

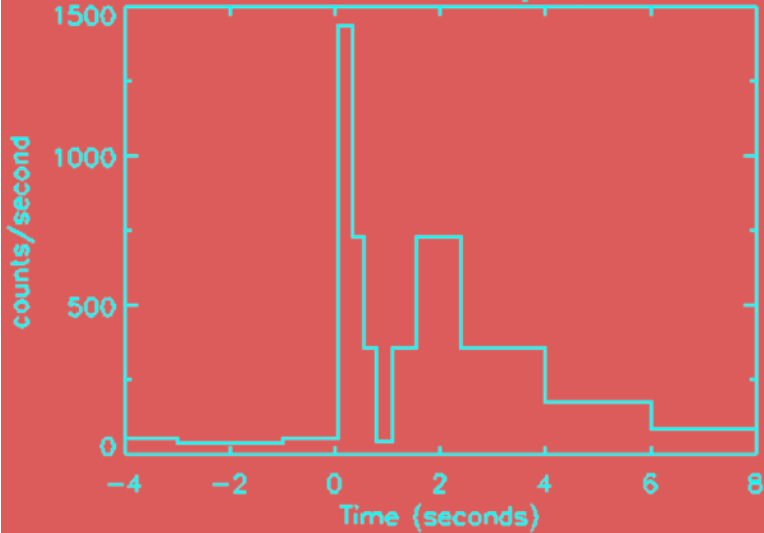
# The GravGroup at GSSI

Science Fair  
**GSSI**

17/02/2025

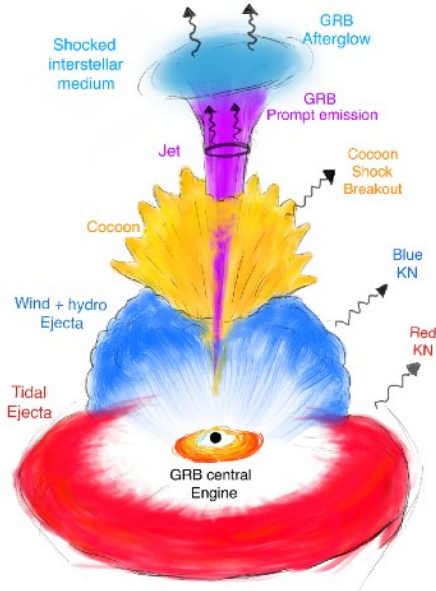
## *From a brief flash of 1967 to thousands of astronomers today*

Vela 4a Event – July 2, 1967



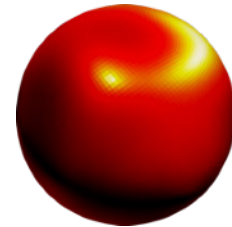
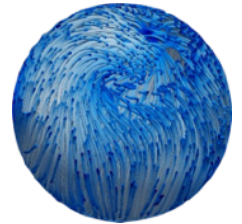
- [rapid astronomical communications]
- [robotic telescopes]
  
- relativistic jets
- collapsars
- first galaxies
- binary neutron star mergers
- multi-messenger astronomy
- nucleosynthesis
- tests of gravity

## Neutron stars - when they are calm and when they merge

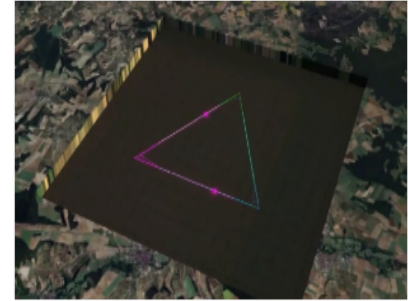
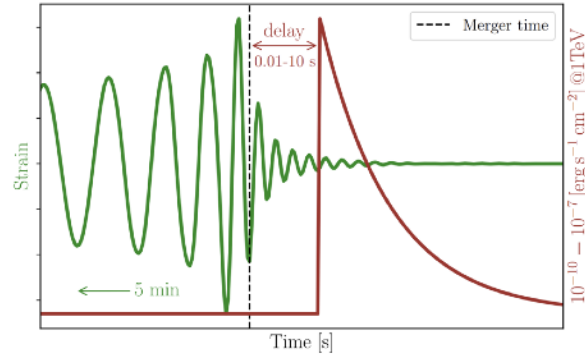


Which transients originate from a binary neutron star merger? How are they related to the properties of neutron stars?

How does the microphysics determine the cooling history and the magnetic field evolution of neutron stars?



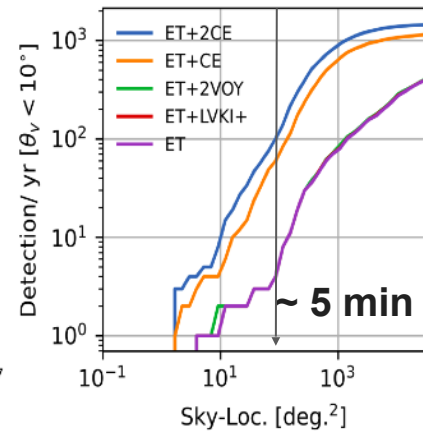
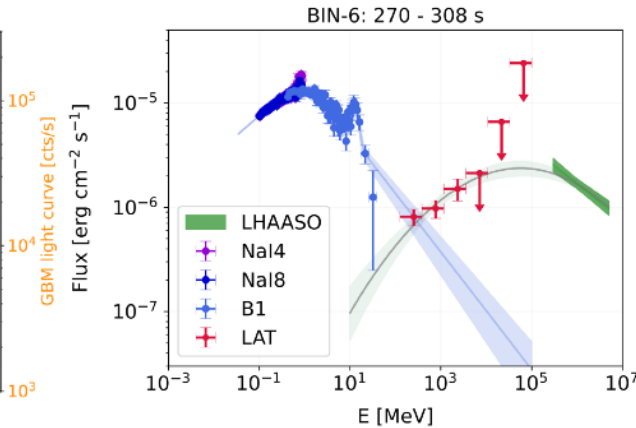
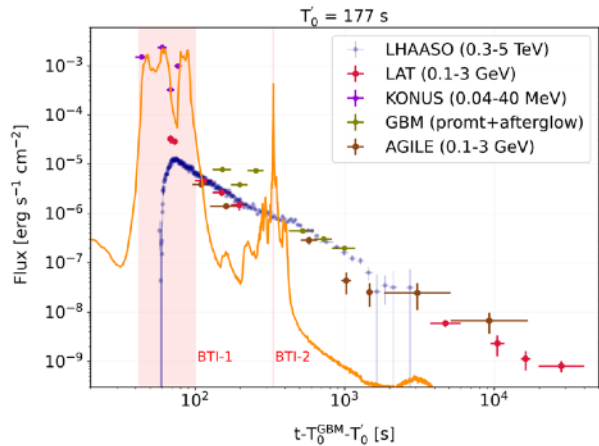
## Very-high-energy gamma-ray sky - extreme astrophysics



**~100 sq. deg.**



**GW FISH**

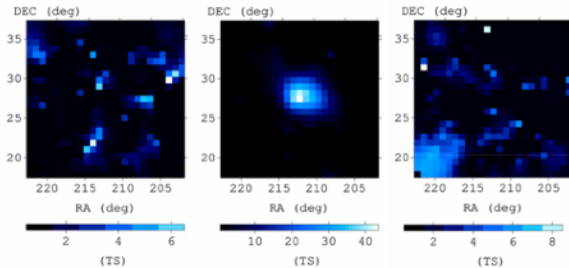
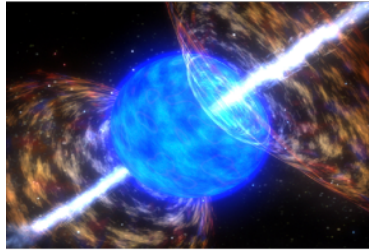
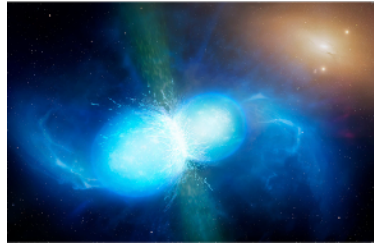


## Order in chaos - GRB detective

Who produces the GRBs?

Neutron star merger

Collapsar

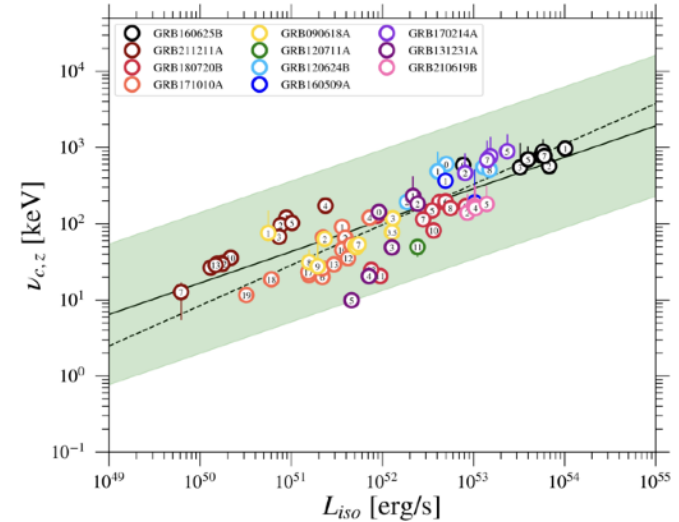


(a)  $t_0 - 1$  d to  $t_0$

(b)  $t_0$  to  $t_0 + 20$  ks

(c)  $t_0 + 1$  d to  $t_0 + 2$  d

What do GRBs have in common?

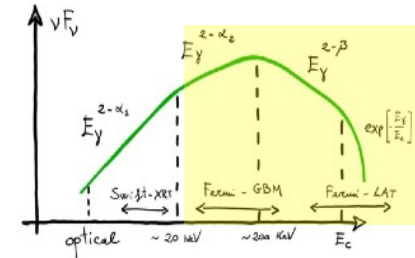
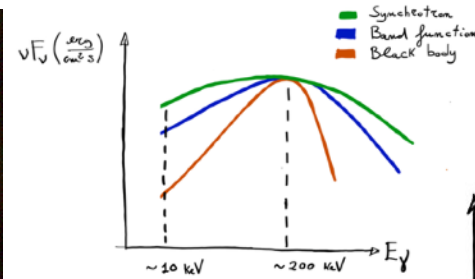
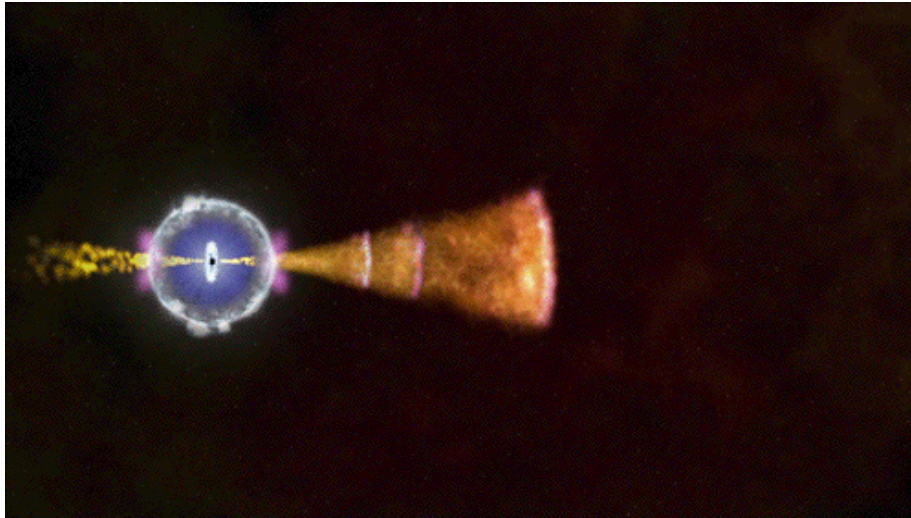




## Looking inside of mysterious jets - GRB detective



What is producing the prompt emission of GRBs?



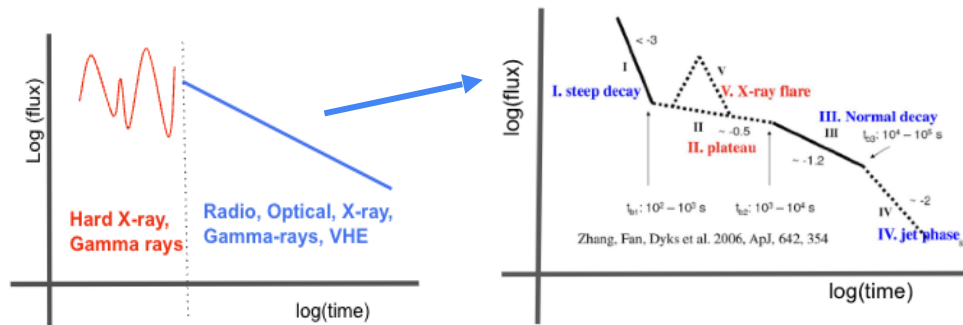
Jet Launching ?

Dissipation ?

Particle  
Acceleration ?

Cooling Mechanisms ?

## Treasure Hunt: X-rays to gamma-rays



For more details See **Poster!!**



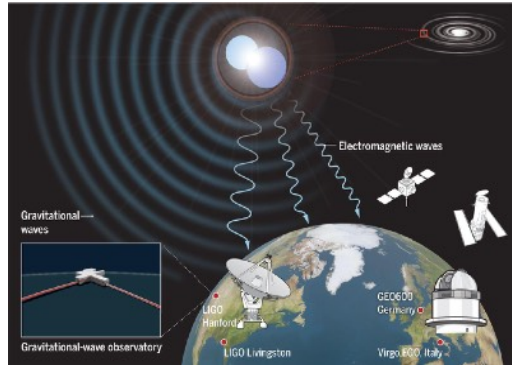
Origin of Anomalies in GRB afterglow

**Multi-messenger observations in coincidence with the GW detections**

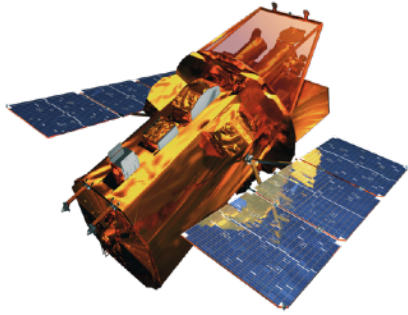
- Prompt**
- Brief flashes of Gamma-rays
  - ~1 keV-10 MeV
  - 0.1 -  $10^3$  sec
  - Highly variable

- Afterglow**
- Radio to VHE
  - Days to weeks
  - Smooth PL lightcurve
  - Non-thermal Spectra

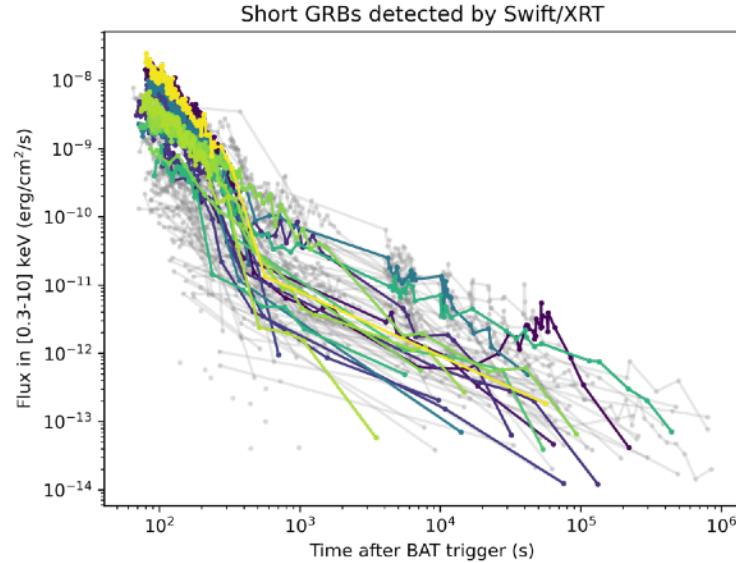
- GeV and TeV Importance!**
- Signature of Inverse Compton.
  - Magnetic Field, Lorentz factor, Emission sites etc



## Catch me if you can: X-ray counterparts of GWs



*Swift*

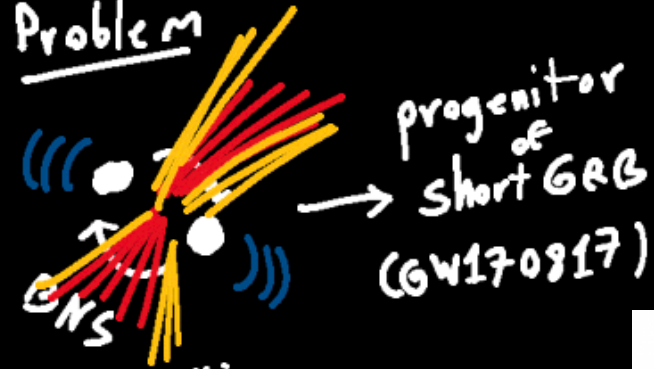


*Einstein Probe*



## sGRB

Problem



progenitor of short GRB (GW170817)

BUT



Investigation



GRB model

BNS population

GBM data



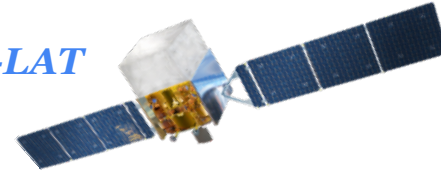
- GRB parameters (peak energy, duration etc...)
- Connection BNS ↔ GRB
- Multimessenger Predictions



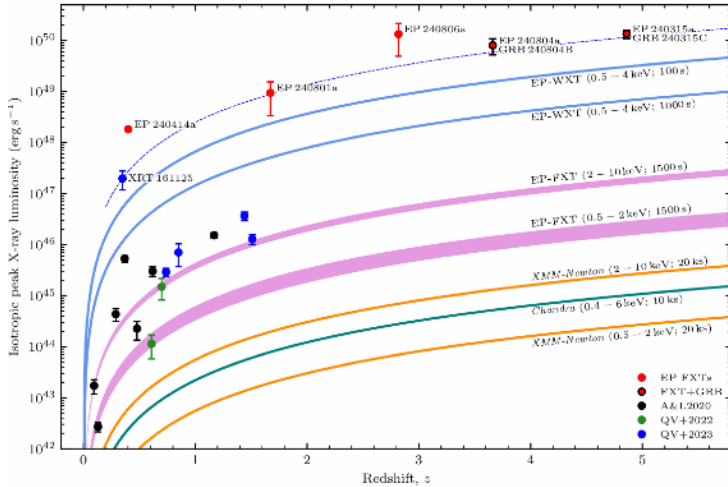
## Fast X-ray Transients: The GRB Perspective



Fermi-LAT



PNRR Fellow



Srivastav+ (2024)

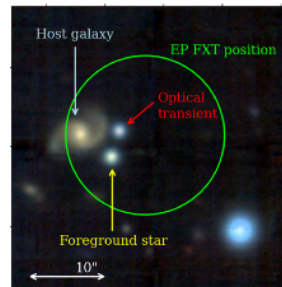
### Few minutes to hour long transients

#### Possible Progenitors:

- CBCs → **GW!**
- Tidal Disruption Events → **IMBH-WD**
- Supernova Shock Breakouts



Einstein Probe

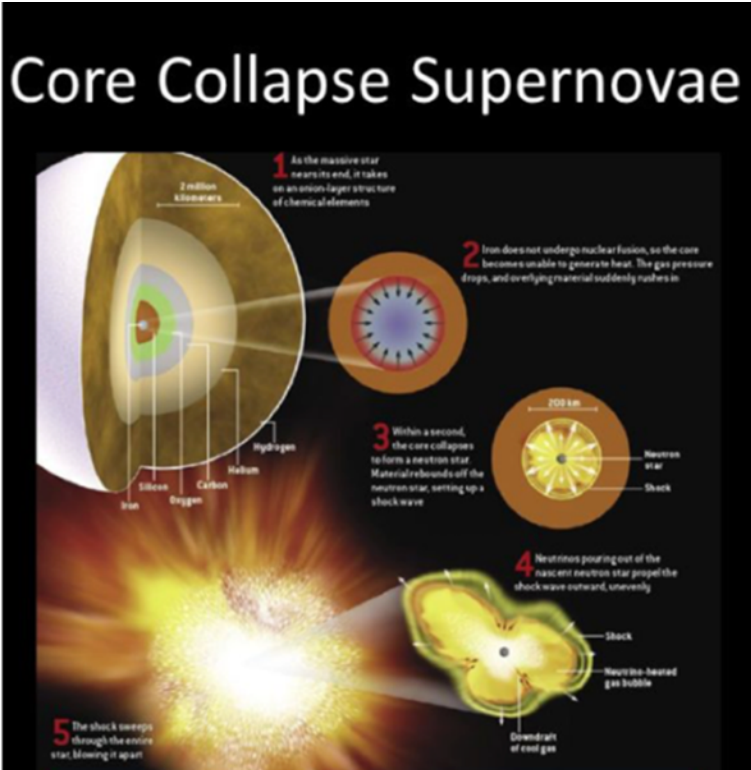


Some could be Luminous FBOs

Dalen+ (2024)



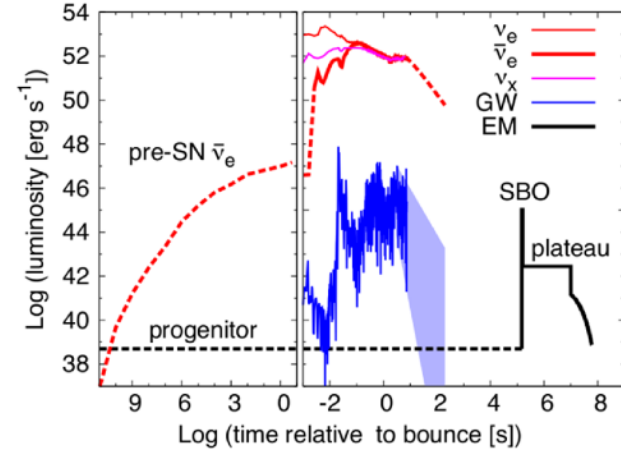
*CCSNe messengers: GWs and neutrinos*



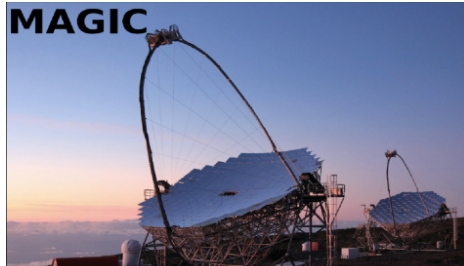
How to get insights into the details of core-collapse?



Look at  $\nu$  and GW 'prompt' emission



## Past and now



## Now and future

