
UnivEarthS
Gamma-Ray Bursts
in the Multi-Messenger Era
Paris, 16-19 June 2014
Concluding Remarks
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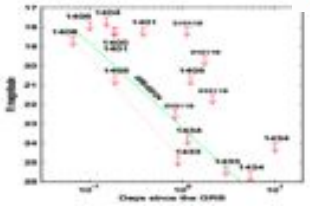
- *This was an intense Conference, with:*
  - A very nice weather… all week long
  - A train strike… all week long
  - A power outage, no Internet connection, and a special dinner… all on Wednesday
  - A football World cup… during night

GRBs
GRBs & neutrinos
GRBs & GWs
GRBs and instruments
GRB theory
… During 4 full days

Short/Hard bursts

- Measure their distances
- X-ray afterglows ?
- Visible afterglows ?
- Localizations in the hard X-ray range (E>50 keV)



✔

GRB 020531

High-z GRBs ?

z	N
0-1	14
1-2	13
2-3	5
3-4	3
>4	1

✔

- Detection of GRBs and their afterglows at z=5-10 is possible --> NIR
- GRBs from population III stars ?

The Prompt Emission

- Radiation processes at work during the burst
- Role and strength of the magnetic field
- Role of neutrons, pairs, neutrinos ...
- Broadband energy distribution

?

GRBs outside the electromagnetic doma

- Neutrinos → ANTARES, AMANDA
- Gravitational waves → VIRGO, LIGO
- High Energy Cosmic Rays ? → AUGER ?

?

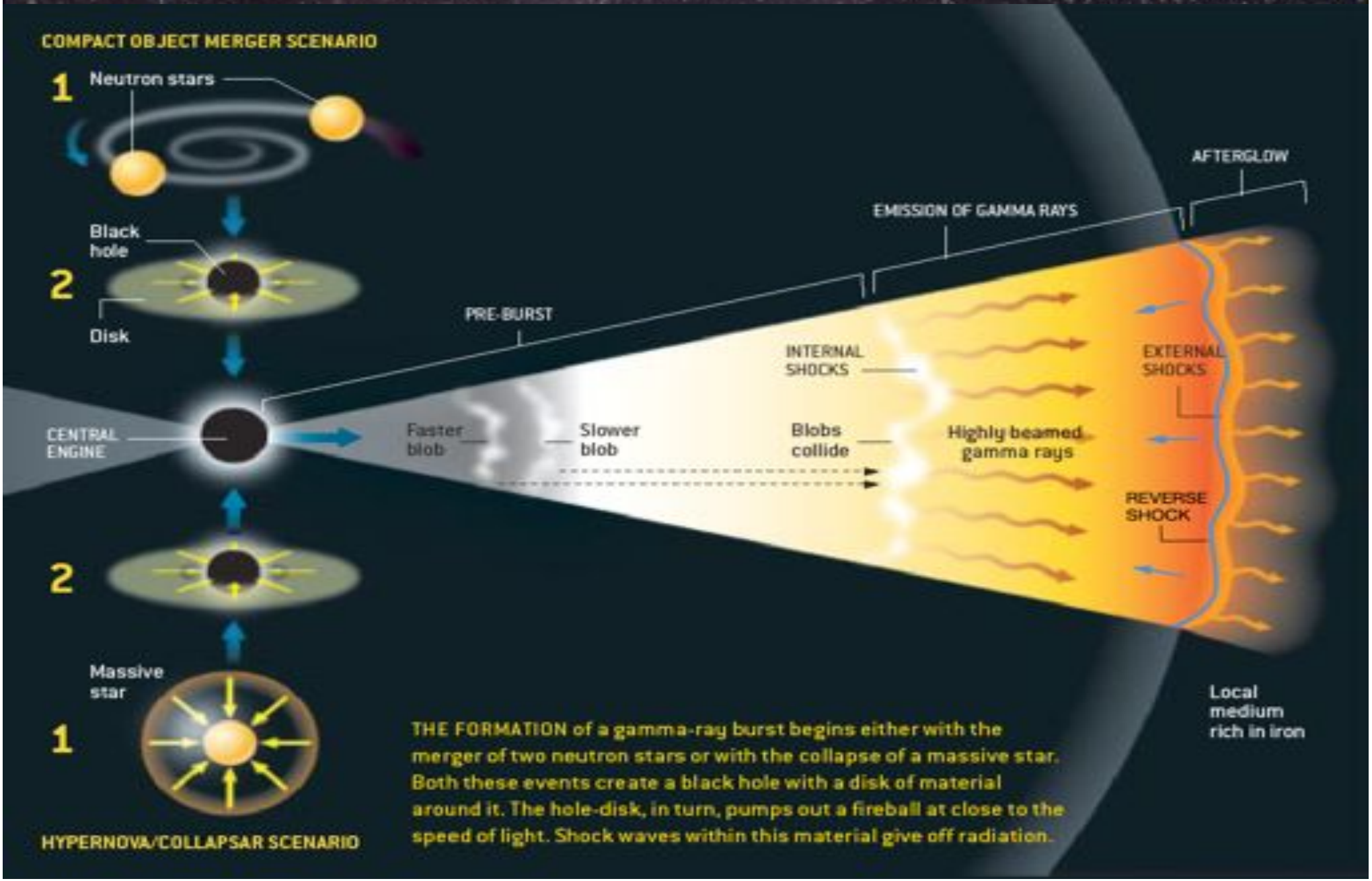
Conclusions (in 2004)

- The exploration phase is not finished
  - Short/Hard GRBs → **Advanced LIGO & VIRGO**
  - Very soft GRBs → **SVOM**
  - GRBs selected outside the hard X-ray range → **SUBARU/HSC & LSST**
- The theoretical work now takes its full value as we understand the nature of the sources
  - Amount of energy released
  - GRB ↔ SN link
  - Probable progenitors
- GRBs already probe the young universe
  - Metallicity of host galaxies
  - History of the stellar formation rate

The presentations and posters

- Very good scientific material with recent or new results and ***excellent review talks***
- Many opportunities for discussions between participants
- Good communication between participants from the neutrino, the GW and the GRB communities
- A focus on the physics of the prompt emission: observations and theory with interesting physical arguments
- Interest for GRBs extends well beyond the community of HE astronomers
  → ***This will impact the design of future GRB missions***
- ***The star was clearly GRB 130427A*** ☺

The interest for GRBs extends well beyond the GRB community
(and we speak a common language!)



The crucial role of magnetic fields
(and some other ingredients)

- GRB efficiency
- GRB light-curves and spectra
- Neutrino emission
- +++

- Crucial ingredient to model the complex physics at work in GRBs
  - Magnetization within the jet?
  - Origin of magnetic fields? connection with fast rotating magnetars?

Renewed interest for nearby events

- 1 normal long GRB Gpc^{-3} yr^{-1} (non corrected for beaming)
- Long GRBs: 100-1000 Gpc^{-3} yr^{-1} (after correction for beaming) (comparable to short GRBs)
- ~9000 SN Ibc Gpc^{-3} yr^{-1}

- Locally ($z<0.1$), we have access to the complete zoo, not only the monsters seen at $z\geq1$ (of which GRB 130427A is an example, the ***nearby monster***)
- ***γ-ray selected GRBs may not be the brightest in GW or neutrinos***

==> There is plenty of room for unusual GRBs which may be relevant for multi-messenger astronomy: low-luminosity GRBs, off-axis GRBs, failed GRBs…

The GRB saga will continue in the coming years

- GRB physics is (very) interesting!
- Our theoretical understanding of GRB physics is making quick progress

The present:

- Swift and Fermi continue to be highly productive!
- Advanced GW detectors will soon be here

The future:

- *In space: SVOM, UFFO-pathfinder, ISS-Lobster* will come after *Swift*
- *On Earth: CTA, LHAASO, Athena, SKA, JWST, ELTs*
- *SUBARU/HSC* and *LSST* will open the field of direct afterglow detection from the ground in optical (how can you recognize a three-day old orphan afterglow?)
- Astrophysical neutrinos have been detected, and improved neutrino detectors are planned

- ***There are many young people in the room***

To conclude…

- *A big thank to the organizers!*
- *Thanks to the participants for the quality of their presentations (talks and posters)*
- *Long life to Swift and Fermi!*
- *We are working hard to prepare SVOM*
- *Enjoy Paris!*
- *Have a safe trip back*