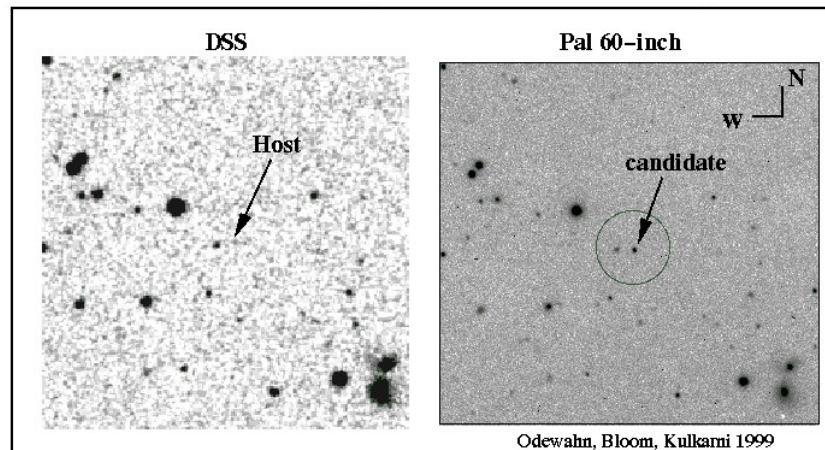


Un'ora da astronomi

A caccia di lampi gamma

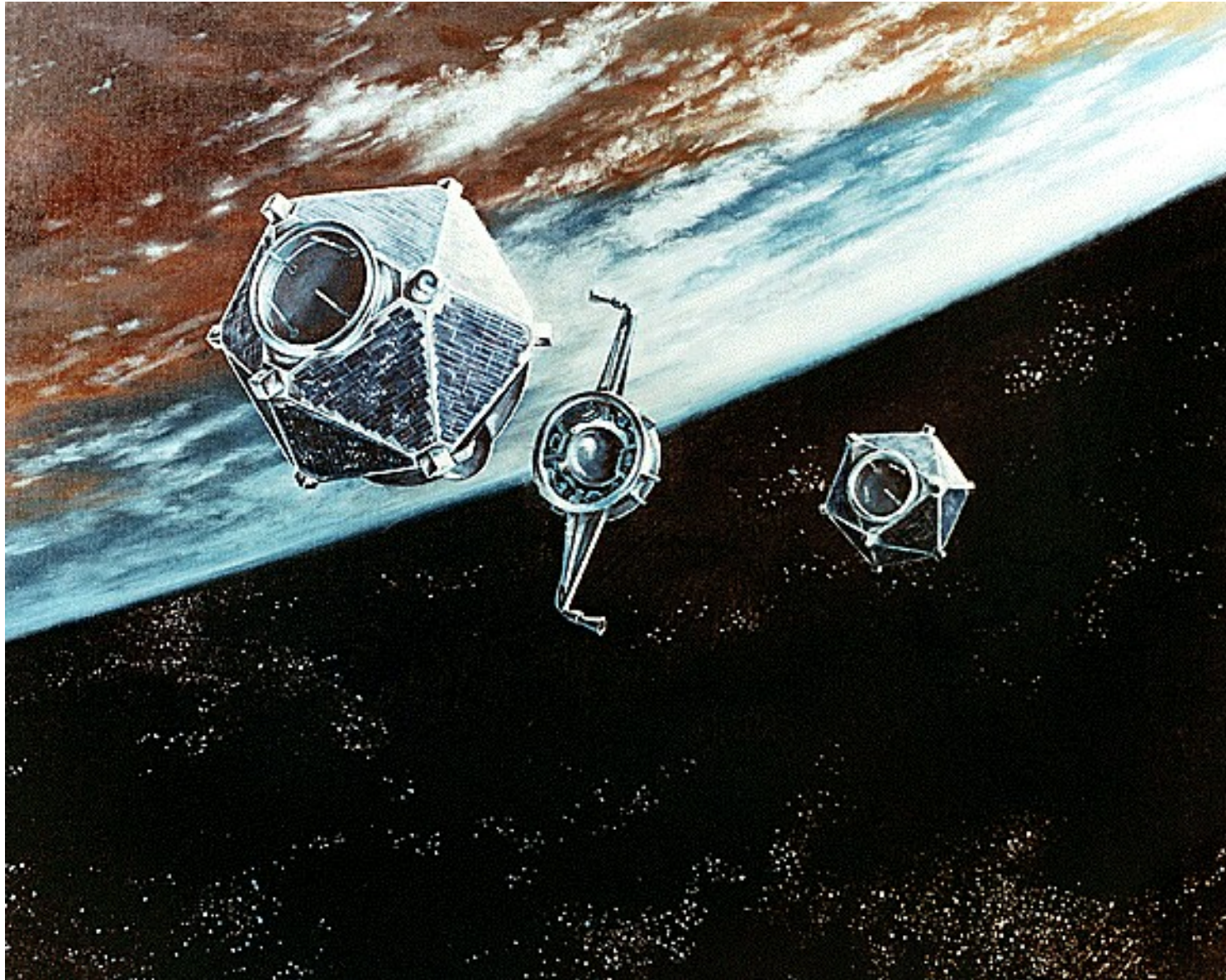


Om S. Salafia

26 ottobre 2016



Lampi gamma: la scoperta



Satelliti Vela [NASA HEASARC]

Lampi gamma: la scoperta

THE ASTROPHYSICAL JOURNAL, **182**:L85–L88, 1973 June 1

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OBSERVATIONS OF GAMMA-RAY BURSTS OF COSMIC ORIGIN

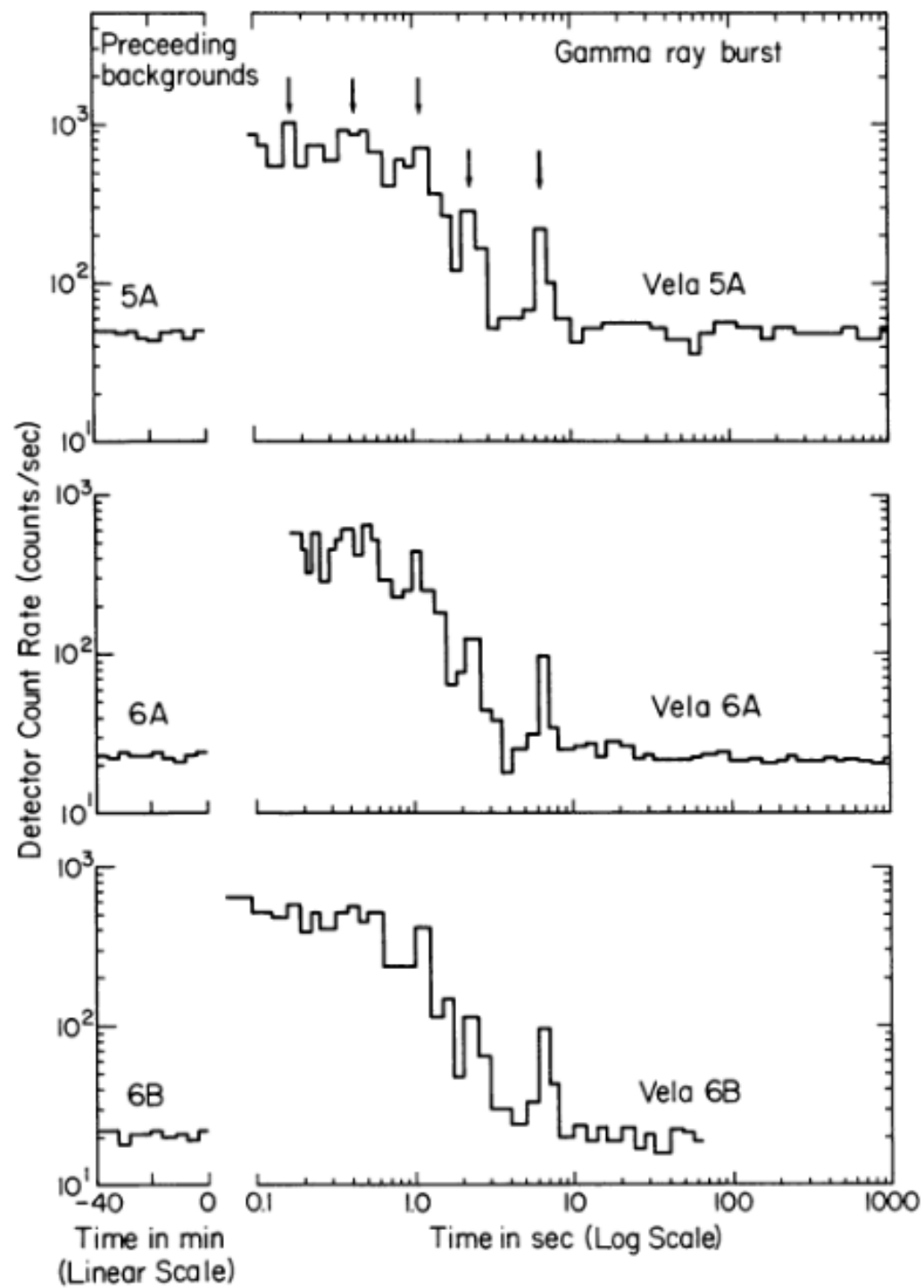
RAY W. KLEBESADEL, IAN B. STRONG, AND ROY A. OLSON

University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico

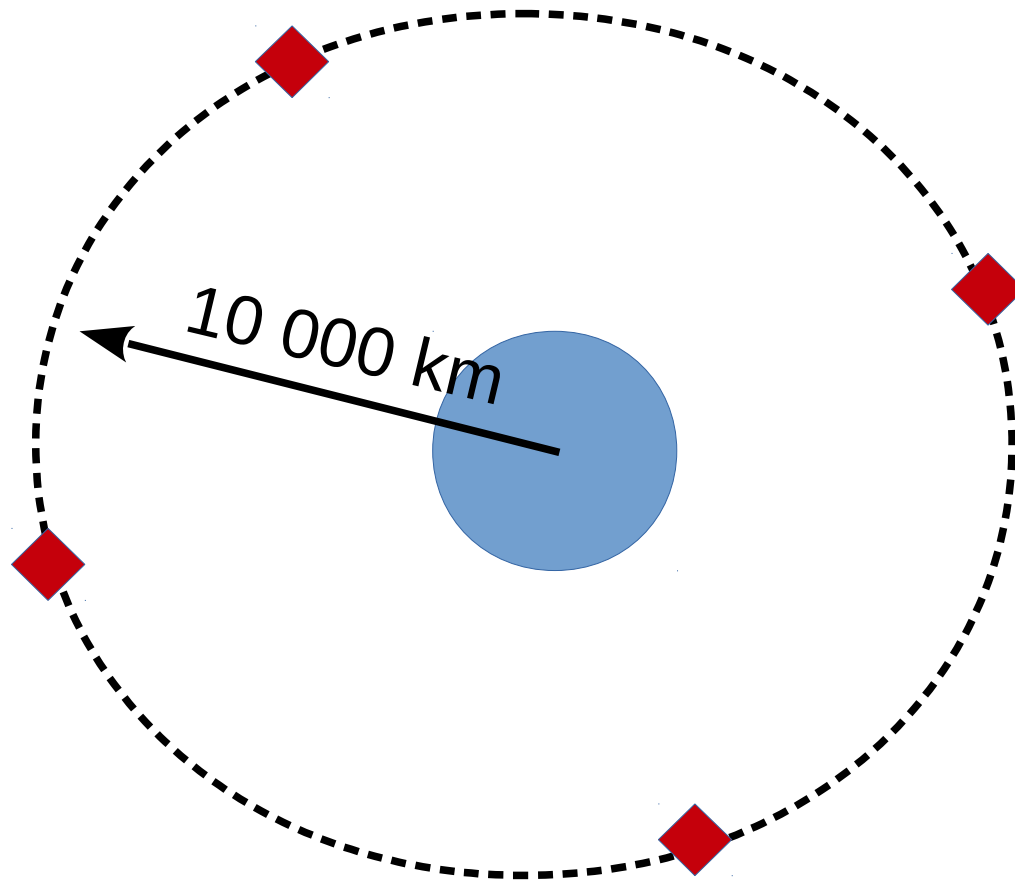
Received 1973 March 16; revised 1973 April 2

ABSTRACT

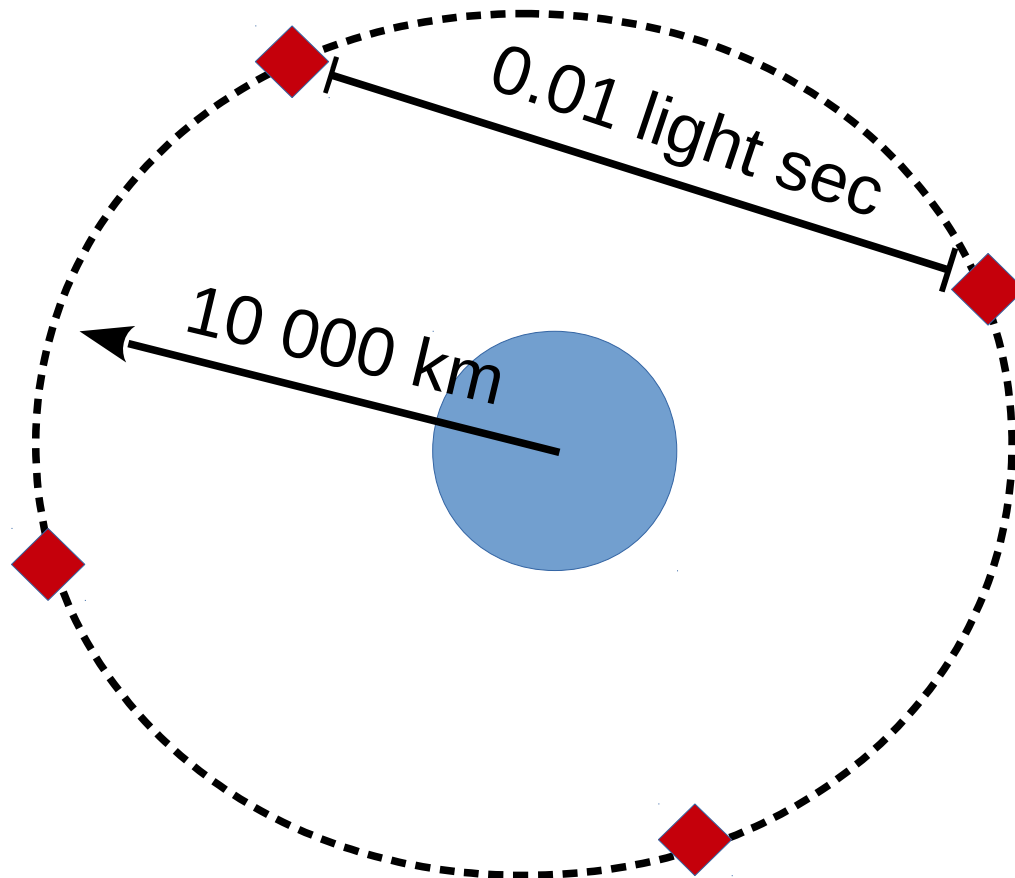
Sixteen short bursts of photons in the energy range 0.2–1.5 MeV have been observed between 1969 July and 1972 July using widely separated spacecraft. Burst durations ranged from less than 0.1 s to ~ 30 s, and time-integrated flux densities from $\sim 10^{-5}$ ergs cm $^{-2}$ to $\sim 2 \times 10^{-4}$ ergs cm $^{-2}$ in the energy range given. Significant time structure within bursts was observed. Directional information eliminates the Earth and Sun as sources.



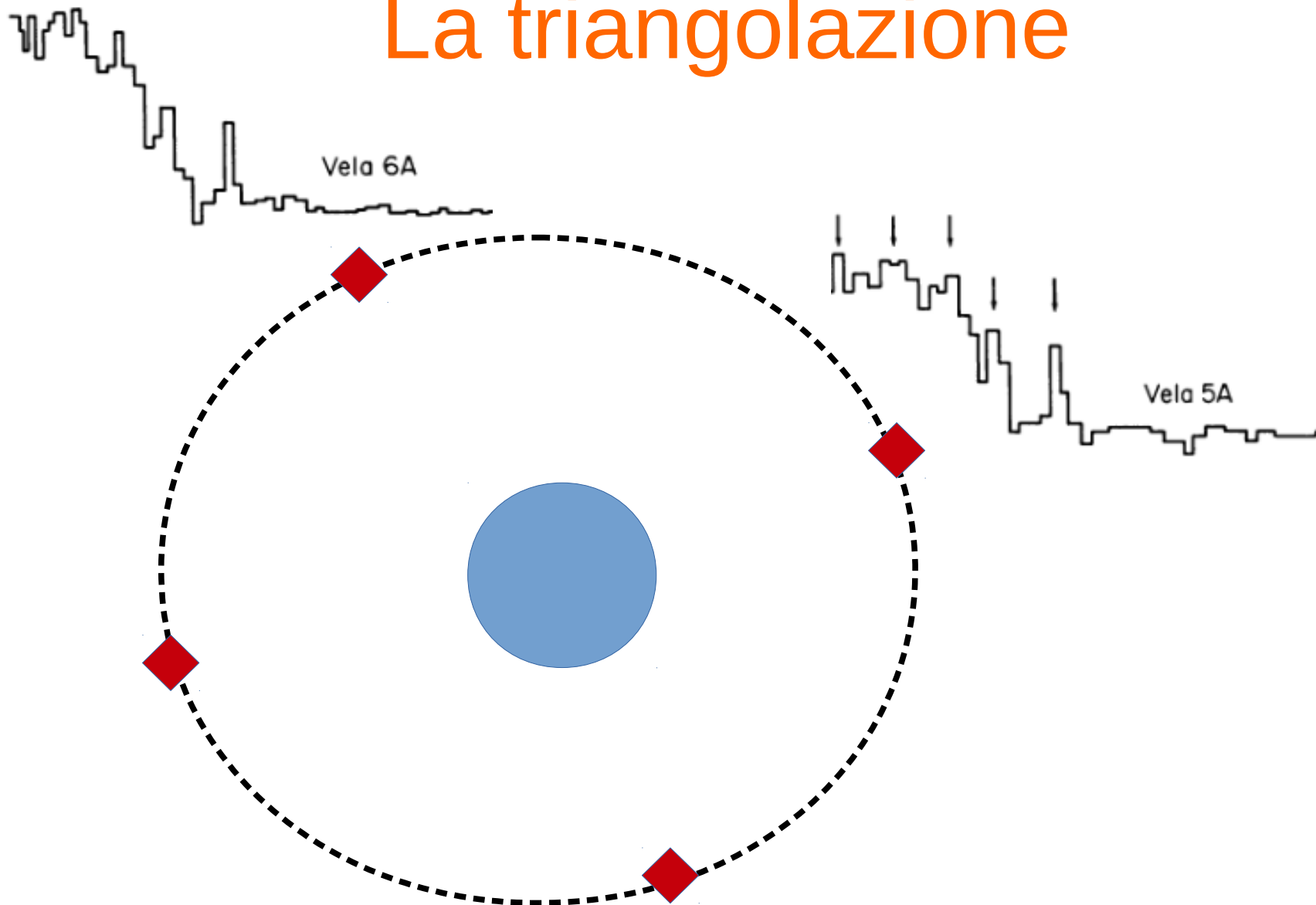
La triangolazione



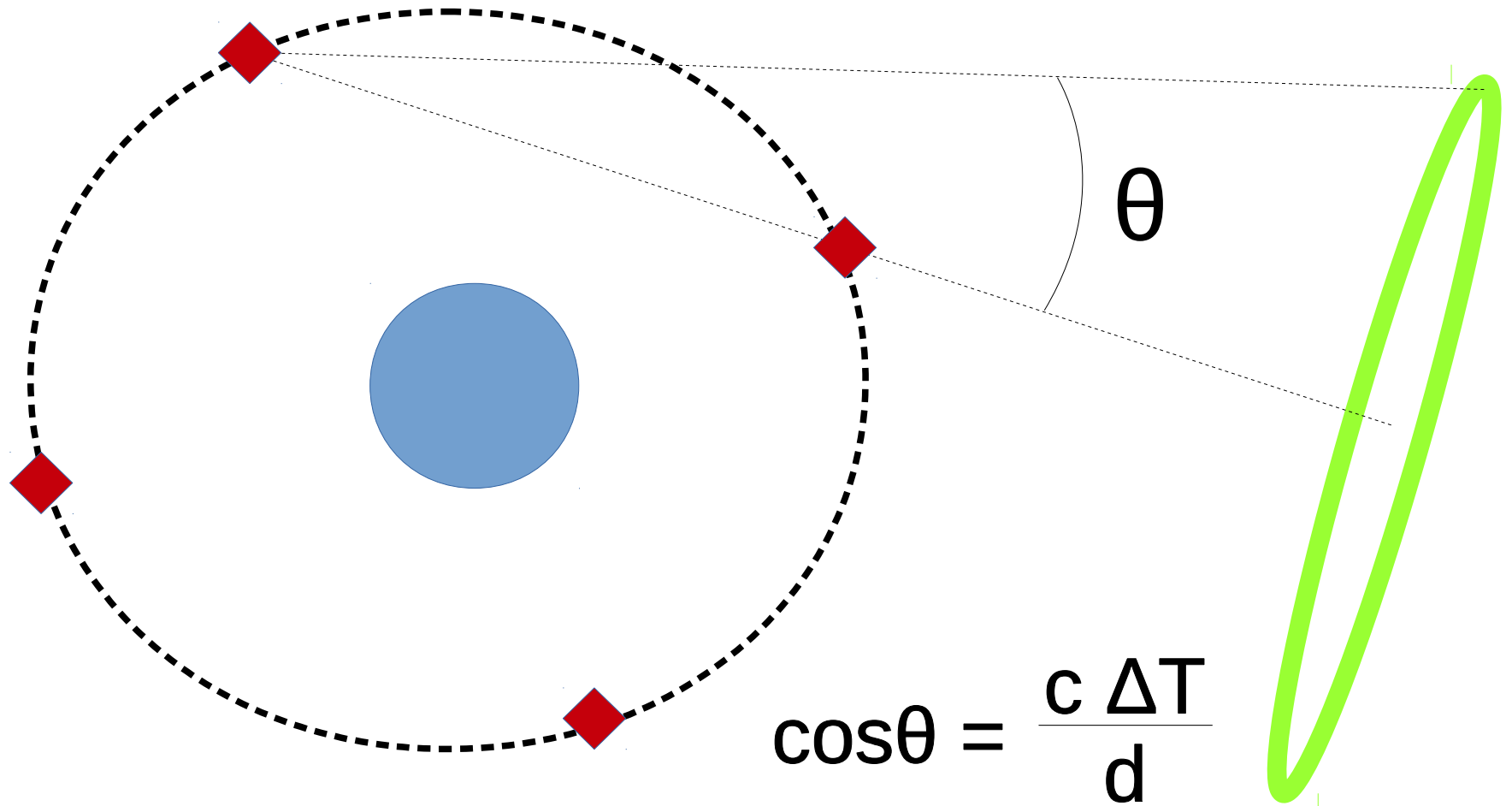
La triangolazione

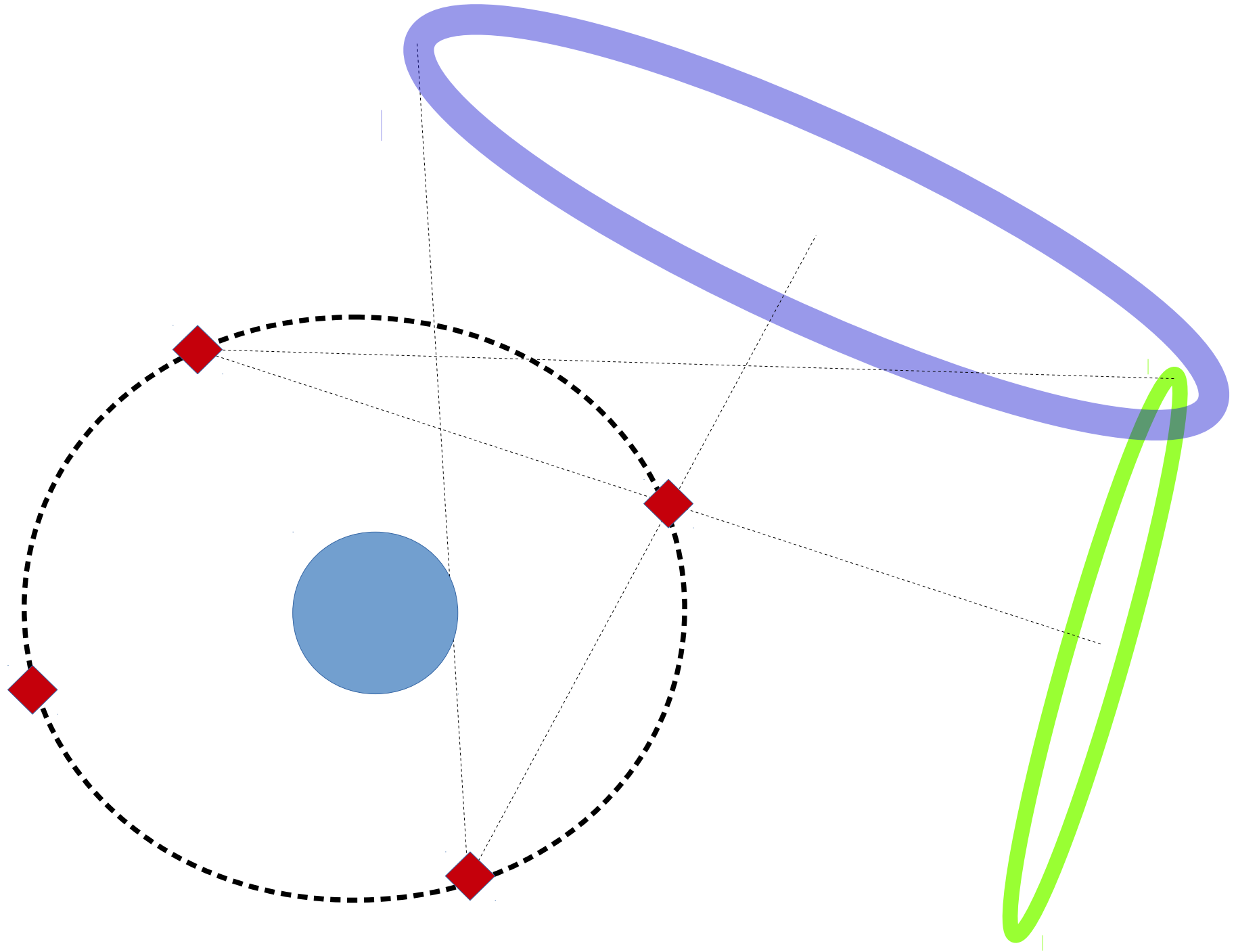


La triangolazione

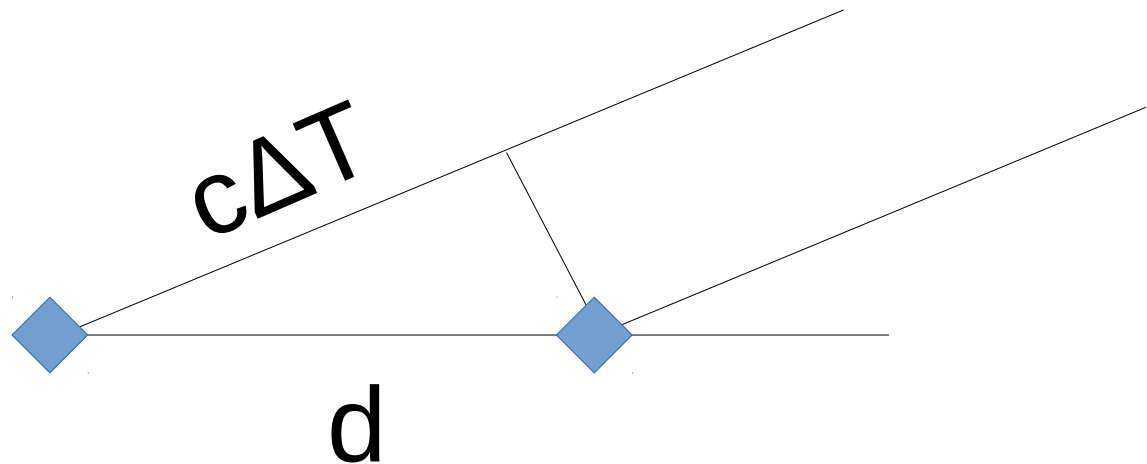


La triangolazione



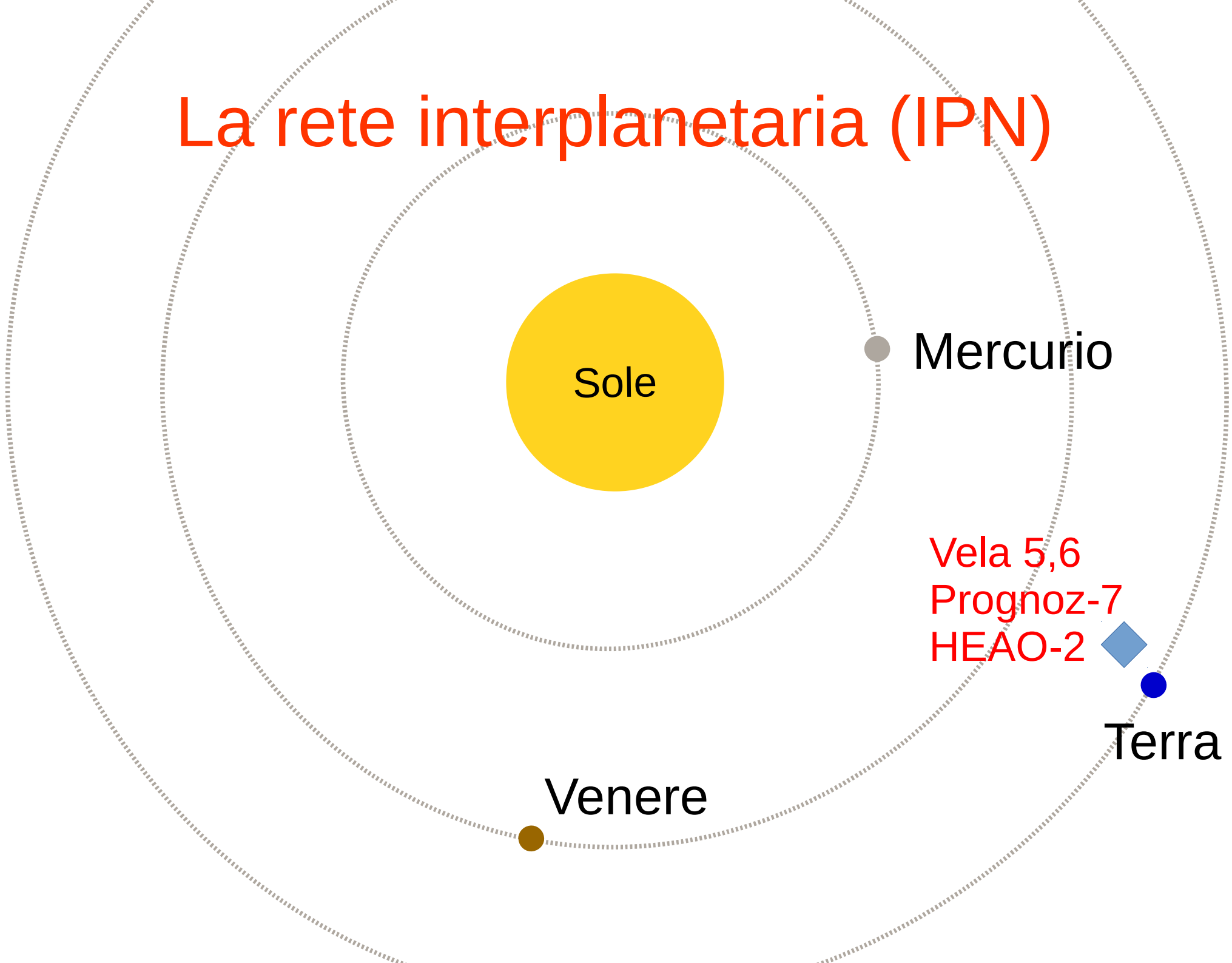


$$\cos\theta = \frac{c \Delta T}{d}$$

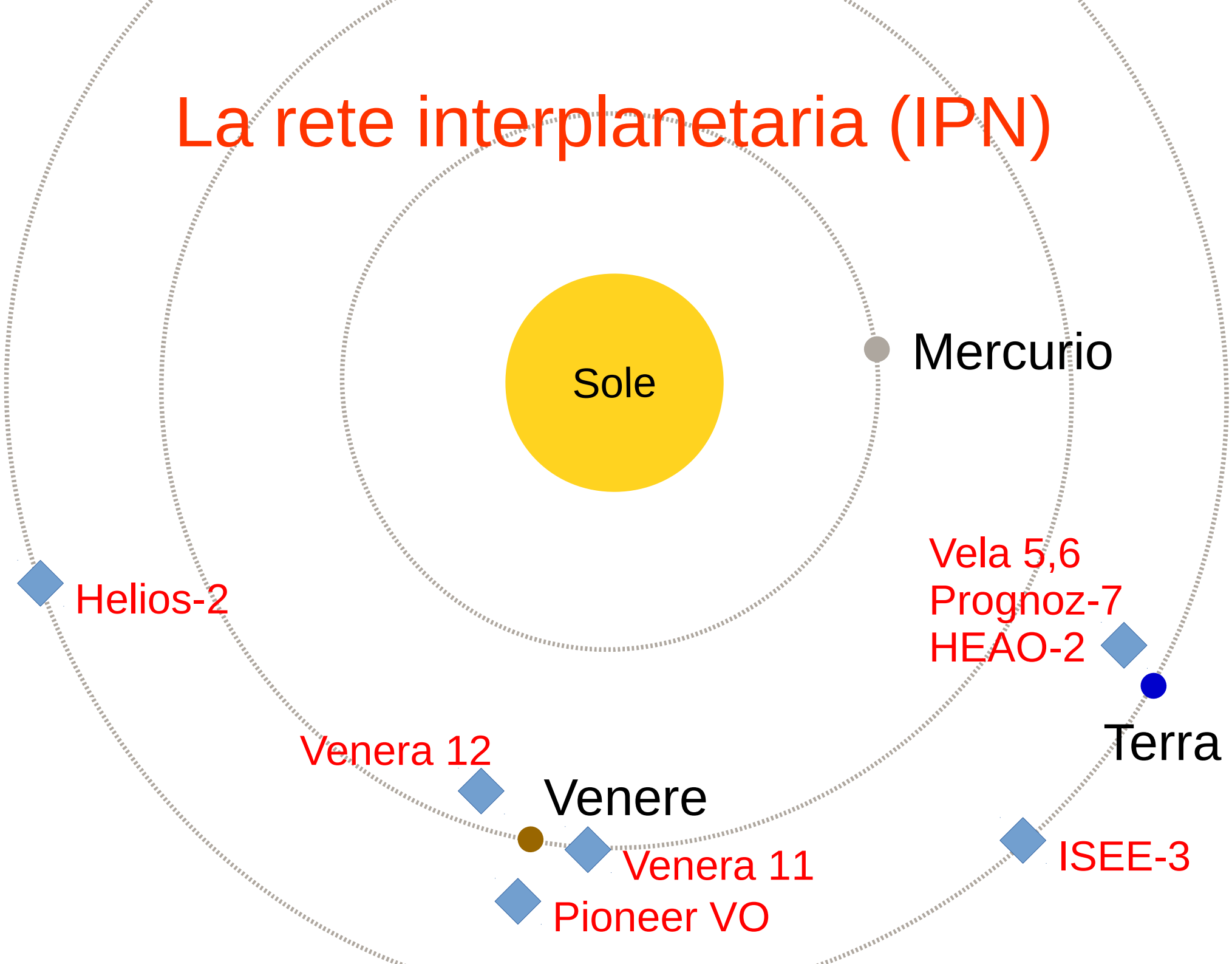


$$\frac{\partial \cos\theta}{\partial \Delta T} = \frac{c}{d}$$

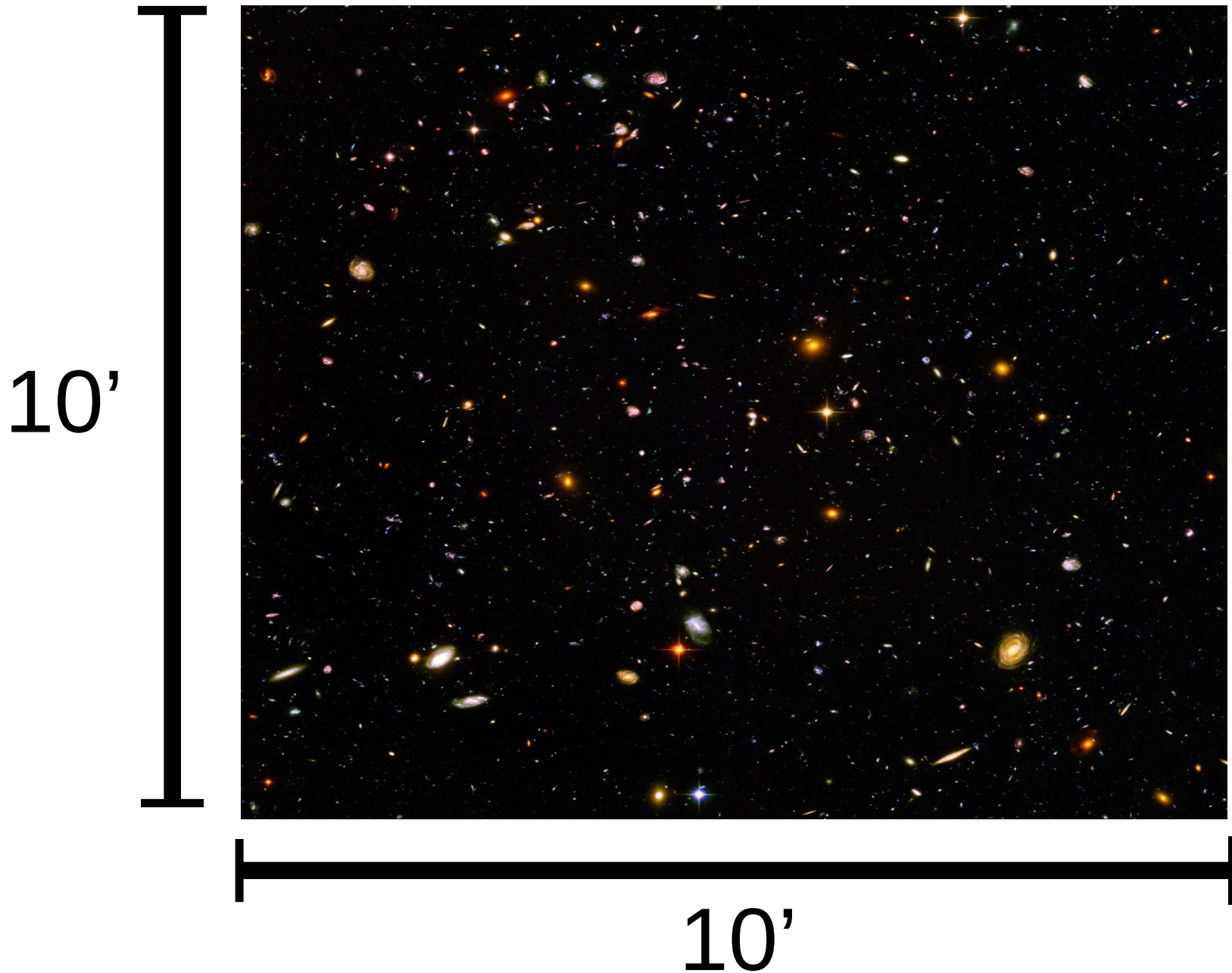
La rete interplanetaria (IPN)



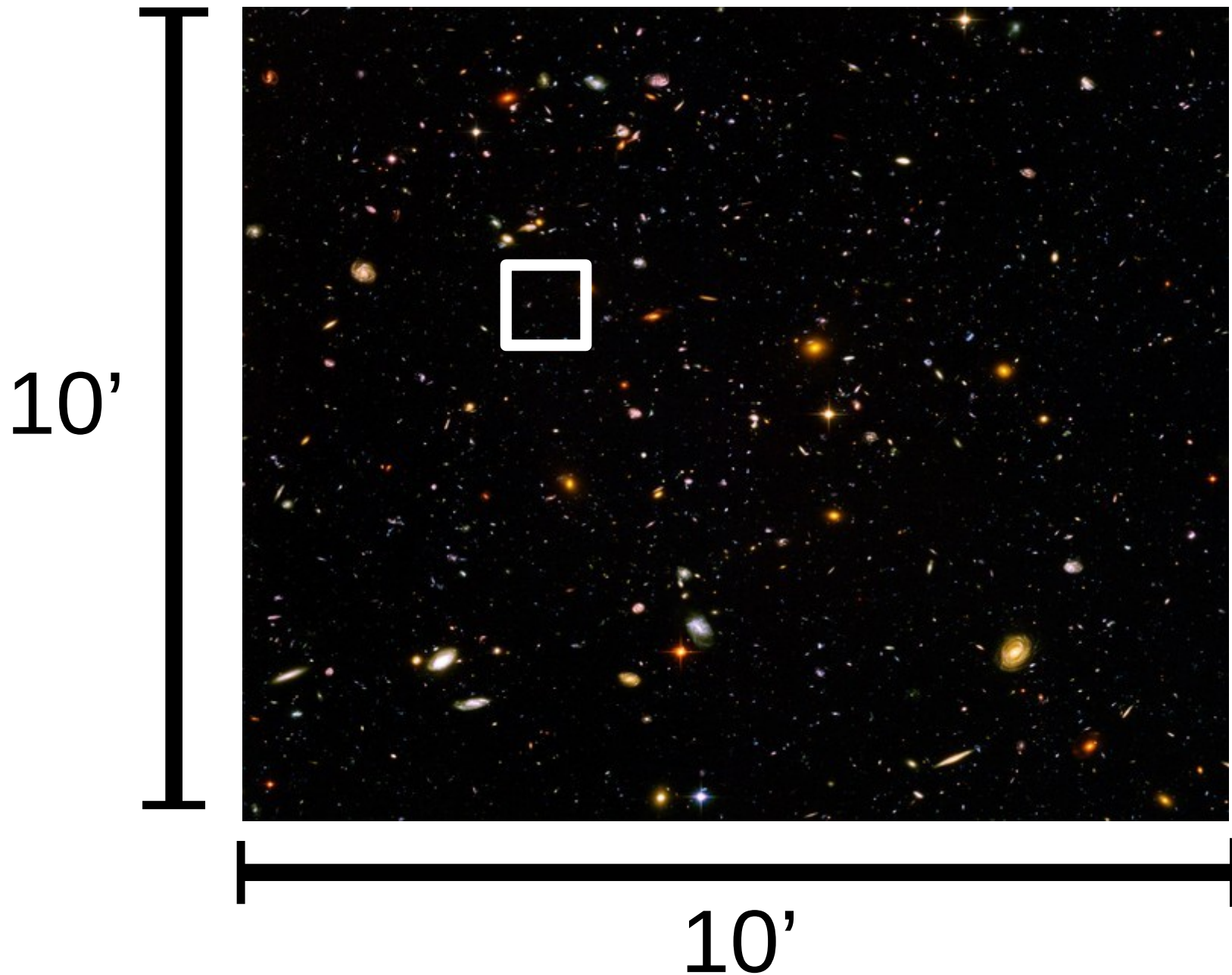
La rete interplanetaria (IPN)



Hubble Ultra Deep Field



Hubble Ultra Deep Field



1'



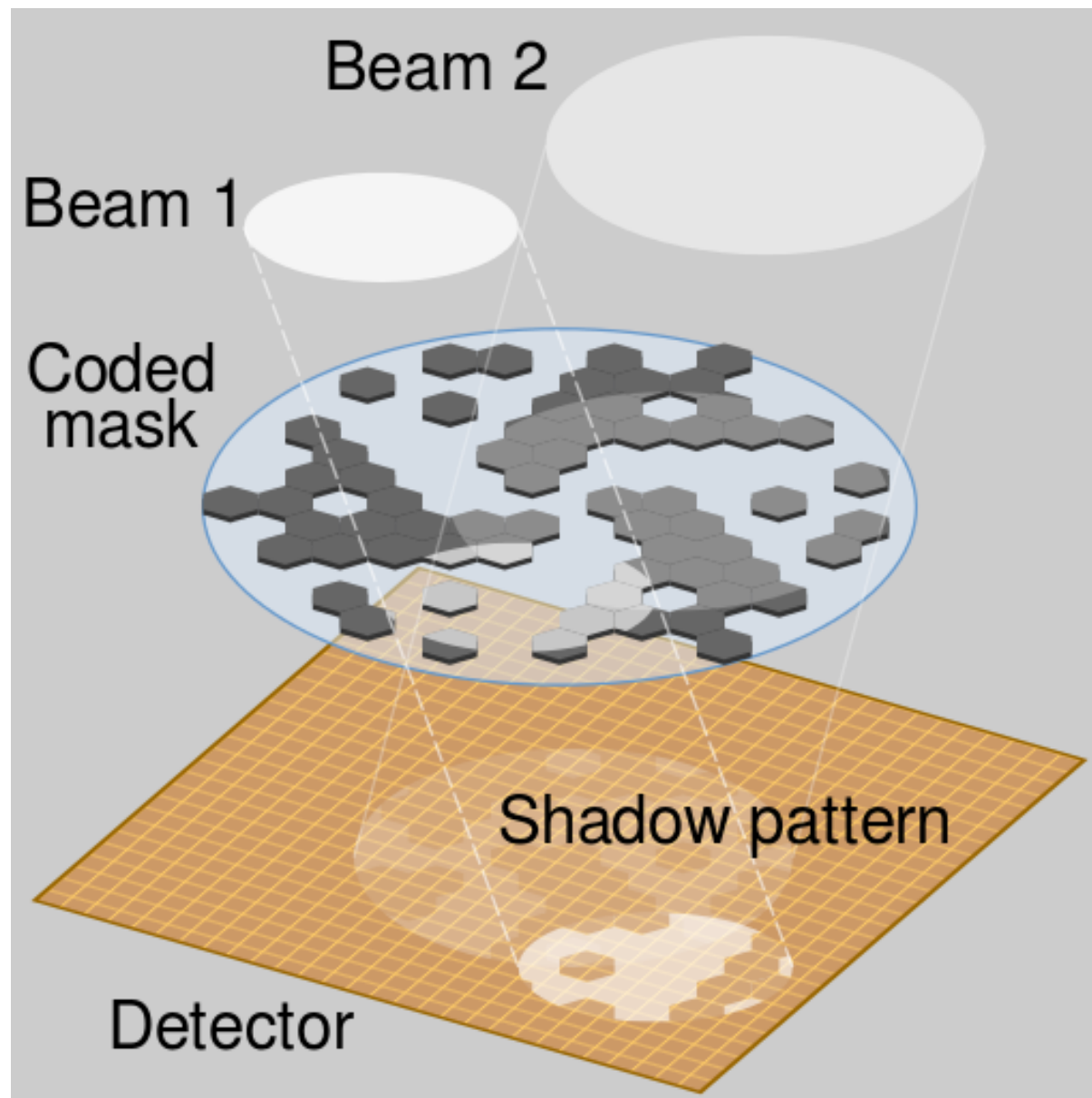
1'

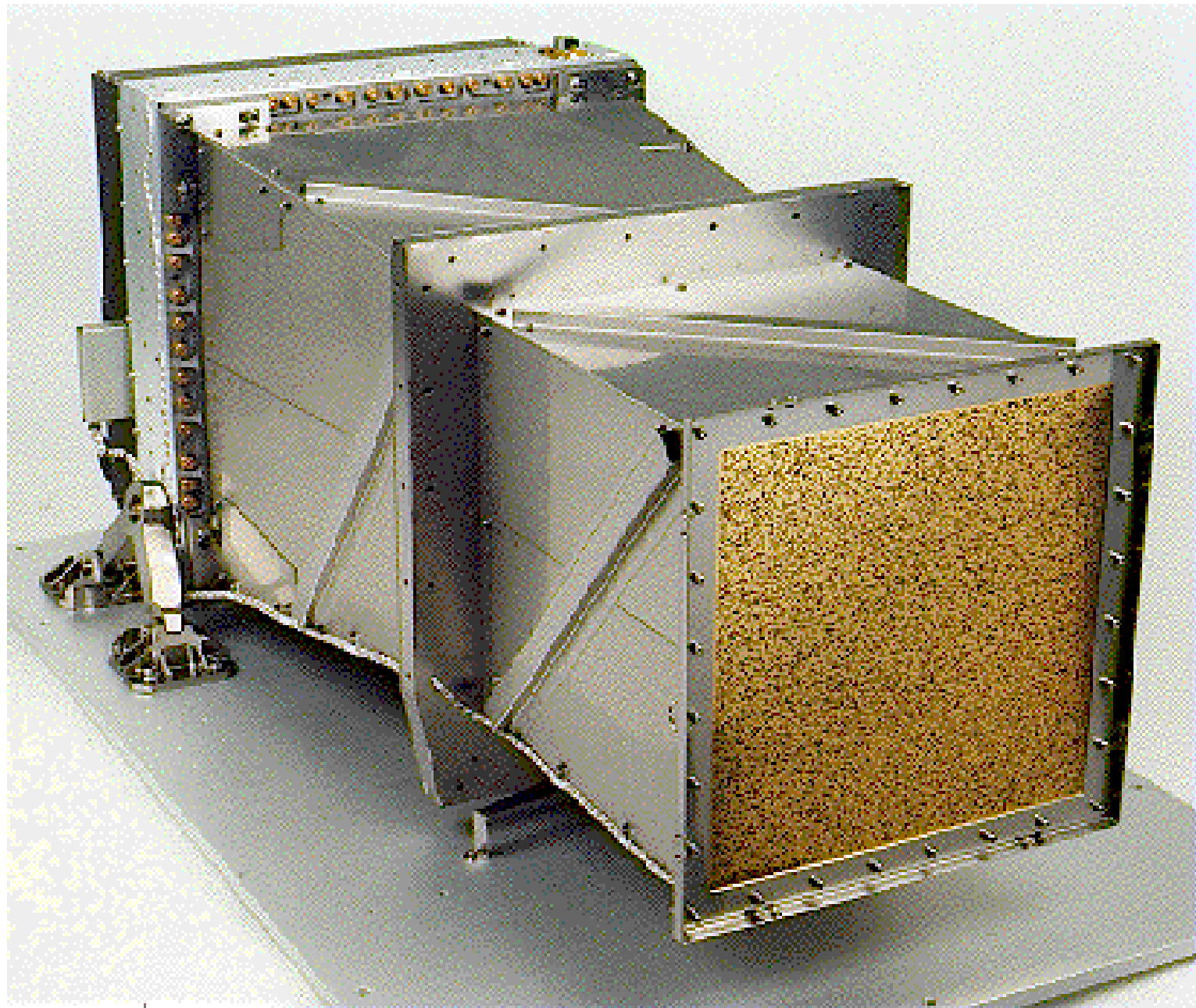
BeppoSAX (1996)

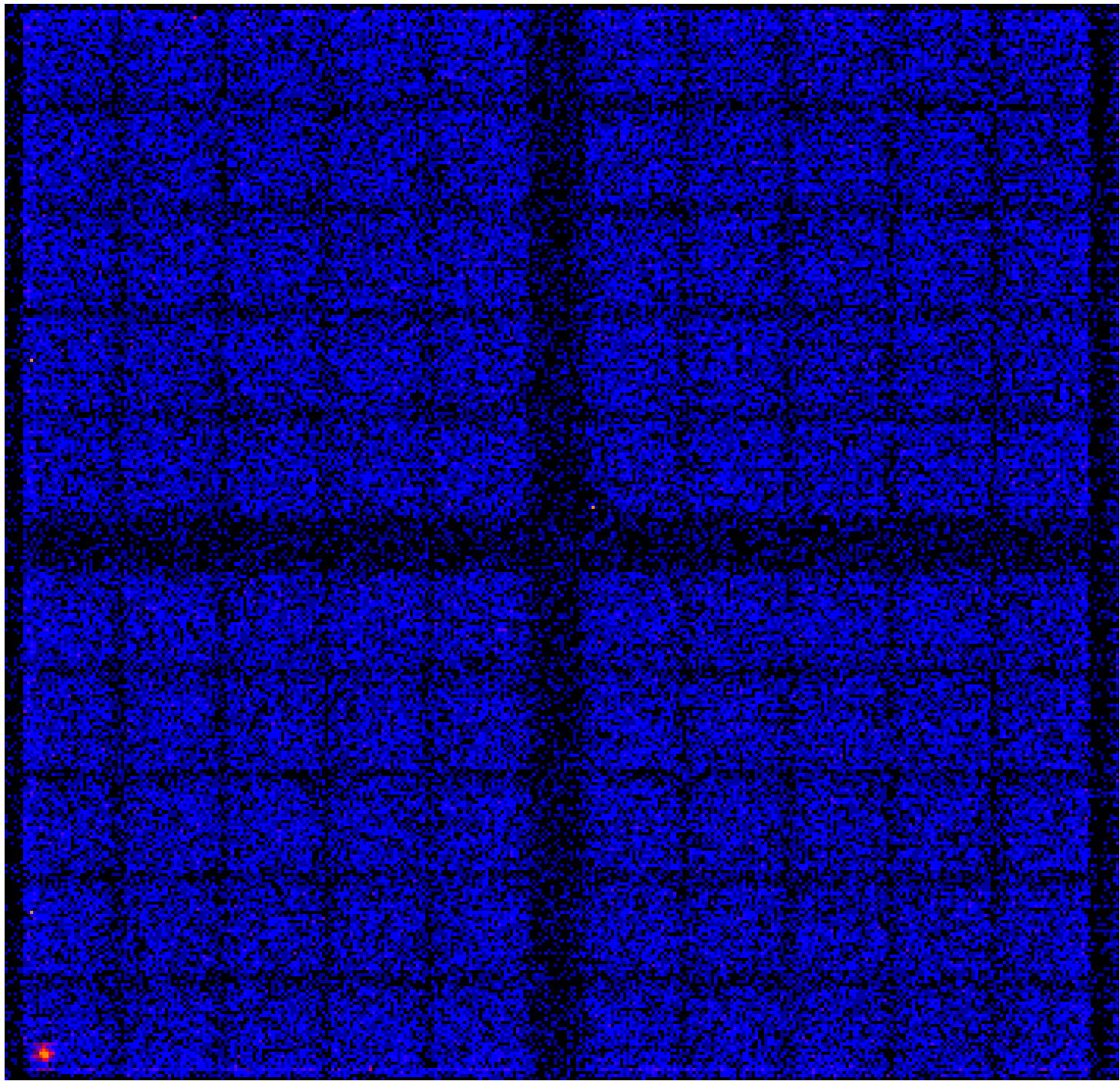


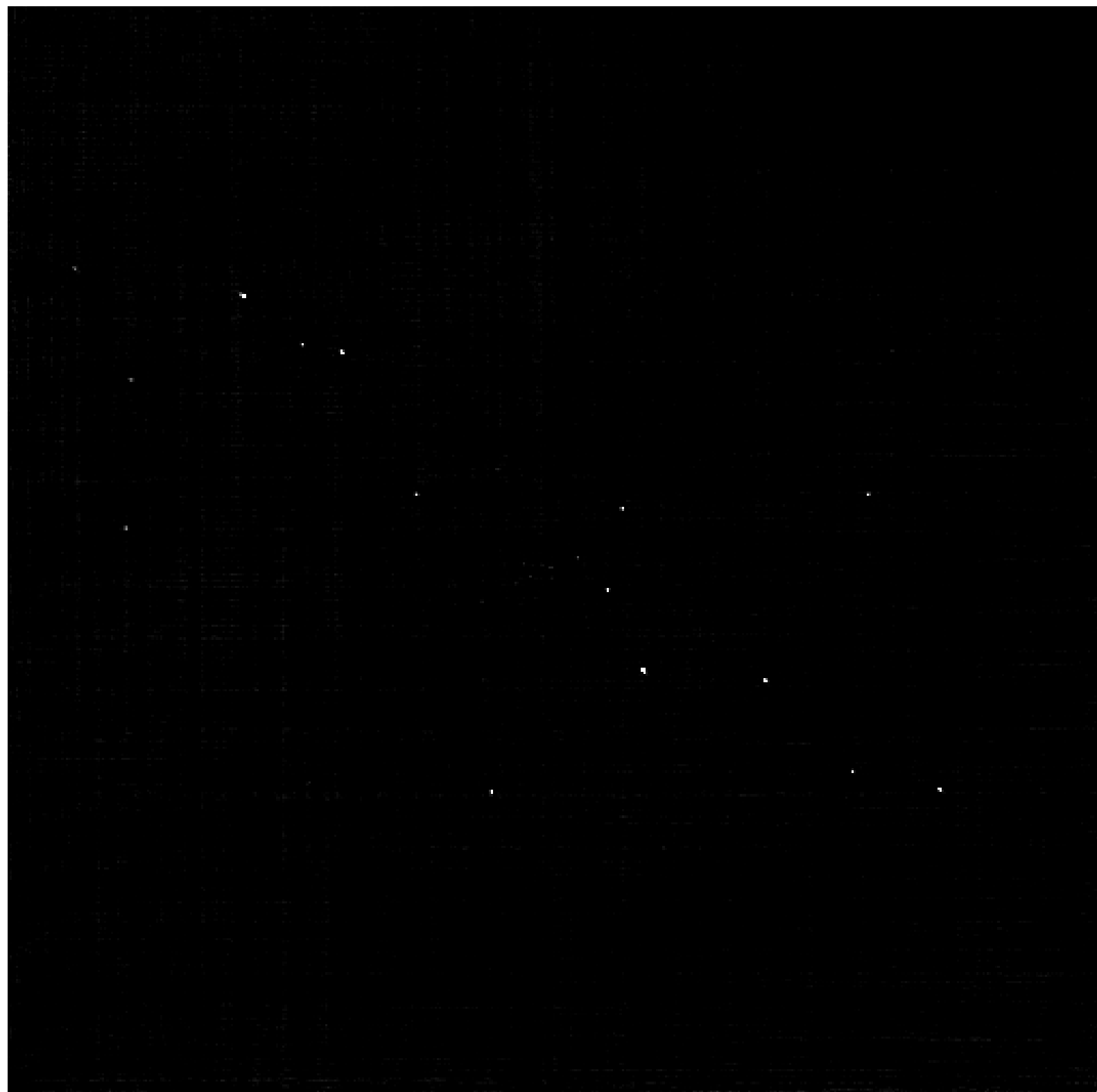
- Wide Field Camera
- Spettrometri X/gamma
[0.1 – 300 keV]
- Puntamento con precisione 1'
- 450 Mbit memoria

La maschera codificata

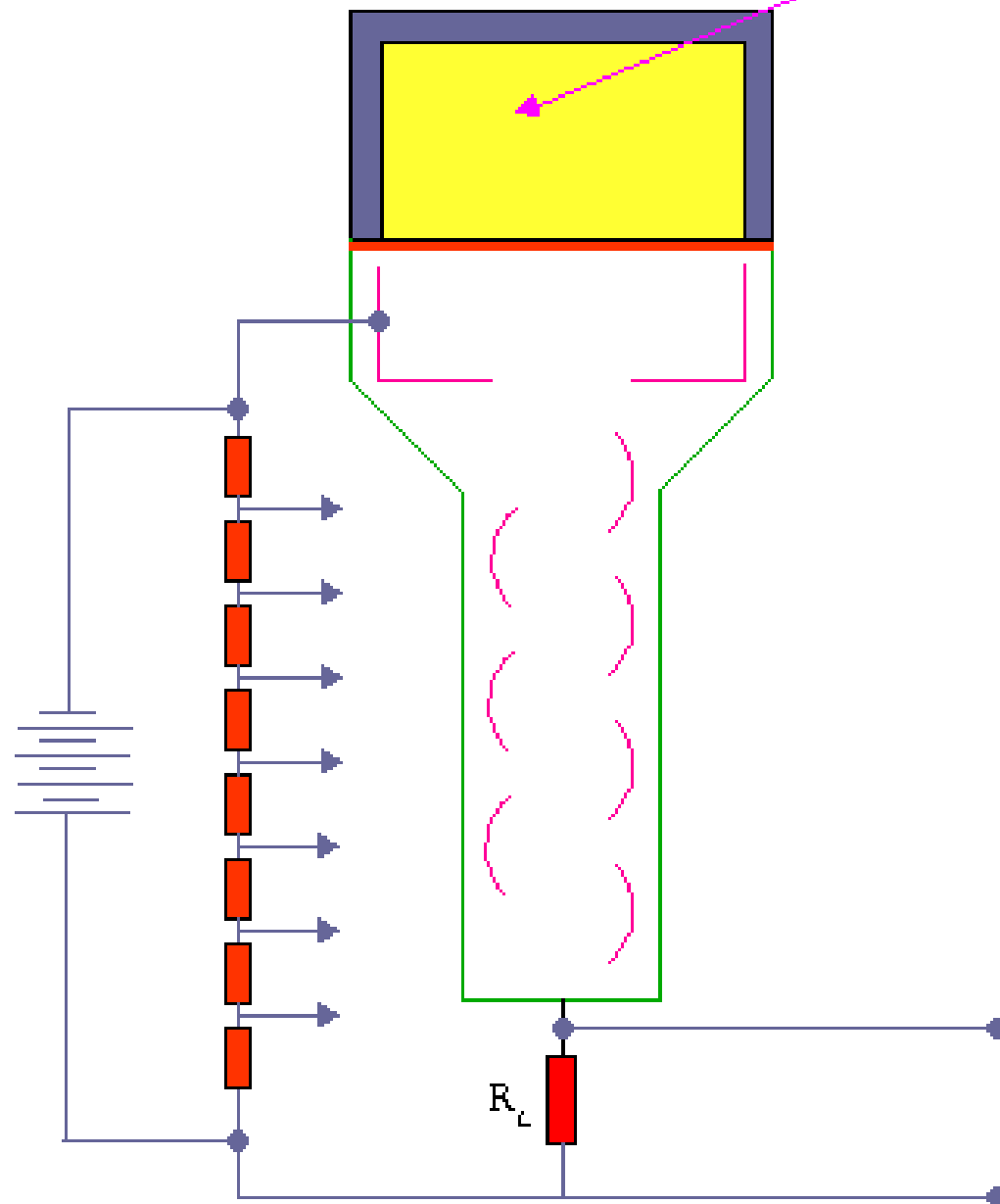




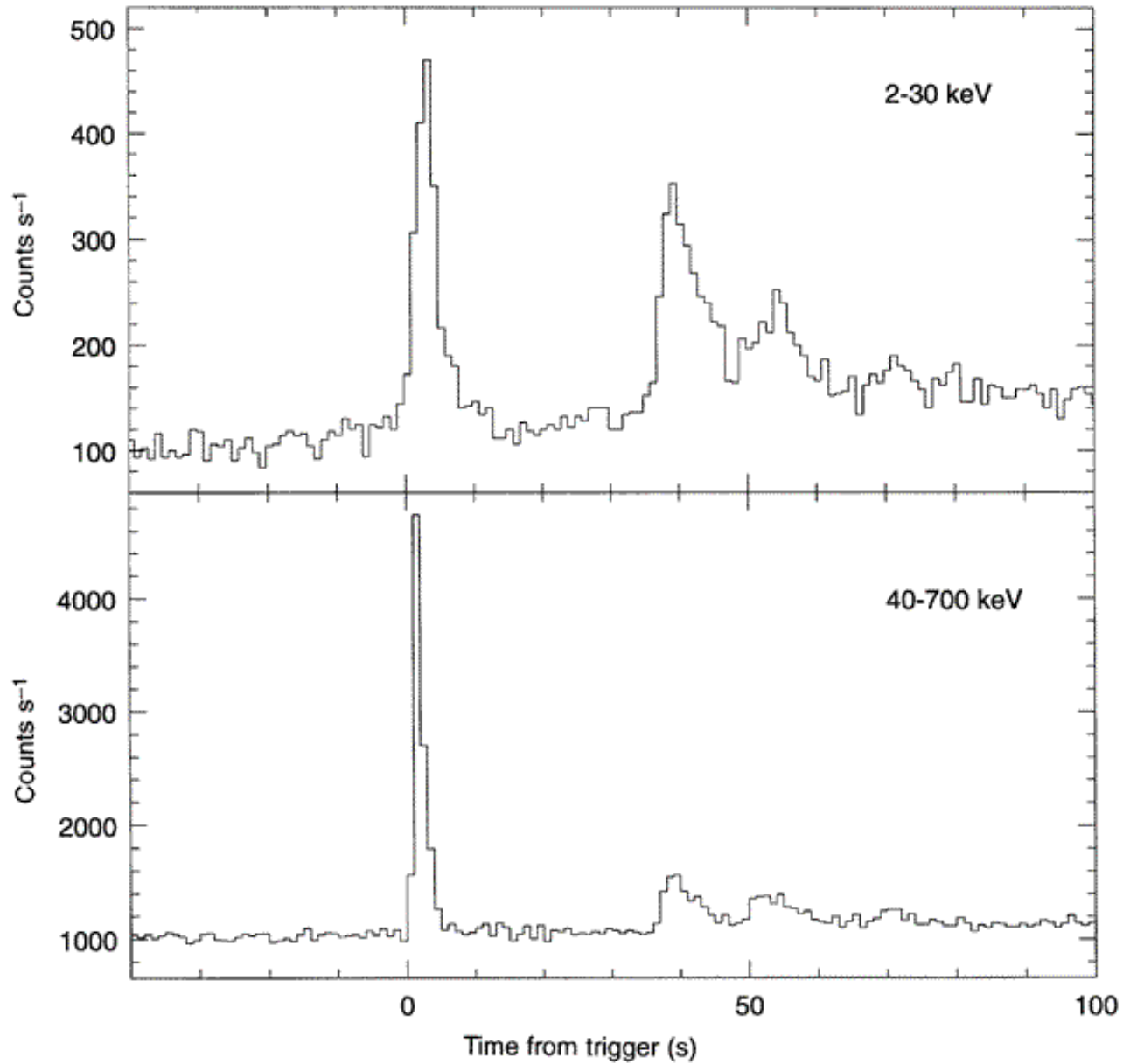




Rivelatore a scintillazione



28 Febbraio 1997



28 Febbraio 1997



Enrico Costa

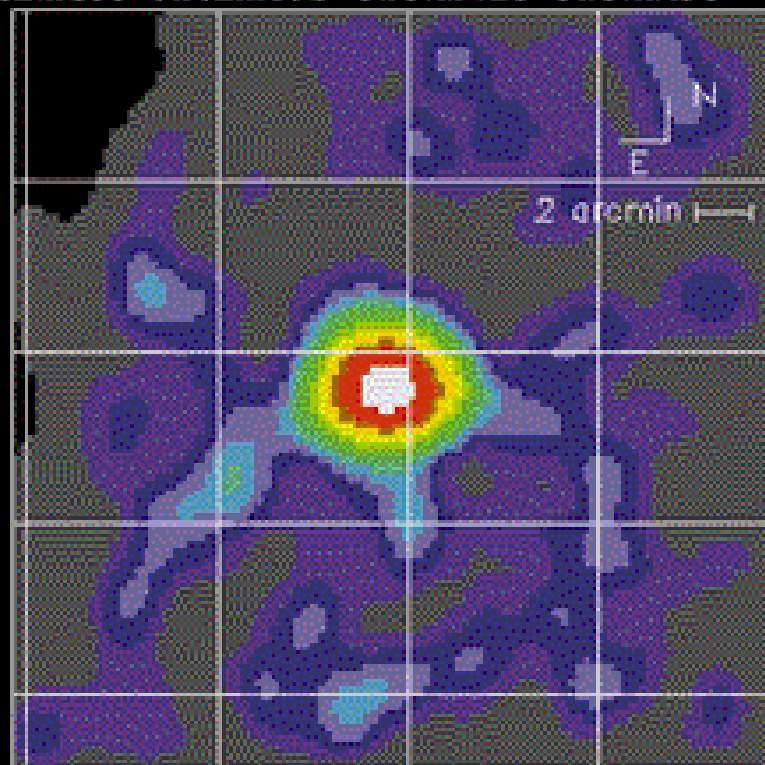
IAU CIRCULAR 6572

GRB 970228

E. Costa et al. communicate: "The **BeppoSAX** Gamma Ray Burst Monitor (**GRBM**) was **triggered on Feb. 28 02:58 UTC**. A quick-look analysis of the GRBM light curve shows a moderately intense, multi-peaked gamma-ray burst lasting about 80 s [...]. **From the WFC image**, we have derived a **preliminary position** of R.A. = 5h01m57s, Decl. = +11 46'.4 (equinox 2000.0), **with a 3' error radius**. A BeppoSAX **TOO** pointing of the Narrow Field Instruments was performed starting on Feb. 28 10:59 UTC, just **8 hr after** the GRB trigger time. The relevant data analysis is in progress. **Observations in all bands are solicited.**"

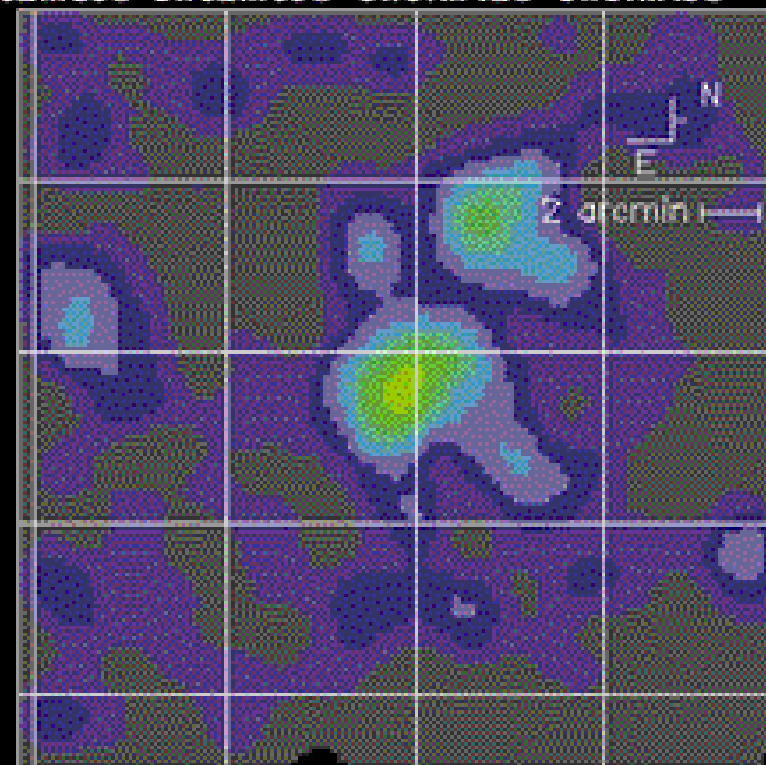
28 Feb 1997

5h02m36s 5h02m09s 5h01m42s 5h01m15s



3 Mar 1997

5h02m36s 5h02m09s 5h01m42s 5h01m15s



+12° 00' 00"

+11° 54' 00"

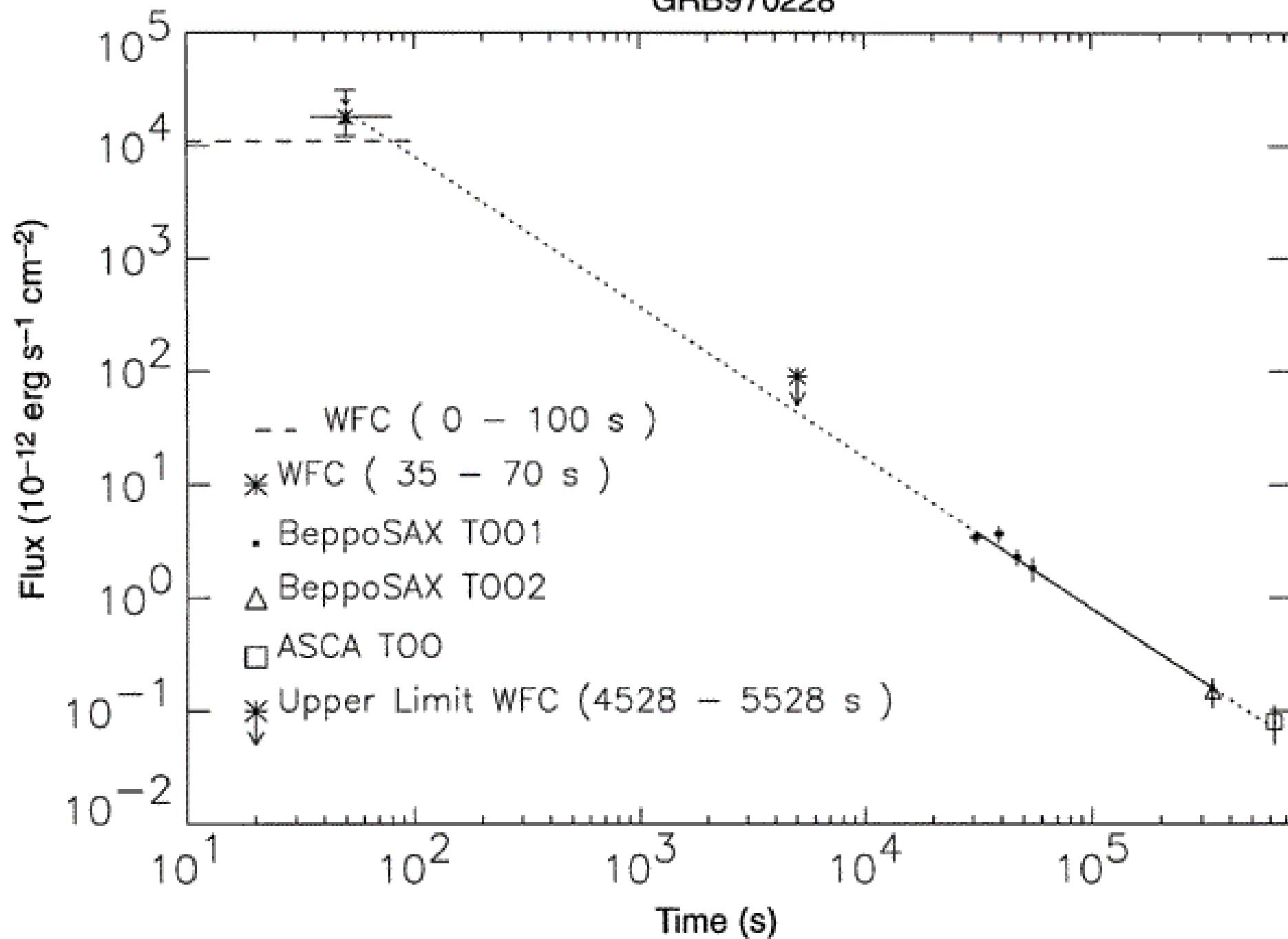
+11° 48' 00"

+11° 42' 00"

+11° 36' 00"



GRB970228



Controparte ottica 1

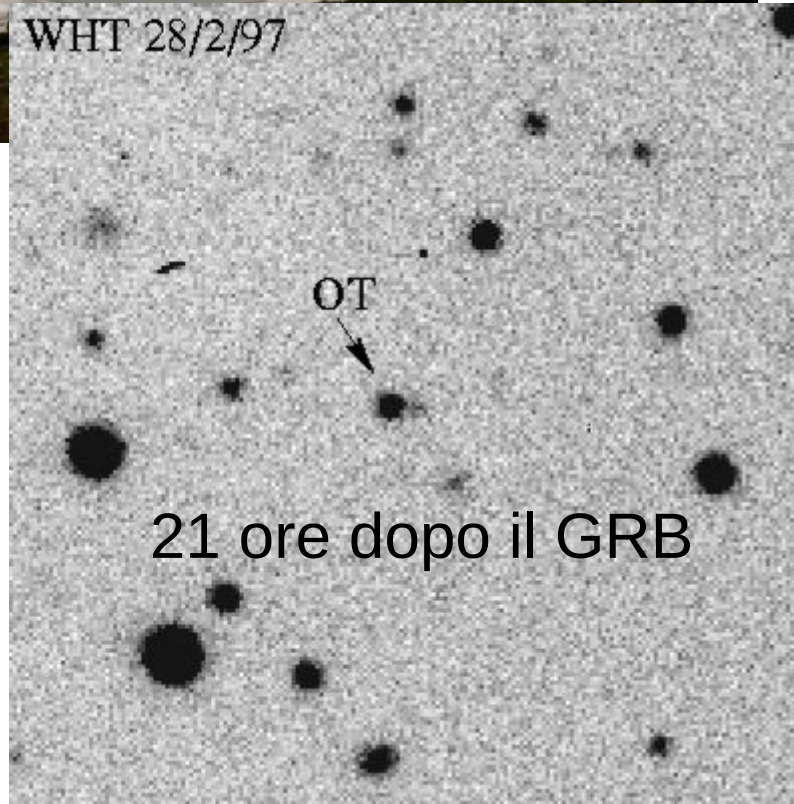
William Herschel Telescope,
Canarie



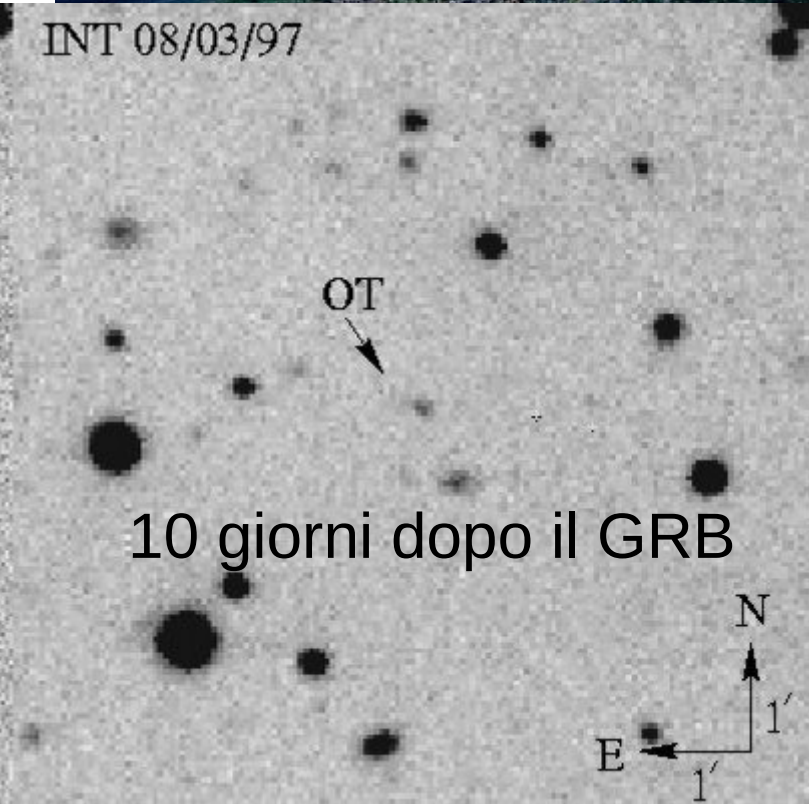
Isaac Newton Telescope,
Canarie



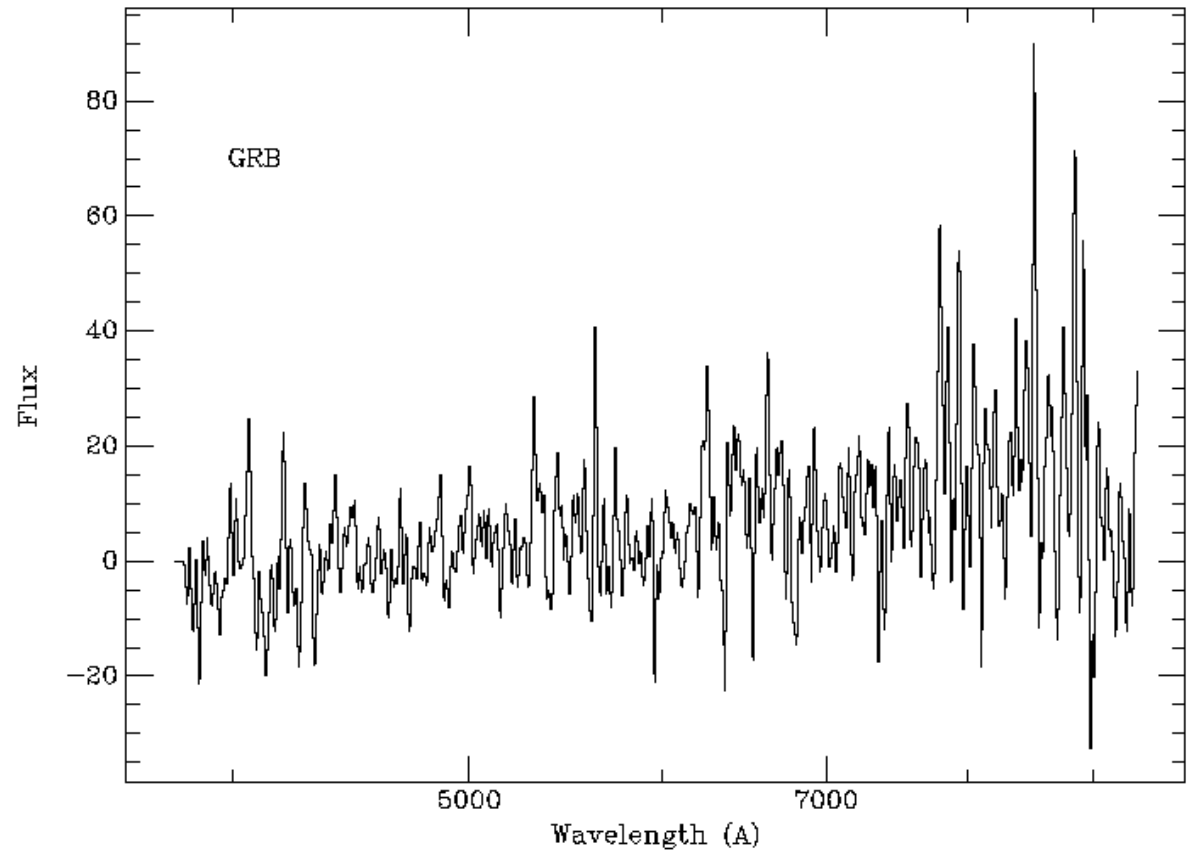
WHT 28/2/97



INT 08/03/97

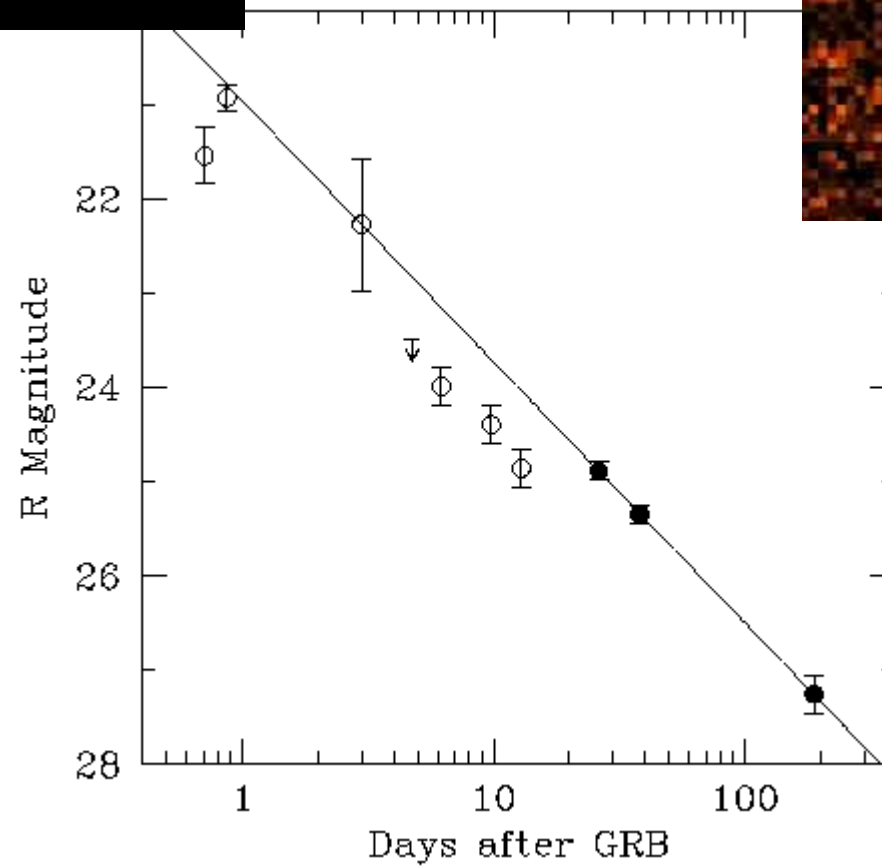
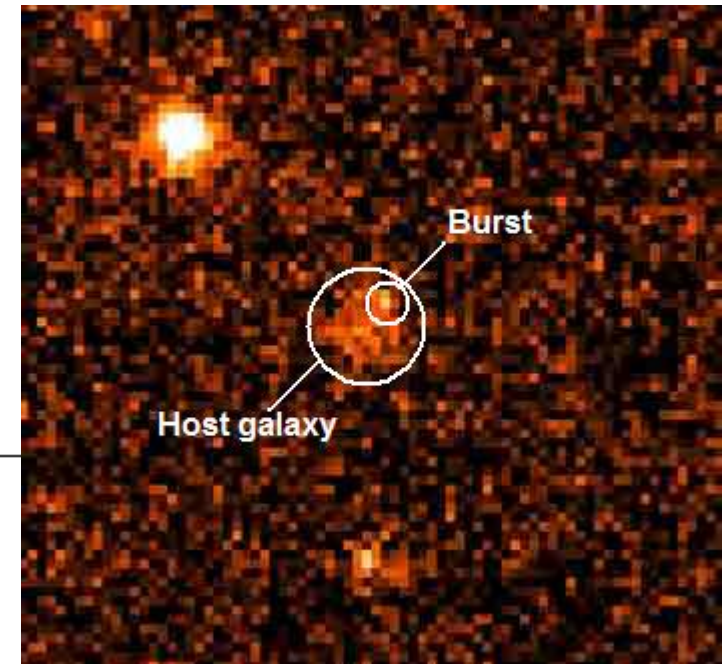
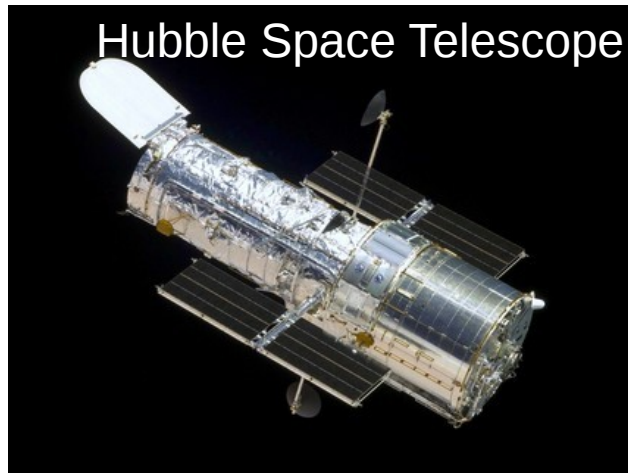


Controparte ottica 2



$z=0.695$

Controparte ottica 3



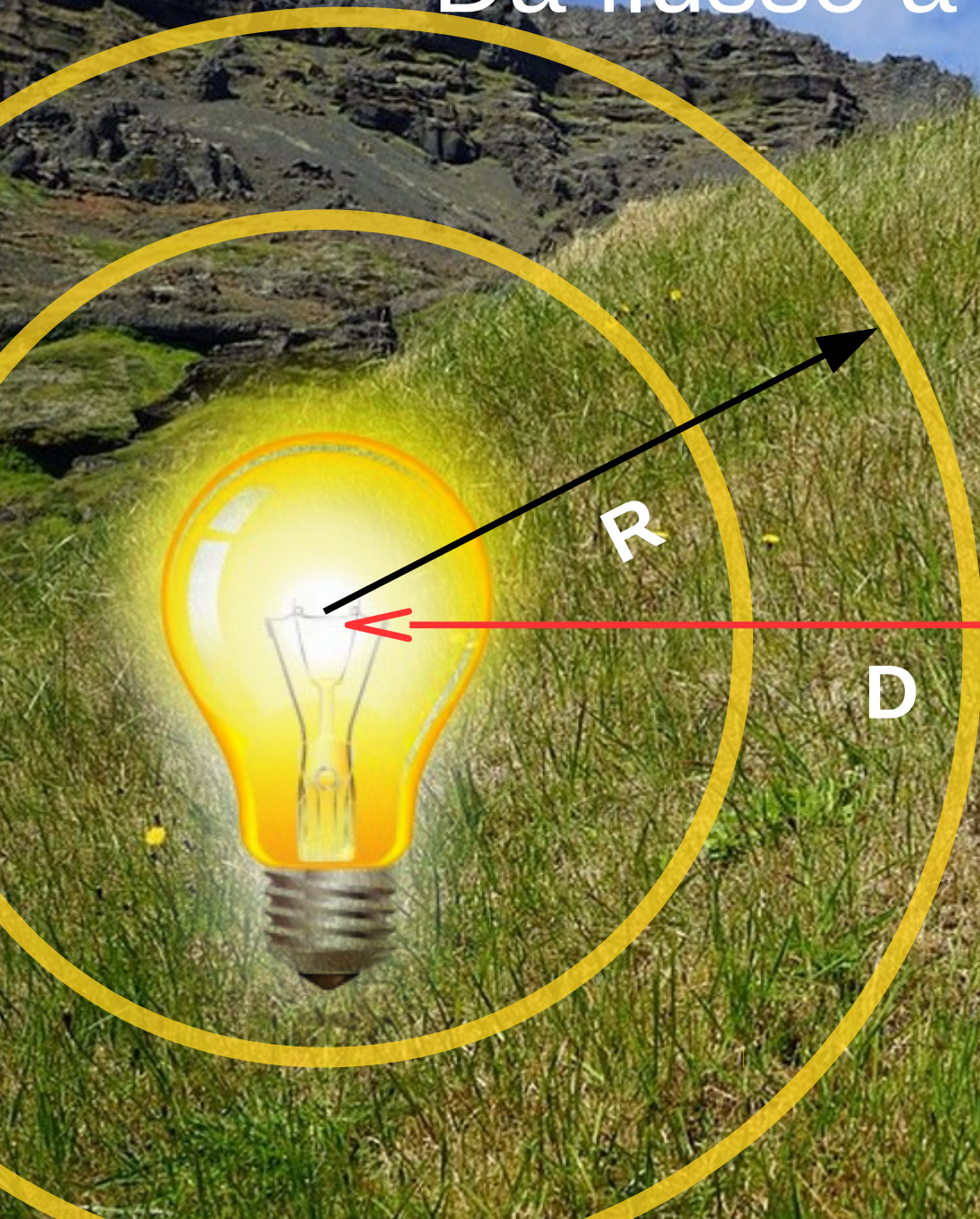
Distanze cosmologiche

$$z=0.695 \longrightarrow d_L = 4,3 \text{ Gpc} = 14 \text{ Gly}$$

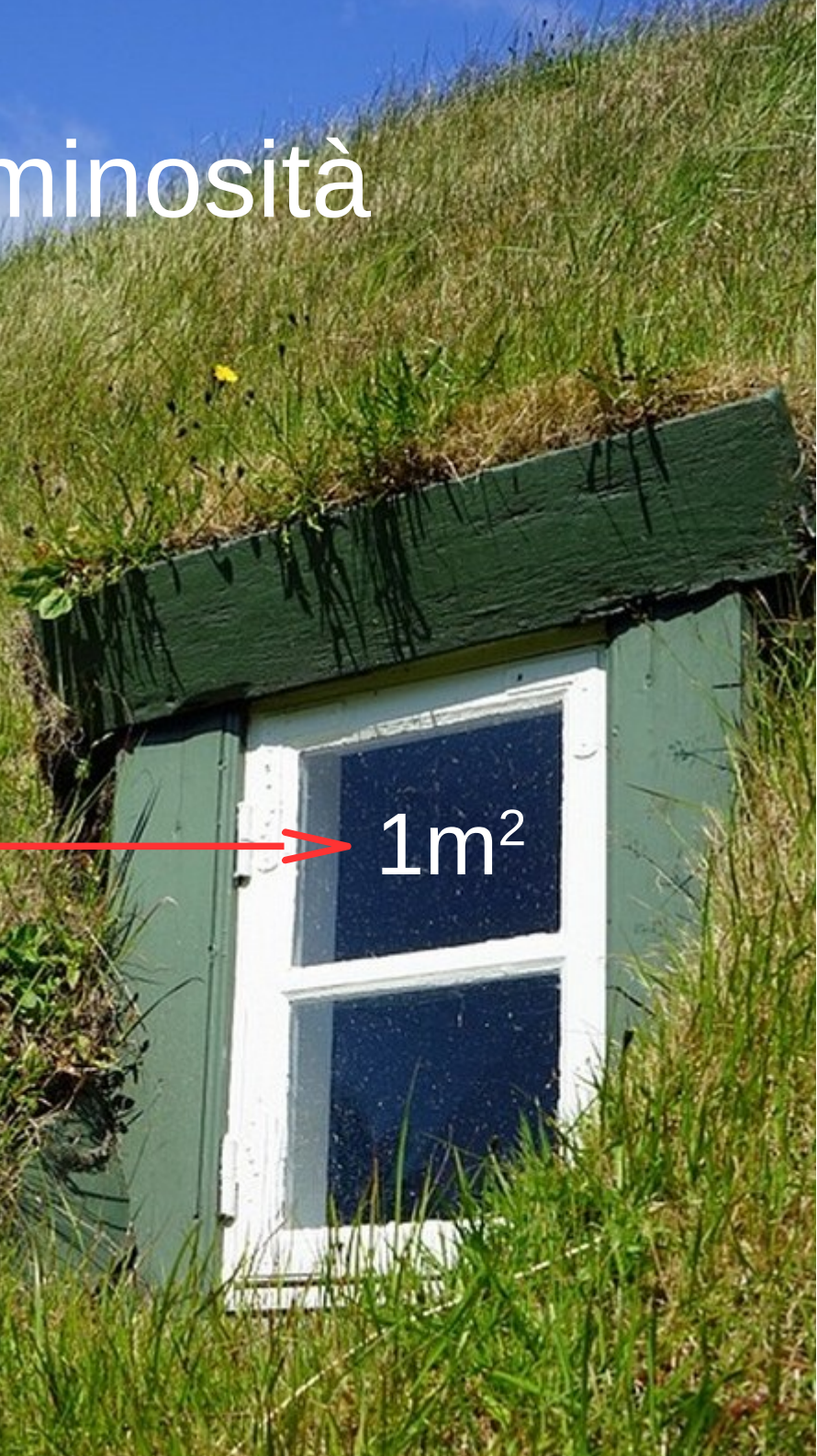
Esploso quando l'Universo aveva
7,3 miliardi di anni!

Quanta energia aveva?

Da flusso a luminosità



1m^2



Area della superficie di una sfera di raggio R:

$$4\pi R^2$$

Luminosità = energia emessa al secondo

$$L = \text{energia} / \text{tempo}$$

Flusso = energia che attraversa la finestra
(o il mio rivelatore) per unità di tempo, per
unità di area attraversata

$$F = 10^{-8} \frac{erg}{cm^2 s}$$

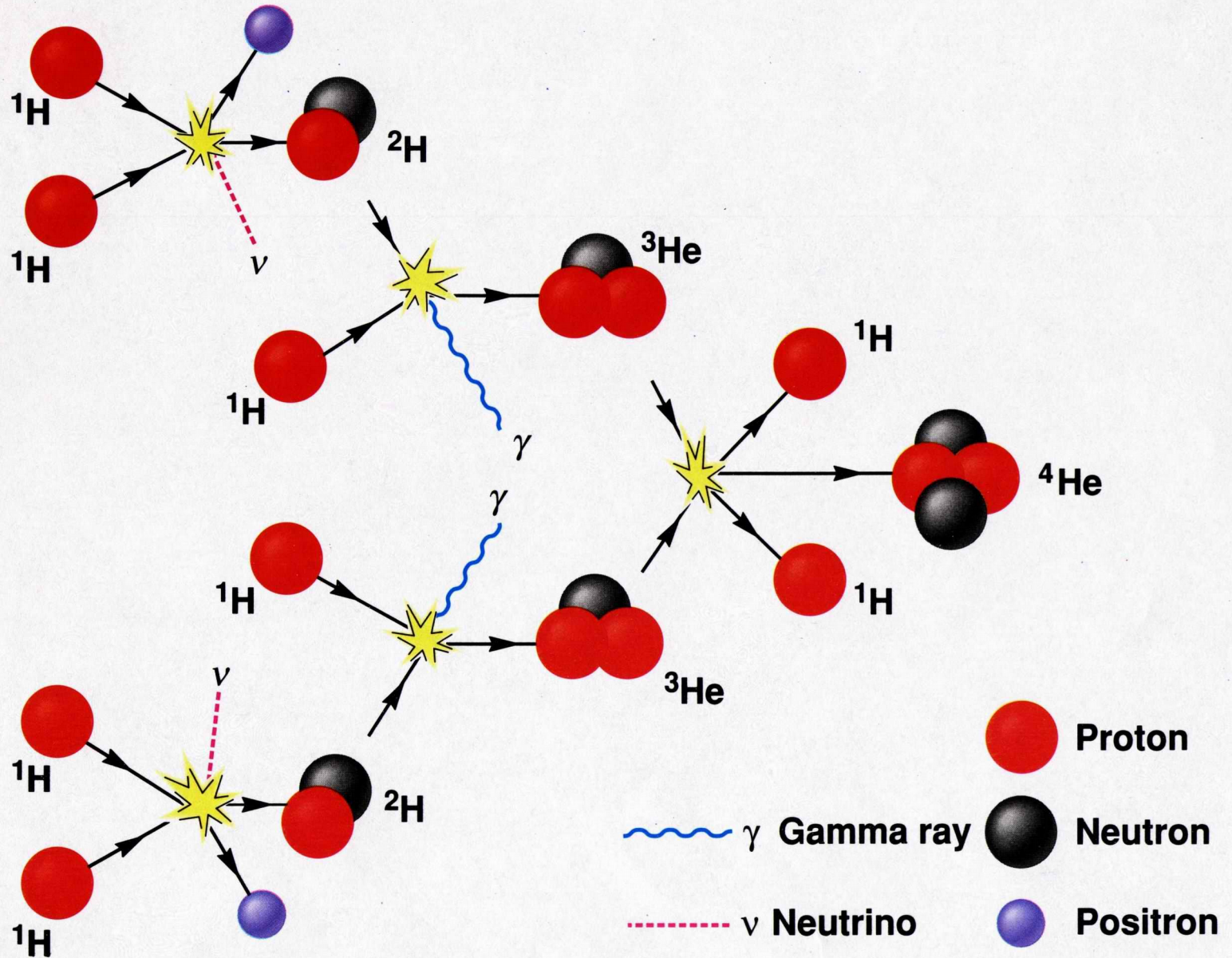
$$L = 4 \pi d_L^2 F$$

$$L \sim 10^{49} erg/s$$

$$L_{Sole} = 4 \times 10^{33} erg/s$$

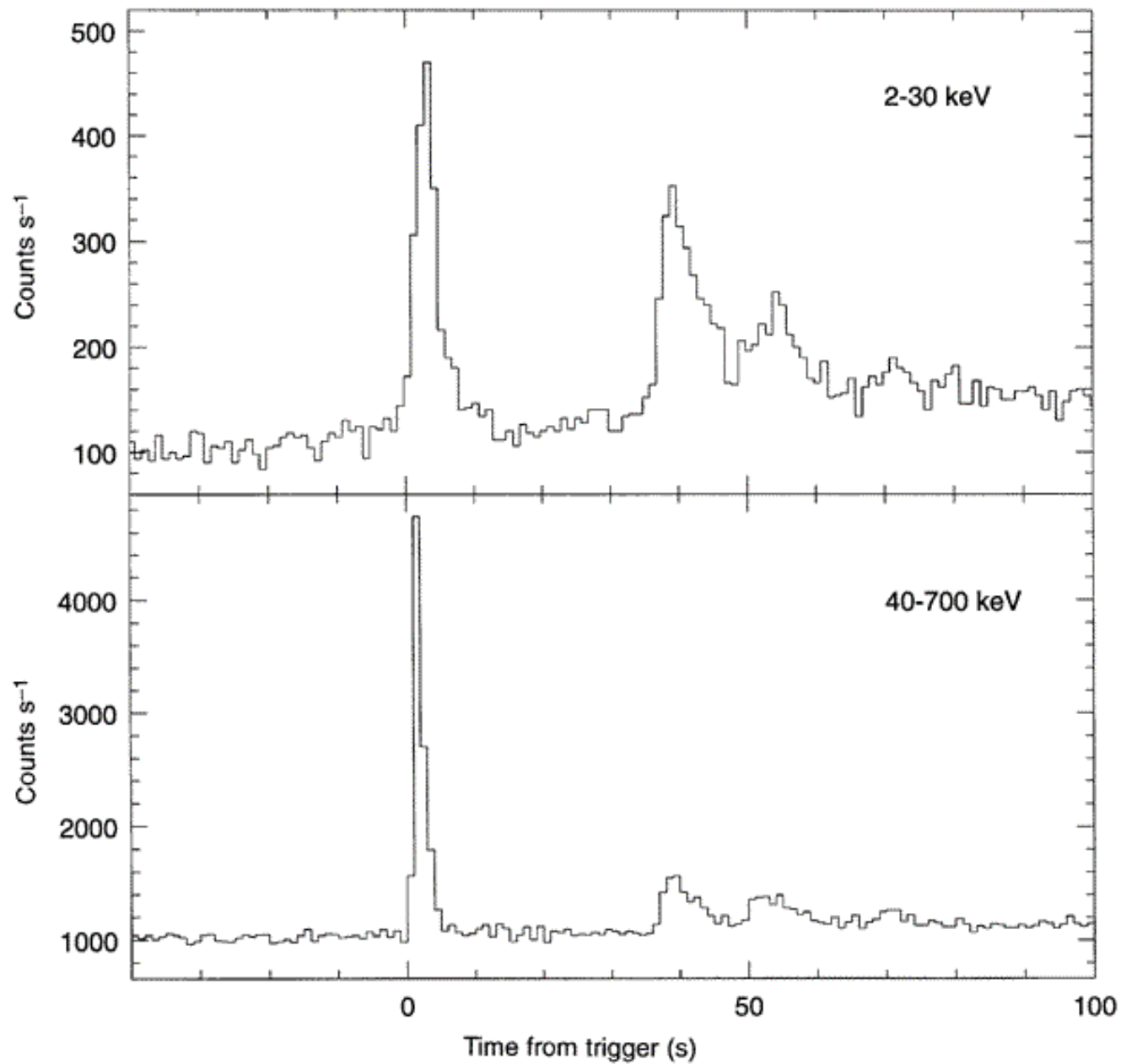
Ciclo p-p nelle stelle

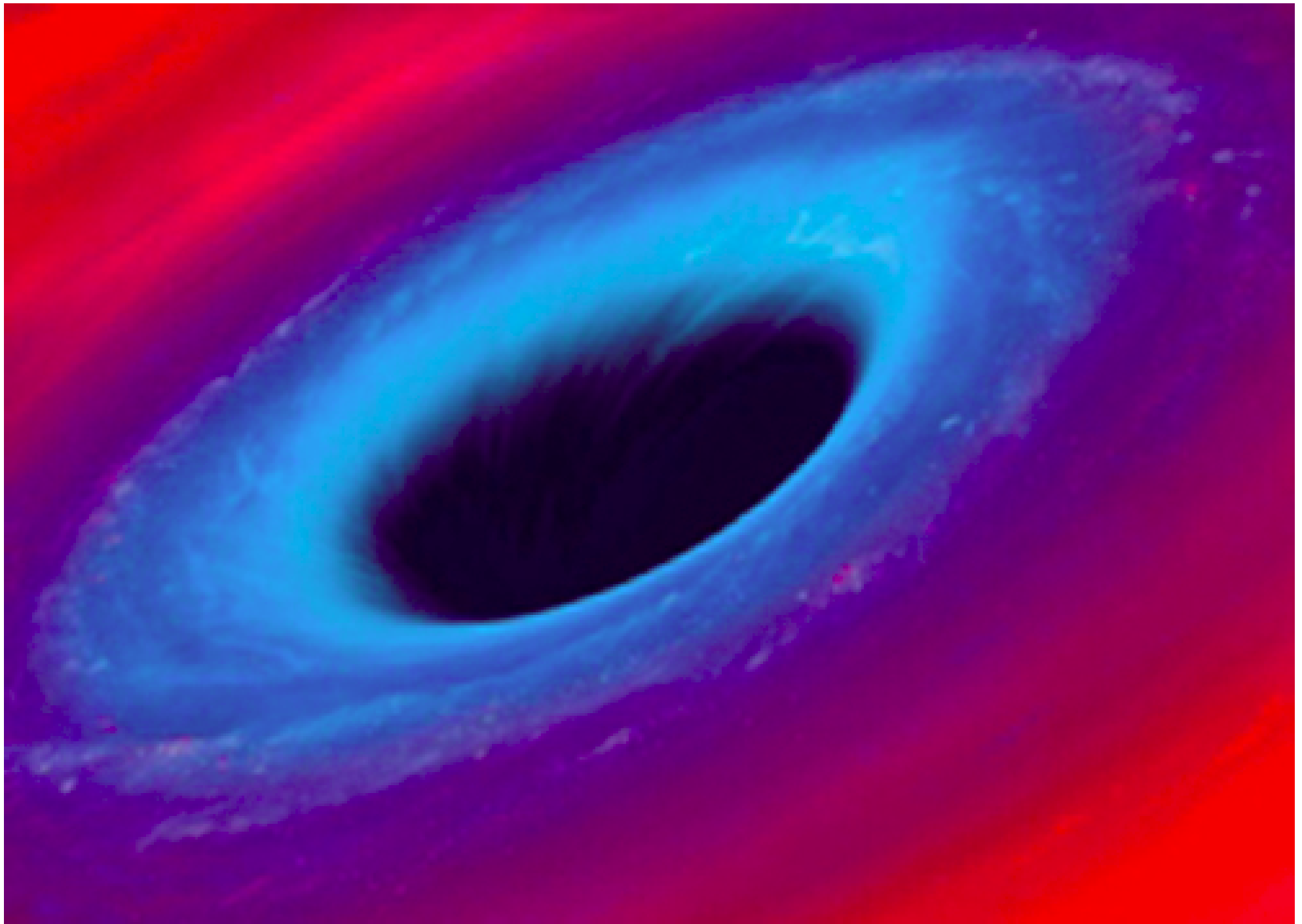
Efficienza: 0.7%



Proton-proton chain.

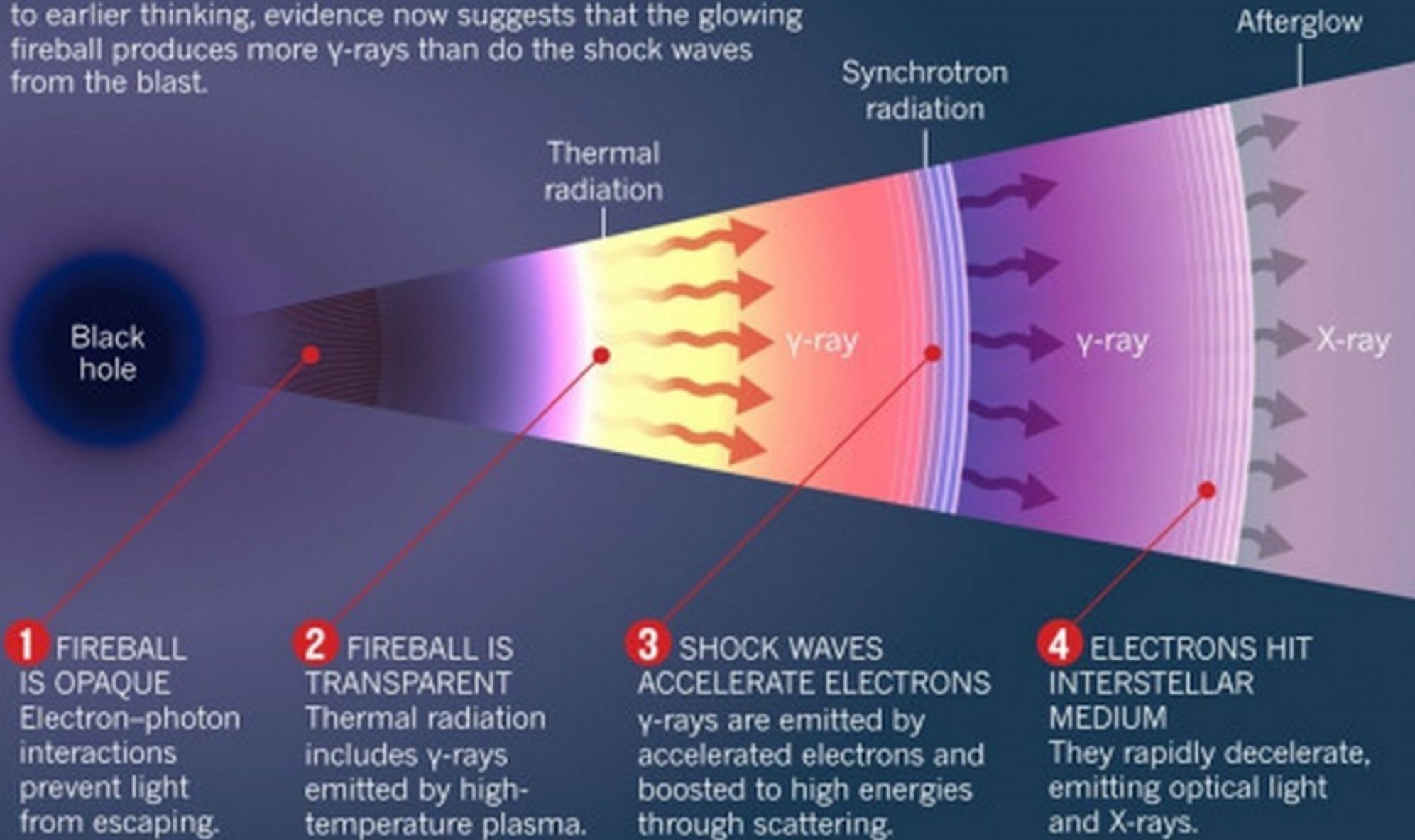
Variabilità rapida: compattezza

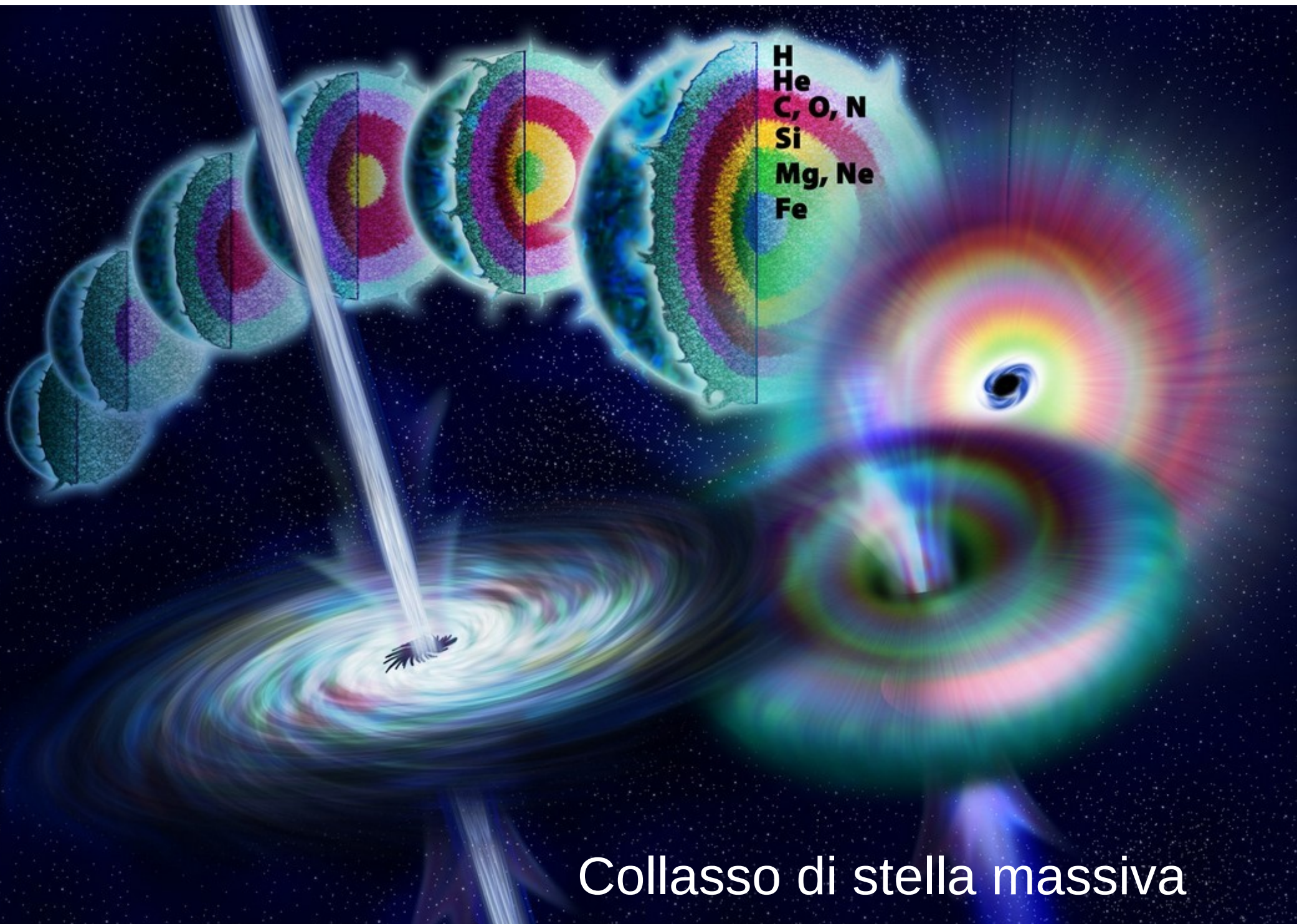


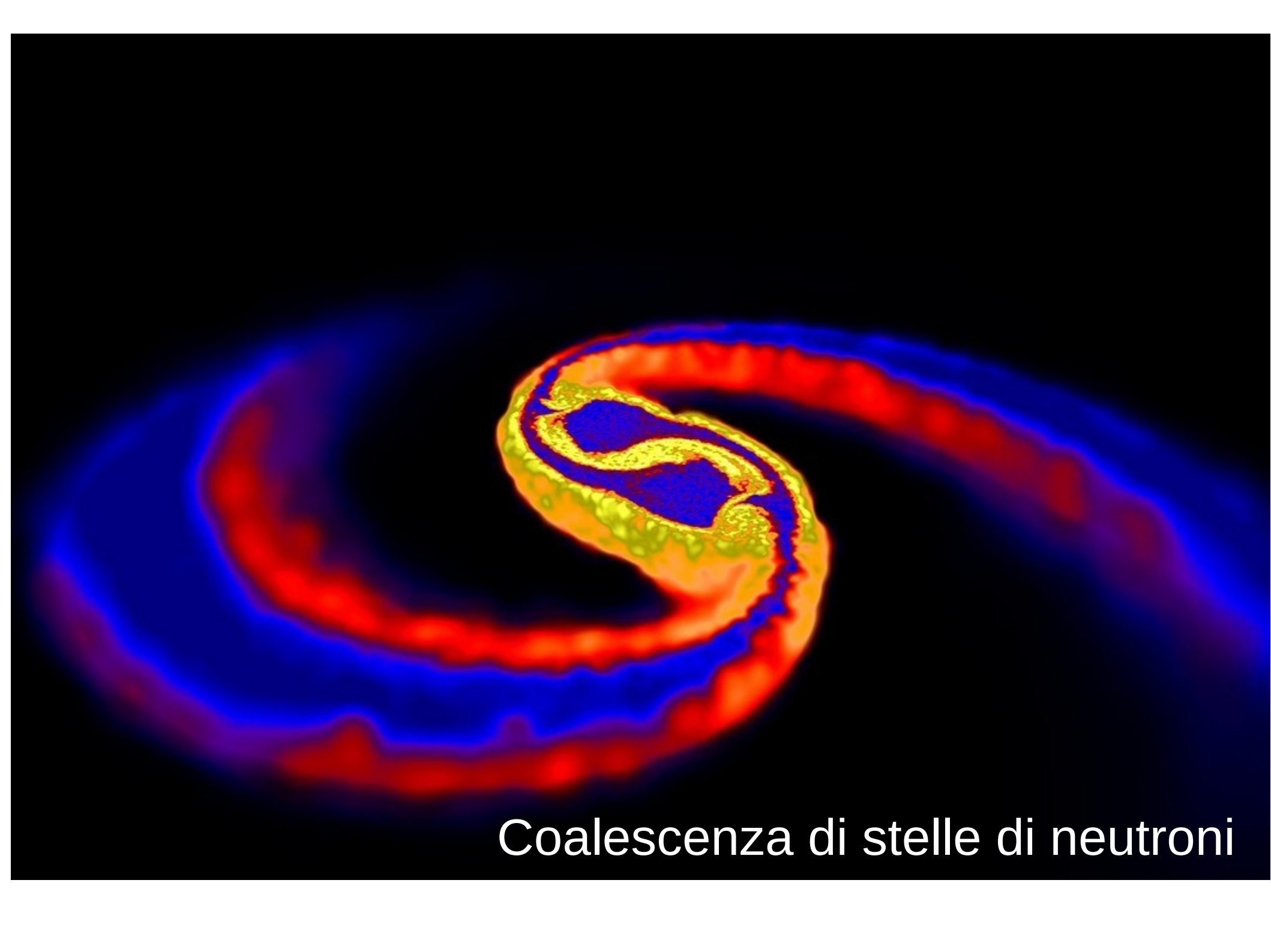


ANATOMY OF A BURST

When a black hole forms from a collapsed stellar core, it generates an explosive flash called a γ -ray burst. Contrary to earlier thinking, evidence now suggests that the glowing fireball produces more γ -rays than do the shock waves from the blast.

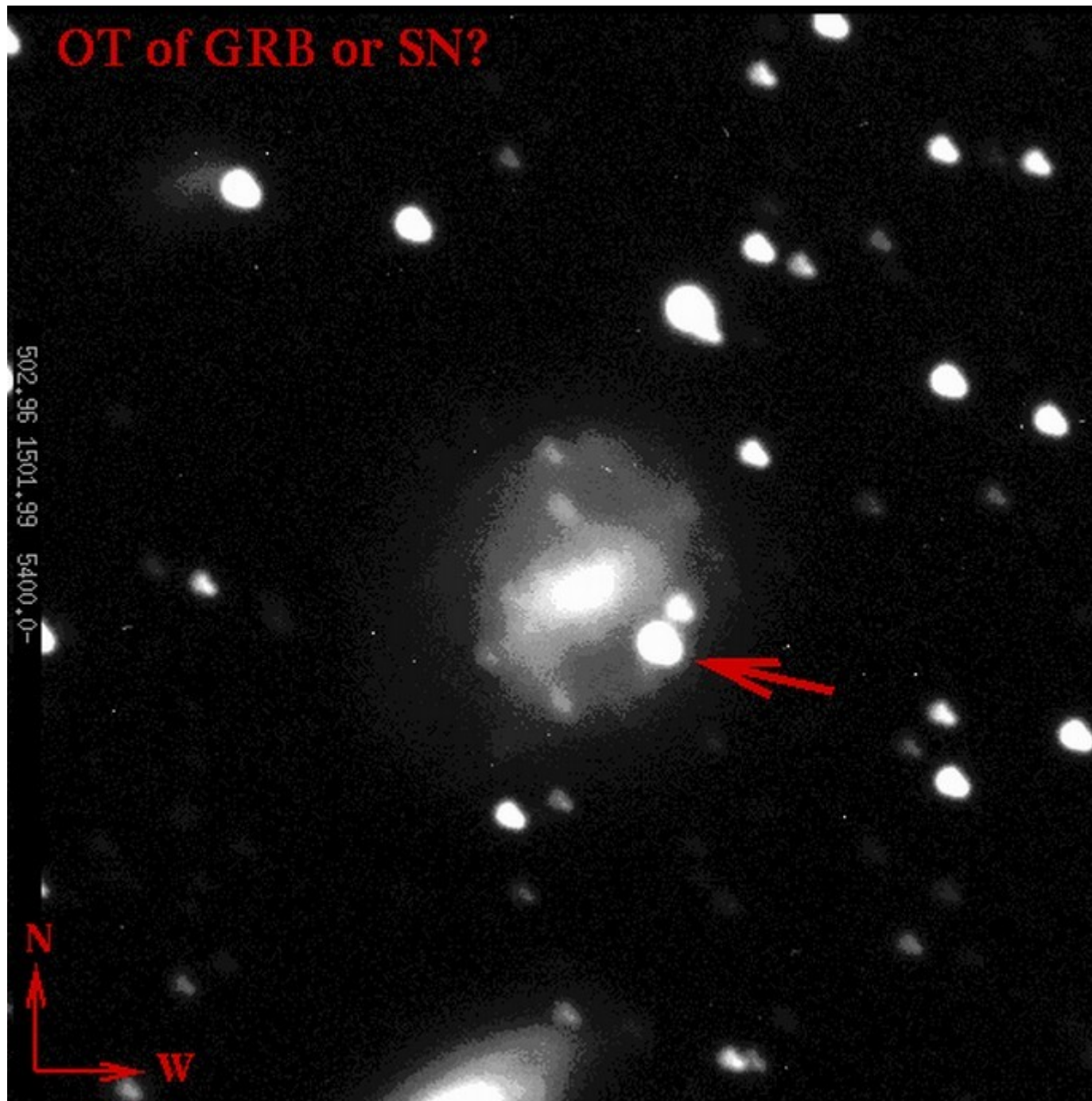




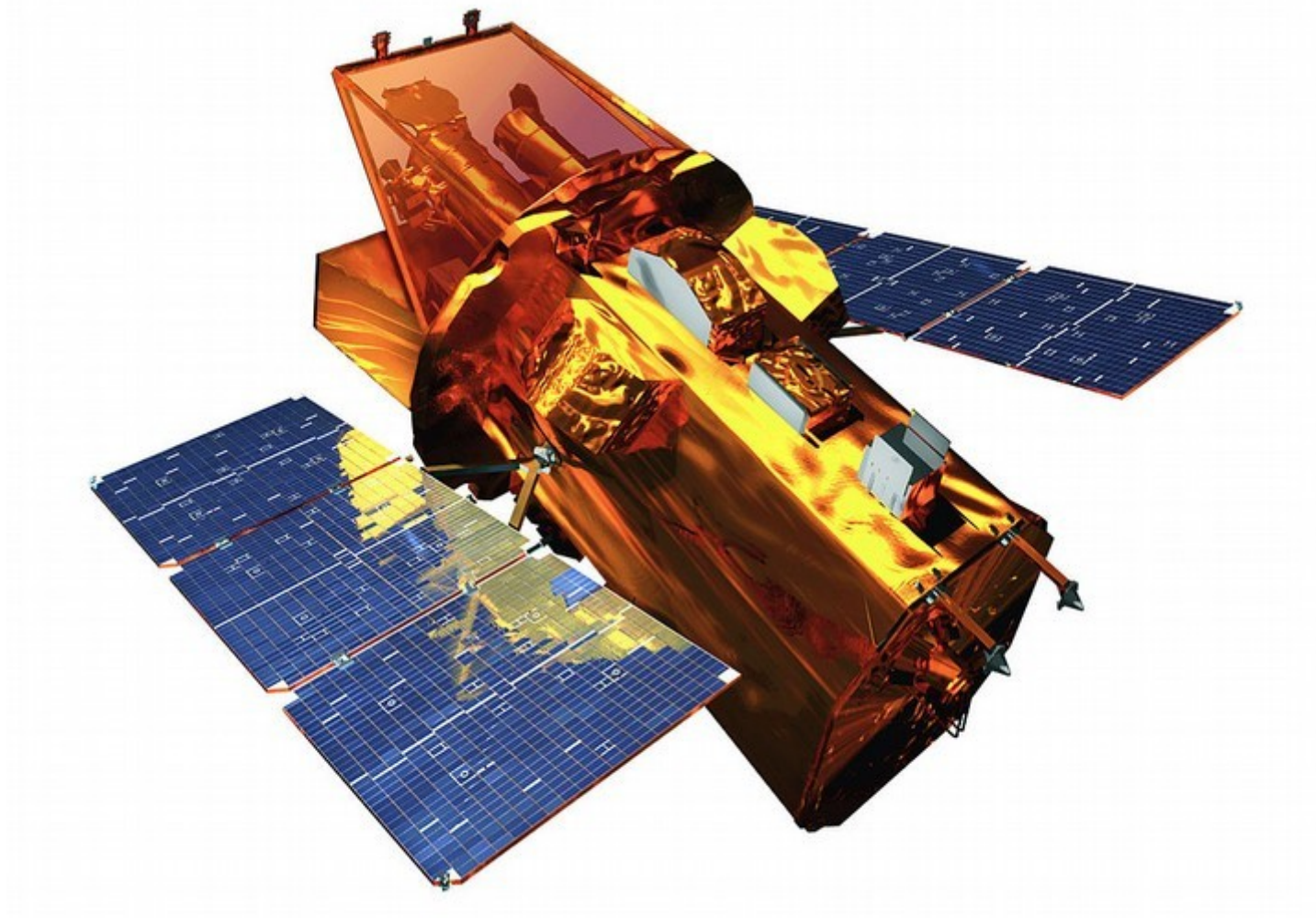


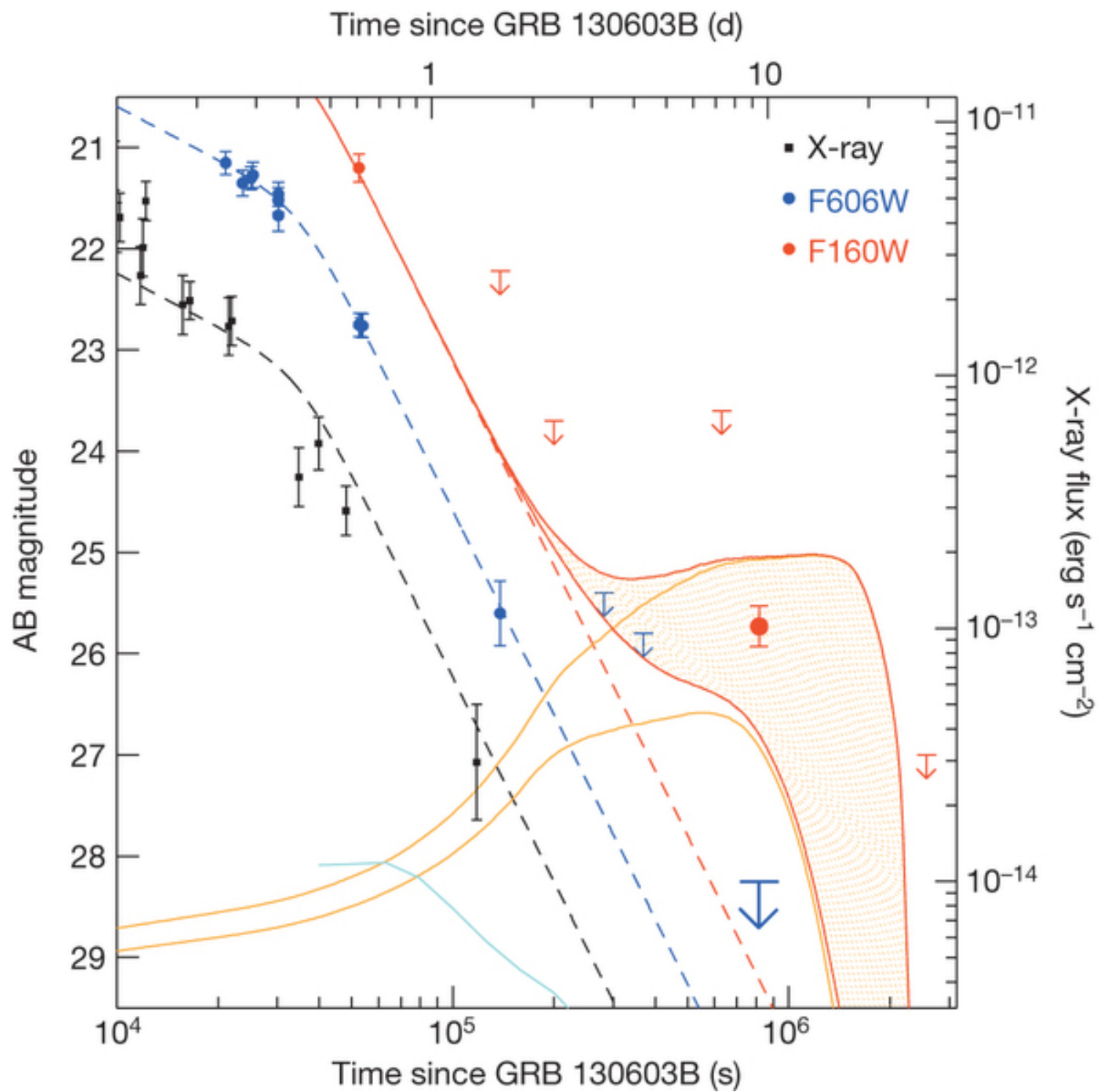
Coalescenza di stelle di neutroni

GRB980425 - SN1998bw



Swift (2004)





Ricapitolando

- Lampi gamma scoperti nel 1969, localizzazione iniziale con triangolazione tra satelliti terrestri
- Alla fine degli anni '70, rete interplanetaria
- All'inizio degli anni novanta: BeppoSAX
- Scoperta la distanza: sono cosmologici e molto energetici → devono essere generati da un buco nero
- Associazione con supernova
- Associazione con coalescenza stelle neutroni?
- Dal 2004 con Swift abbiamo tantissimi GRB con redshift