND ROY A. OLSON

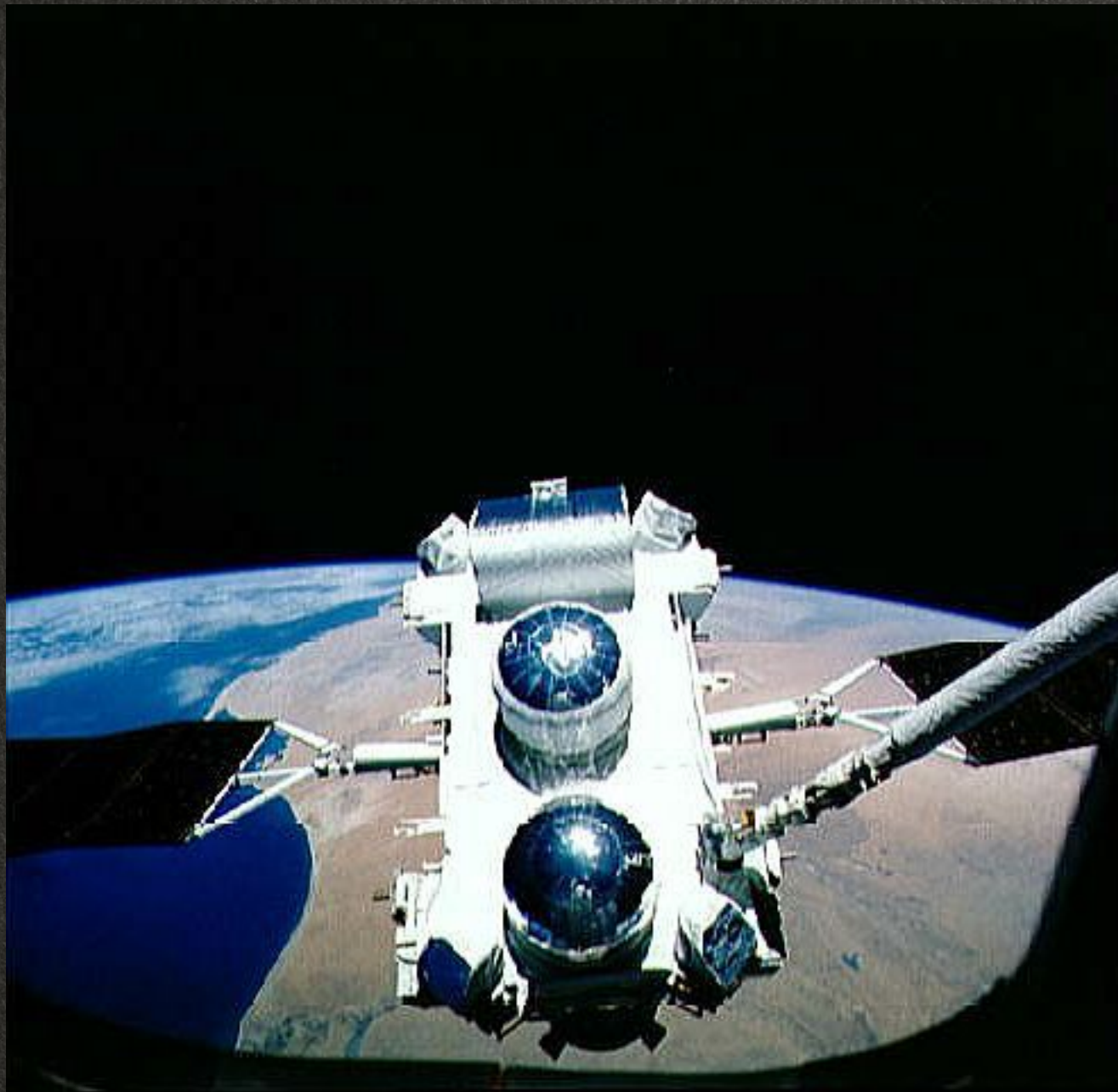
University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico
Received 1973 March 16; revised 1973 April 2

Ray Klebesadel

“Since the beginning it was clear these were not terrestrial phenomena... then where did they come from?”

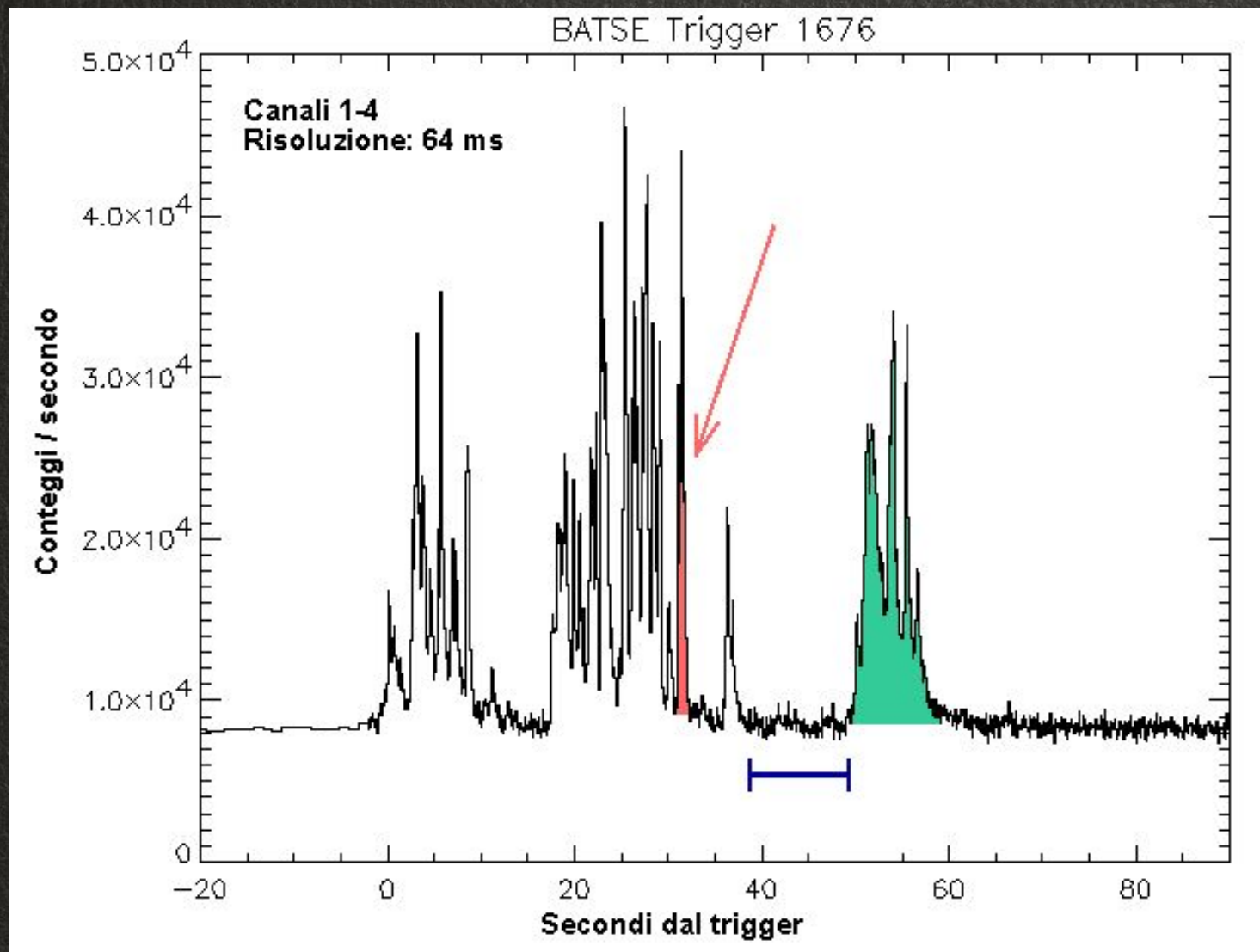


The Compton Gamma-Ray Observatory



Launched in 1991. One of the goals was to study GRBs. In a few years of operation thousands of them were detected.

Extreme variability



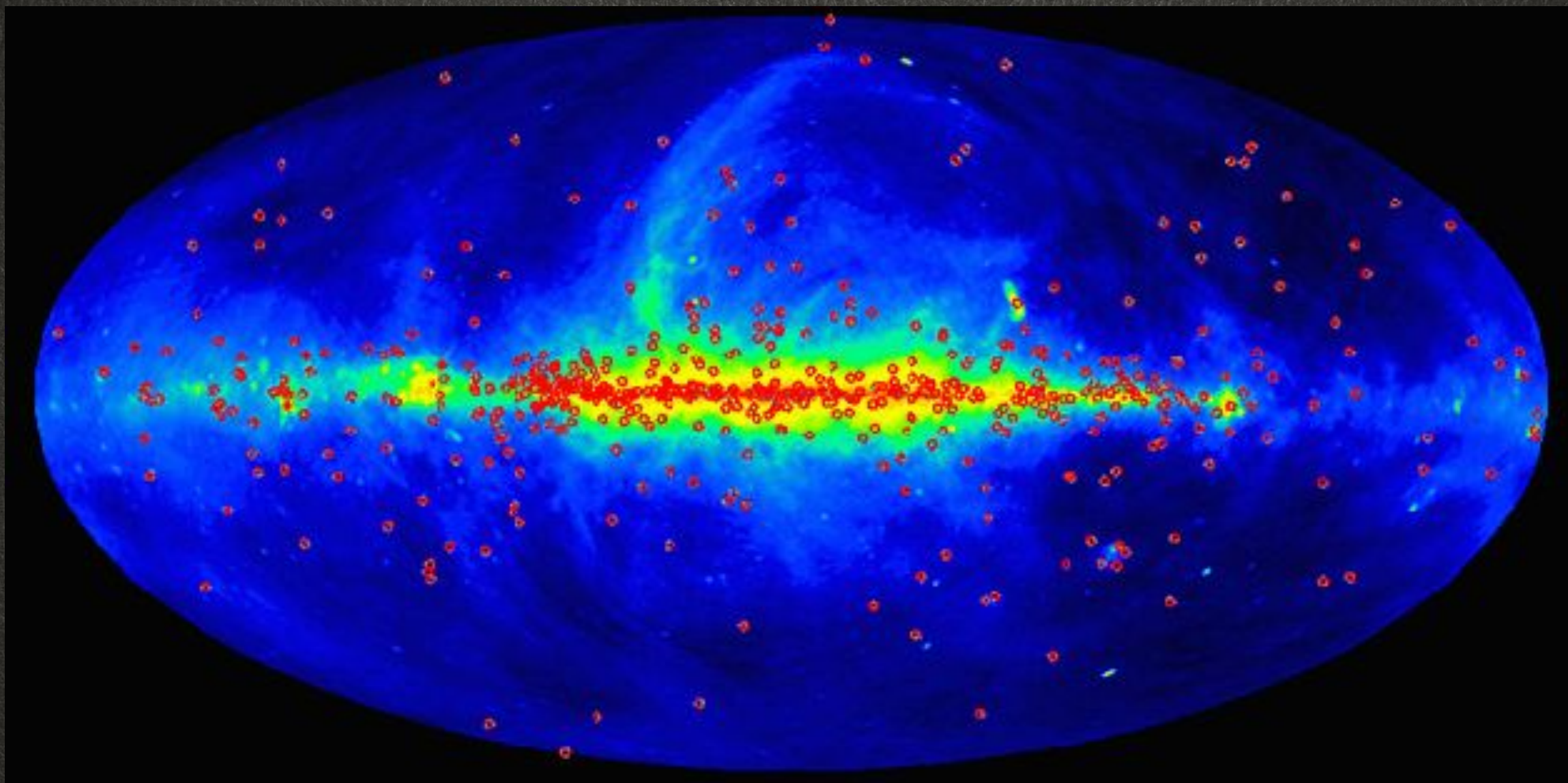
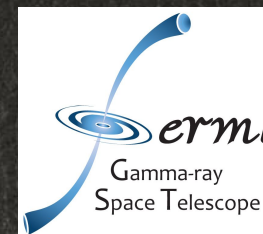
Rapid variability allows one to derive an estimate of the source size. It turns out to be very compact: of the order of tens of km.

The problem of GRB localization

Typical uncertainty
was about 1 deg.

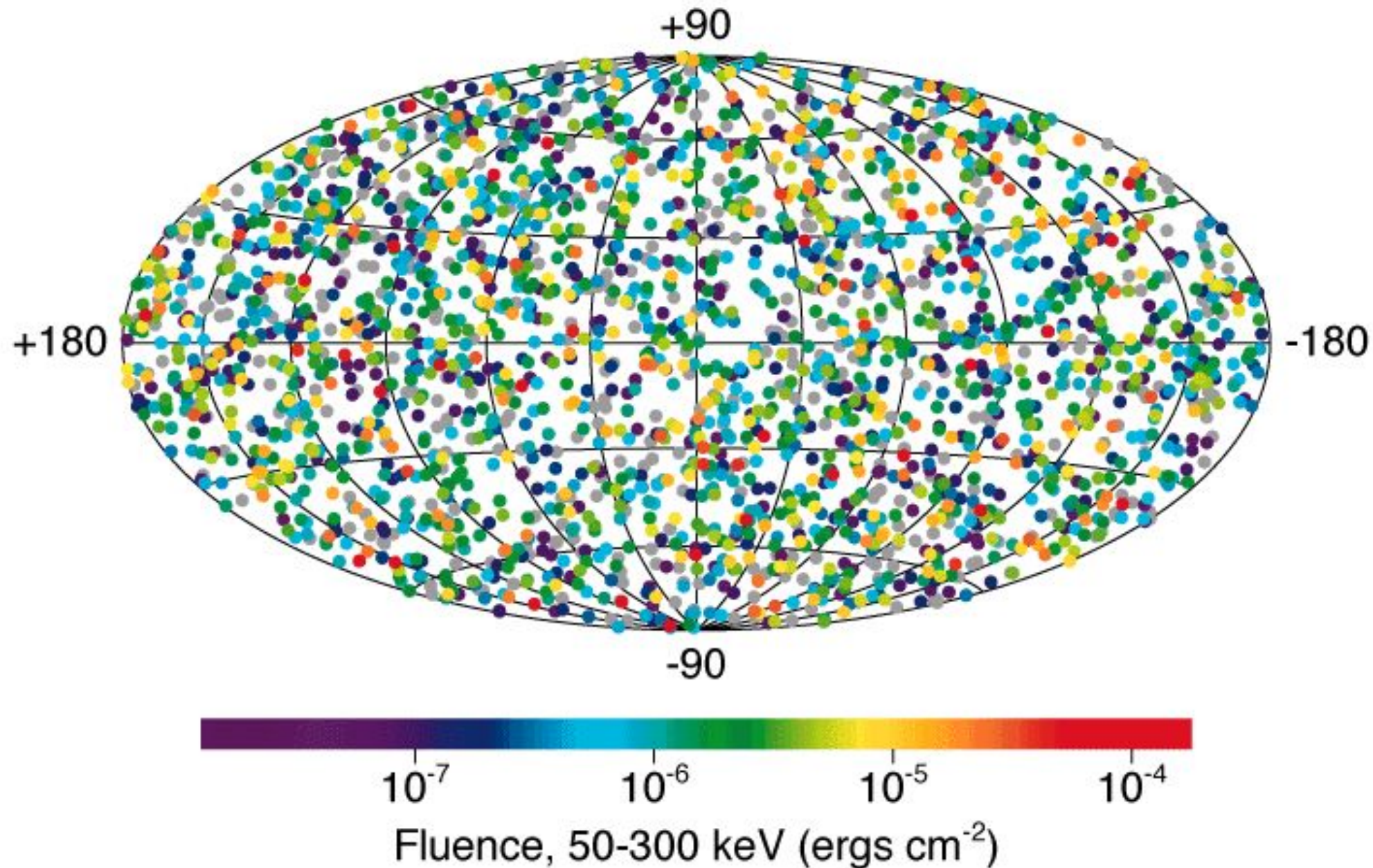


High-energy pulsars

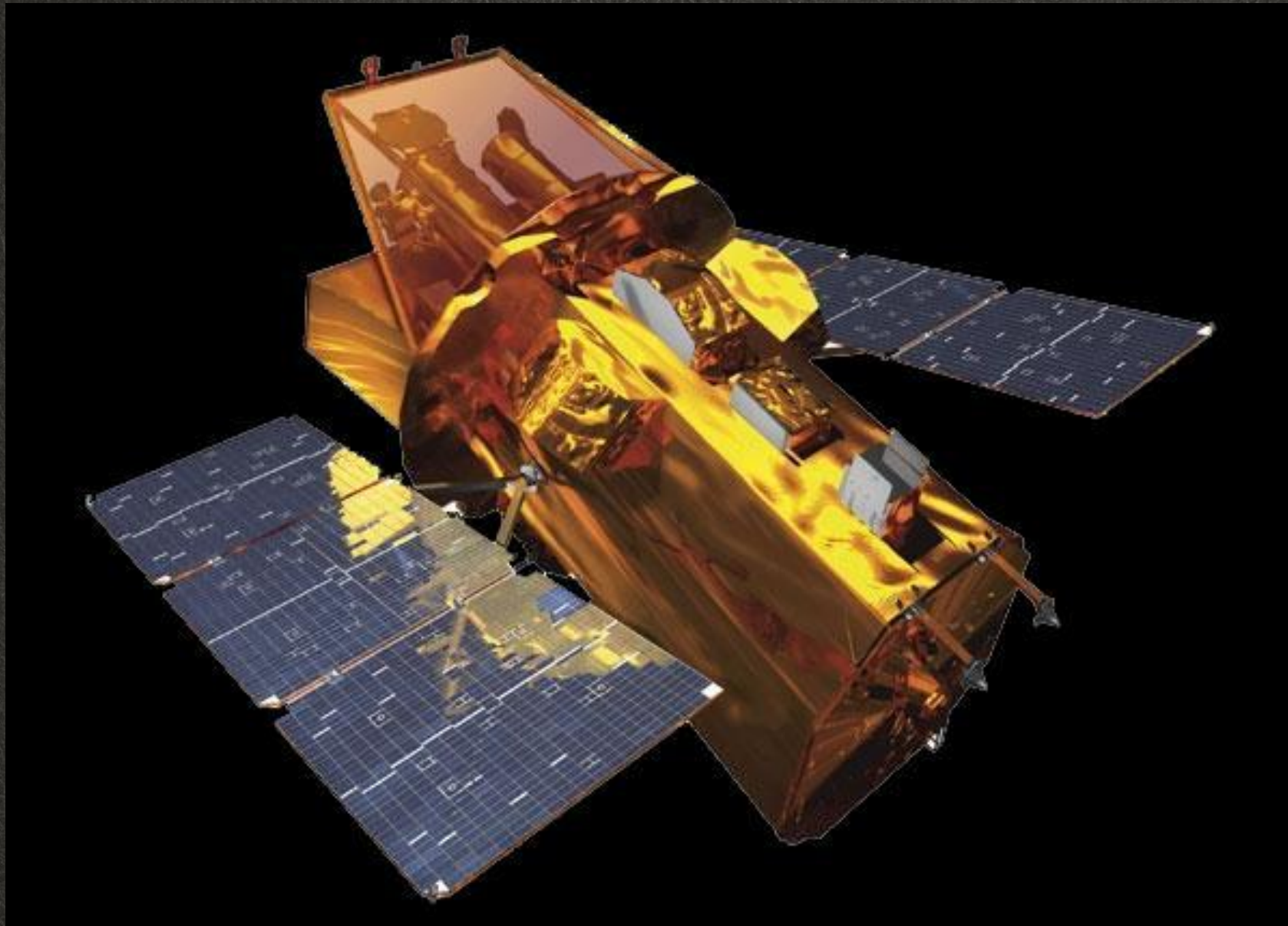


An isotropic distribution!

2512 BATSE Gamma-Ray Bursts

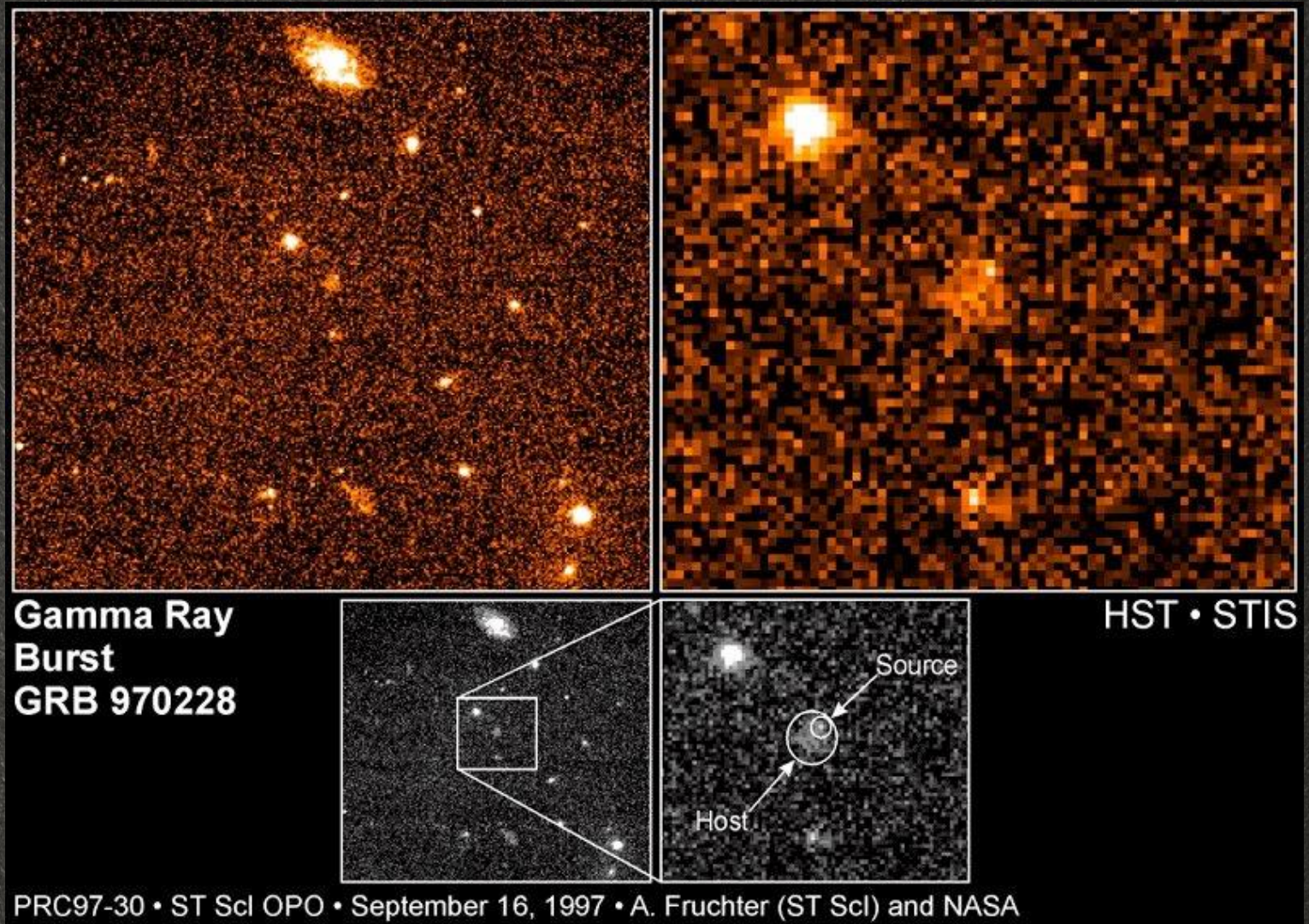
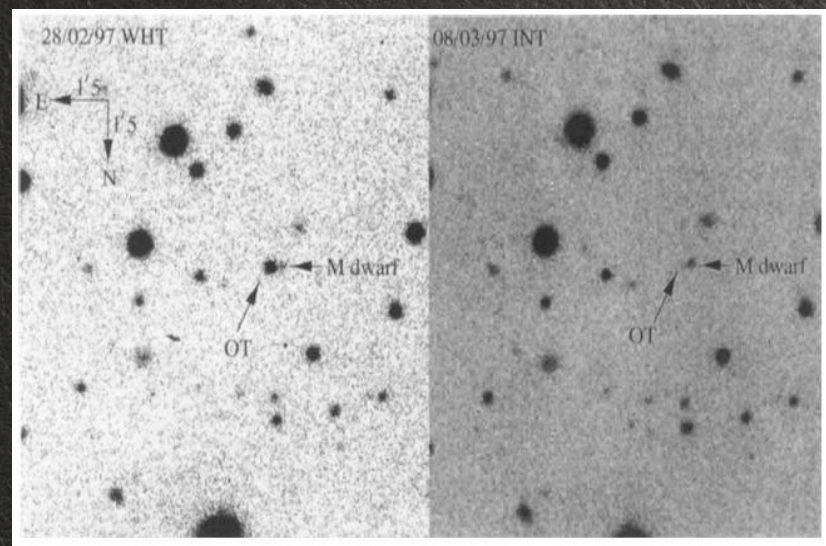
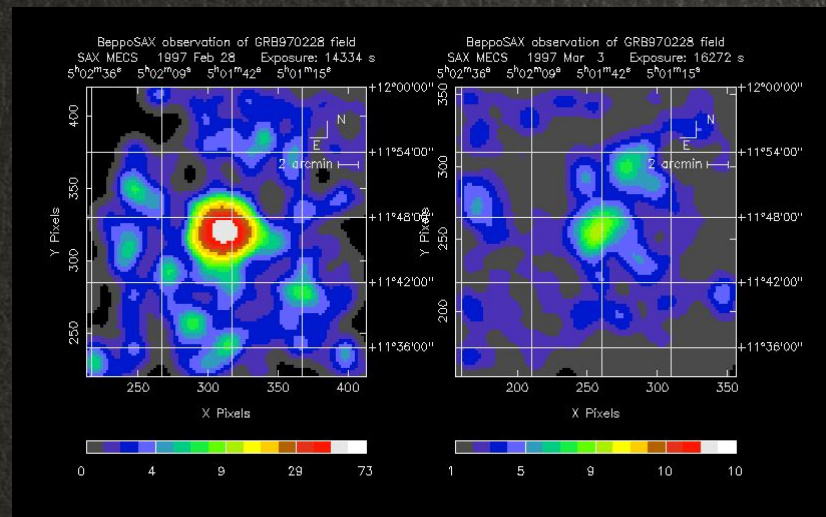


The BeppoSAX contribution



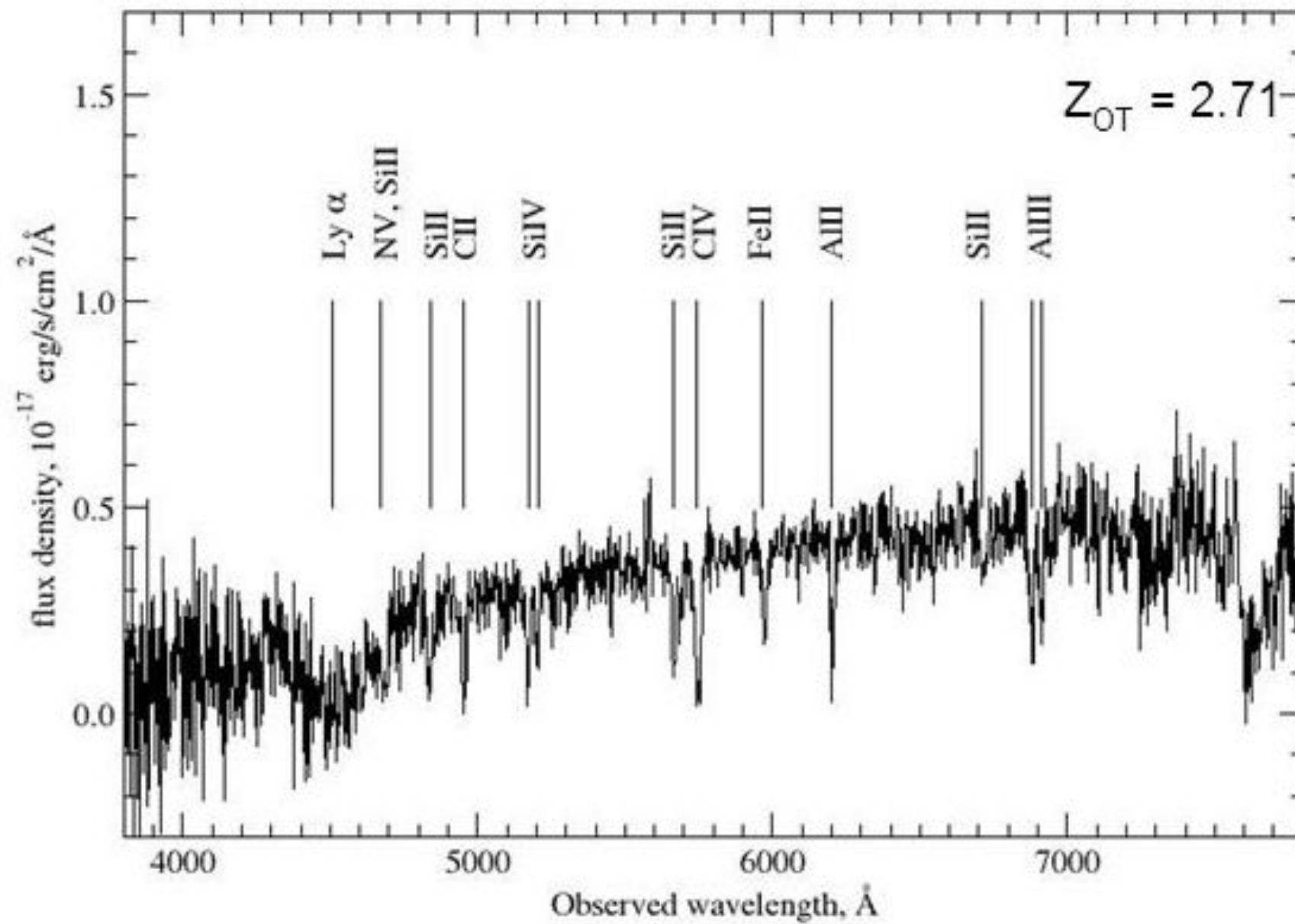
BeppoSAX was a Dutch-Italian satellite launched in 1996

Identifying the first “afterglow”!



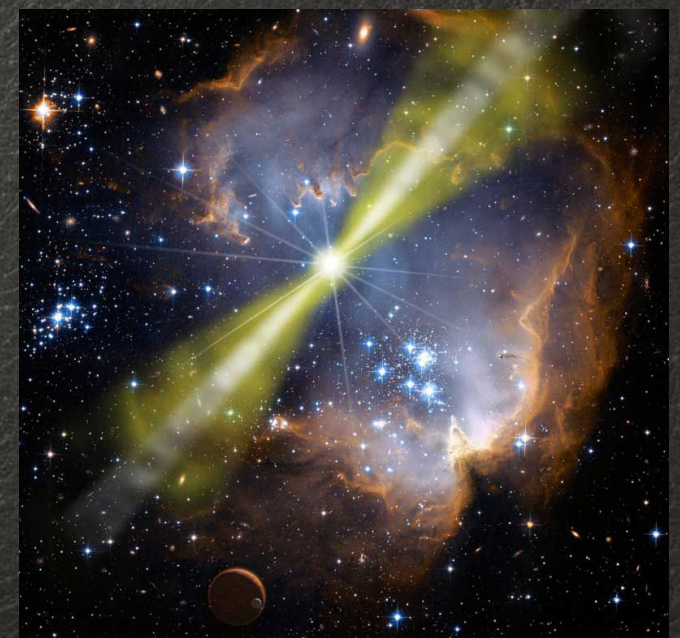
and determining the distance of the host galaxy...

GRB 090726



Amazing findings

- The energy output of these events is huge, comparable to a SN but in a timescale of seconds!
- The cosmological origin of GRBs and their “extreme” features have been one of the hottest problems for astrophysics in the 2000s.

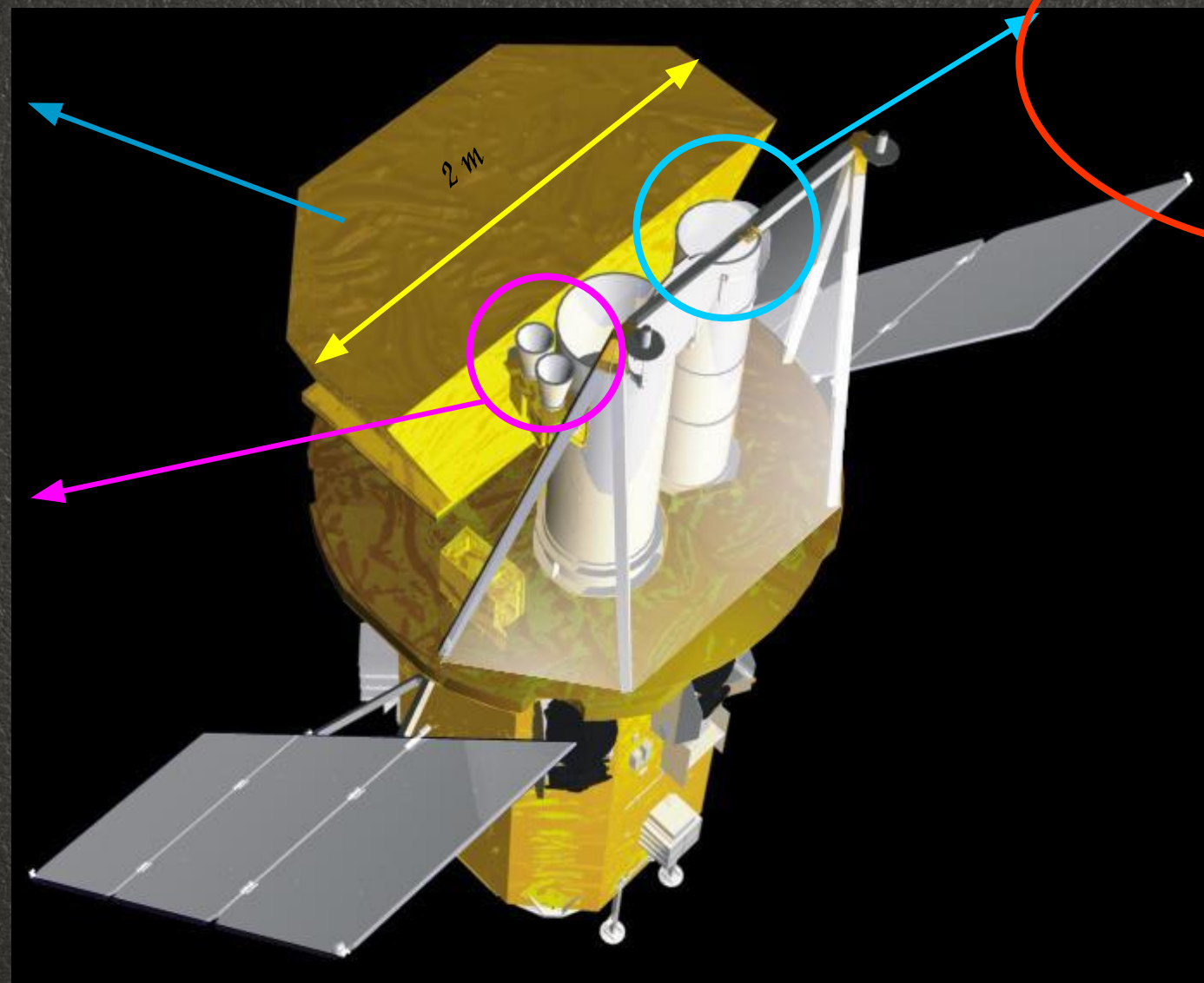




We need to be Swift...

Telescopio γ

Telescopio
ottico



Telescopio X:

Osservatorio Astronomico
di Brera!

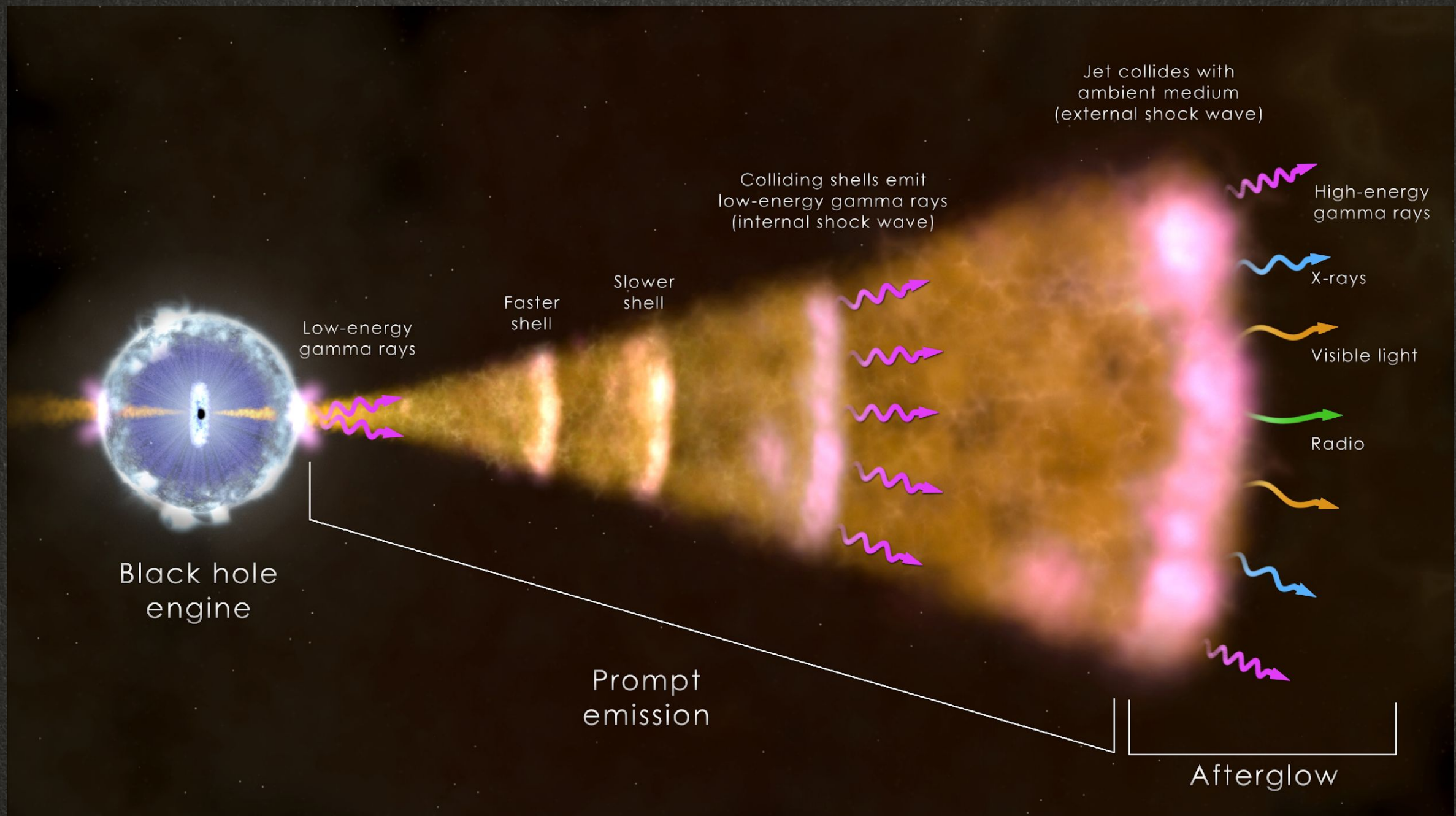
Launched on 2004, Nov 20, and still operational.

Swift has been design for rapid pointing

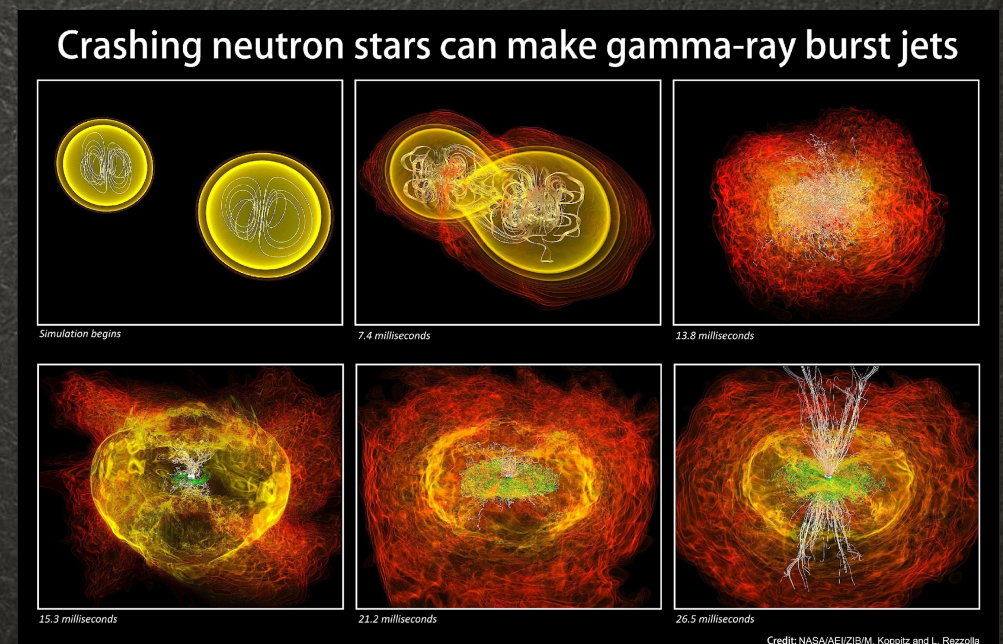
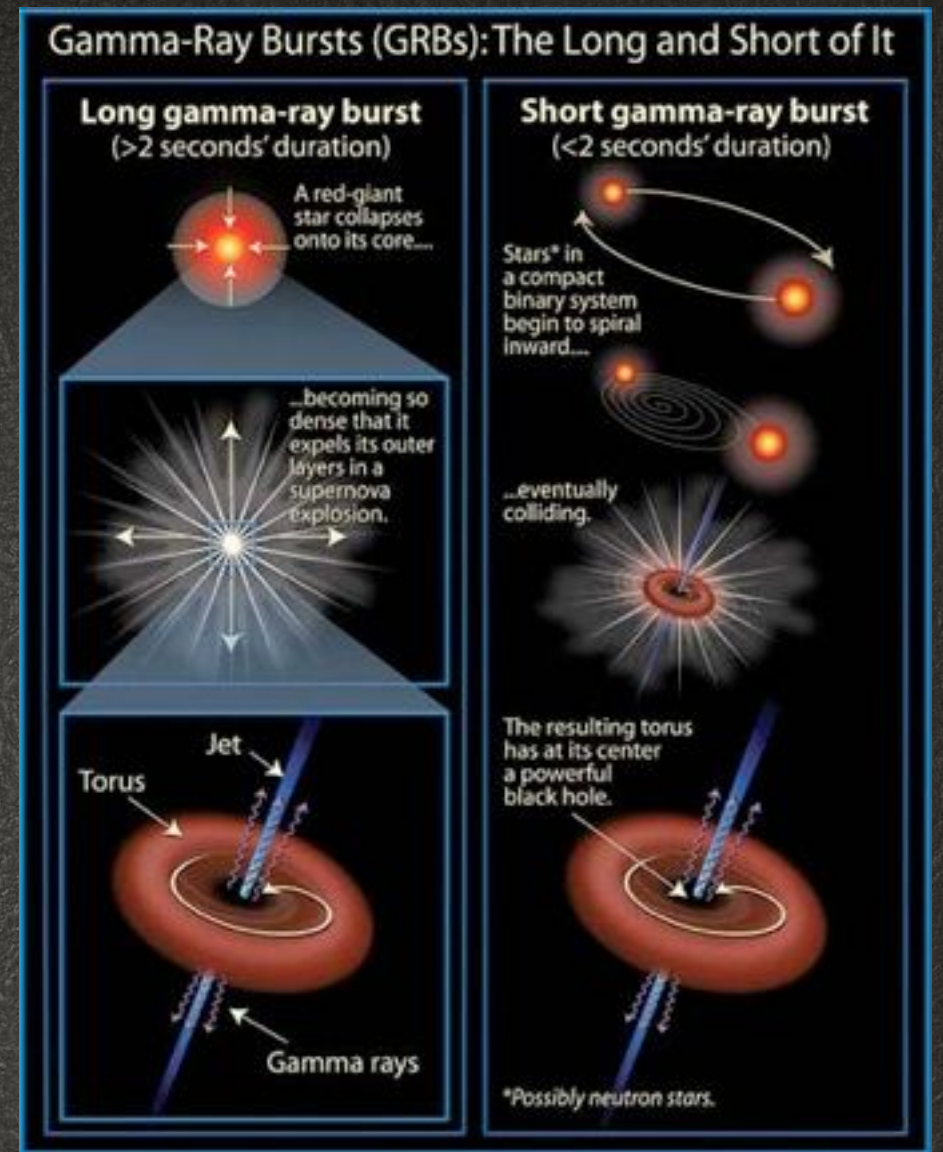


It can be on target in a matter of tens of seconds

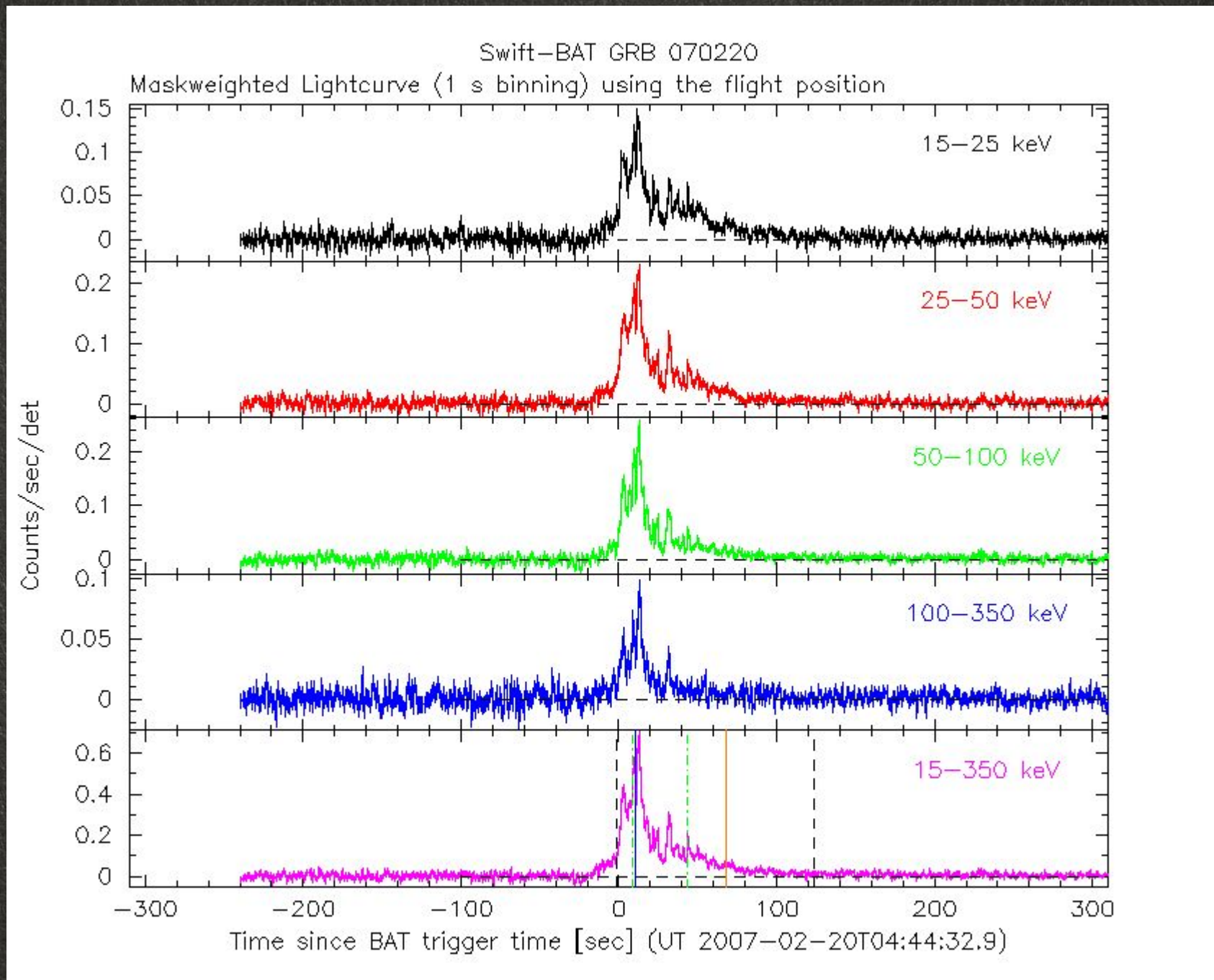
So, what are these GRBs?



There are two (or probably three) families of GRBs: the long and short duration, with a possible further subdivision for the short.



Notebook: GRBQPO



REFERENCES AND DEEPENING



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arXiv:astro-ph/0405503 v1 25 May 2004

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Abstract

Gamma-Ray Bursts (GRBs), short and intense pulses of low energy γ -rays, have fascinated astronomers and astrophysicists since their unexpected discovery in the late sixties. During the last decade, several space missions: BATSE (Burst and Transient Source Experiment) on Compton Gamma-Ray Observatory, BeppoSAX and now HETE II (High-Energy Transient Explorer), together with ground optical, infrared and radio observatories have revolutionized our understanding of GRBs showing that they are cosmological, that they are accompanied by long lasting afterglows and that they are associated with core collapse Supernovae. At the same time a theoretical understanding has emerged in the form of the fireball internal-external shocks model. According to this model GRBs are produced when the kinetic energy of an ultra-relativistic flow is dissipated in internal collisions. The afterglow arises when the flow is slowed down by shocks with the surrounding circum-burst matter. This model has numerous successful predictions like the prediction of the afterglow itself, the prediction of jet breaks in the afterglow light curve and of an optical flash that accompanies the GRBs themselves. In this review I focus on theoretical aspects and on physical processes believed to take place in GRBs.