GRANDMA and HXMT Observations of GRB 221009A

The Standard-Luminosity Afterglow of a Hyper-Luminous Gamma-Ray Burst

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Our article on the afterglow, is submitted to ApJL for the GRB special issue, arxiv 2303.01203

In Gedenken an David Alexander Kann 💙

You can also have a look at *Insight-HXMT and GECAM-C observations of the brightest-of-all-time GRB 221009A* for prompt studies of GRB221009A (Ann et al., 2023) in collaboration with GRANDMA

Who we are ? Join us for O4 !

GRANDMA for Global Advanced Rapid Network Devoted to Multi-messenger Addicts - grandma.ijclab.in2p3.fr

Team is composed by GW physicists & Observers & Astrophysicist

25 telescopes - 18 countries - 40 groups involved

We operate GRANDMA with SkyPortal

Our main science is focusing on :

- *Gravitational waves Astrophysics*
- *Compact objects & Kilonovae*
- *Neutrino Astrophysics*

If you have a telescope, join us for O4 to observe the GW sky together

KILONOVA CATCHER

Citizen science program to observe GW counterparts

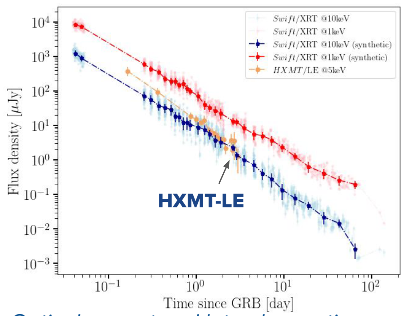
~ 150 active amateurs

Connect to kilonovacatcher.in2p3.fr/

Our measurements of GRB 22109A

Early X-ray from HXMT-LE

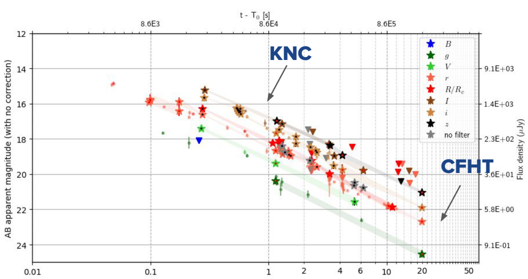
The unabsorbed X-ray light curve of GRB 221009A detected by the Swift/XRT (given at 10 keV in blue and 1 keV in red) and the HXMT/LE (orange) instruments: data are collected from 9.8 hours to 3 days after the trigger time



Optical prompt and late observations

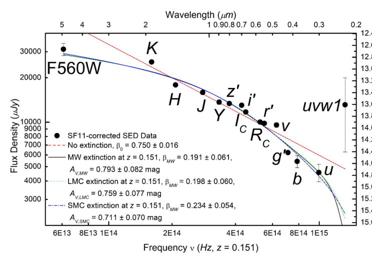
Prompt upper-limit during the GRB prompt sequence (V, 3.8 upper limit)
15 professional and 15 amateurs telescopes from 2h30 to 20 days post T0)

Data are analysed with MUPHOTEN (Duverne, Hussenot, arxiv 2201.07565) and Stdpipe (Karpov, arxiv 2202.09766) packages



The optical afterglow of GRB 221009A (not corrected for the Galactic extinction). The selected optical GCN data we use are represented by dots and the GRANDMA data measurements and upper limits are indicated by larger stars and downward-pointing triangles. The red points within the stars indicate measurements made by professional observers, while black points represent observations made by KNC observers.

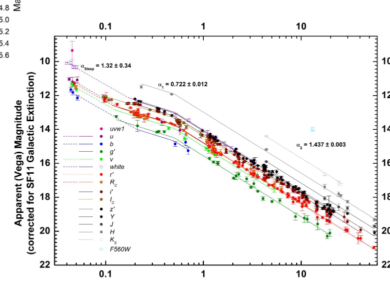
SED Analysis and Empirical LC



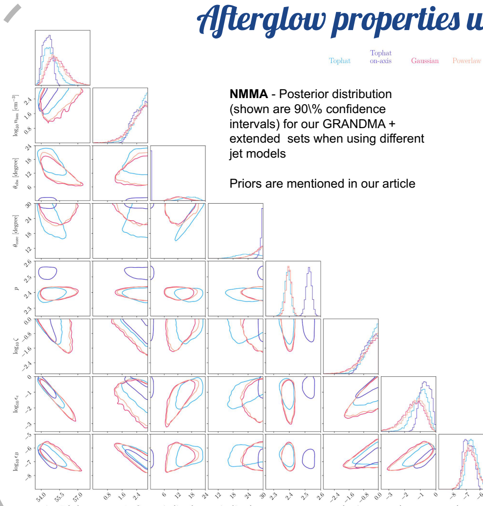
Fits to SED after correcting it for SF11 (Schlafly, 2011) foreground extinction and shifting it to z = 0.151. The correction leads to significant scatter, with the uvw1 being clearly brighter than any fit, even one without additional host-galaxy extinction.

No evidence for any spectral evolution in data from 0.09 days up to about 20 days after the GRB, making the passage of an evolving spectral break unlikely.

The data after ~ 0.1 d show a clear break and a relatively shallow post-break slope with no further indication of a jet break, which would usually lead to a decay slope α ≥ 2



Afterglow properties with Bayesian Inference



NMMA - Posterior distribution (shown are 90\% confidence intervals) for our GRANDMA + extended sets when using different jet models

Priors are mentioned in our article

Data sets

GRANDMA + HXMT-LE + XRT + UVOT
++ Extended (Williams, Shrestha, Laskar, Levan, O'Connor - 2023)

Two independent methods

Nuclear physics and Multi-Messenger Astronomy framework NMMA (Dietrich & Pang 2022) with afterglowpy - We also investigate the possibility of an SN connected to the GRB with nugent-hyper model

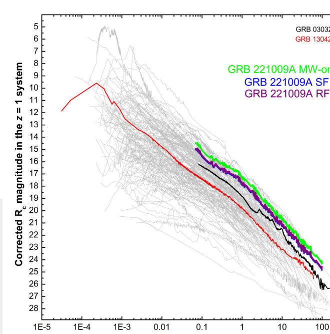
The afterglow model from Pellouin & Daigne (2023) which model and compute both synchrotron radiation and the Synchrotron Self-Compton (SSC) radiation.

Conclusions

Fitting the afterglow lightcurve with a model describing the synchrotron radiation at the forward shock of a relativistic top-hat jet propagating through a constant density medium ***only result in a moderate reproduction of the observed data.*** This can be explained by a tension between the observed temporal and spectral evolution. Including a different jet structure (Gaussian or power-law), synchrotron self-Compton emission, or presence of an underlying supernova do not help to disentangle this tension. Further analysis will require going beyond the most standard GRB afterglow model.

How extraordinary is the GRB221009A afterglow ?

Not intrinsically extraordinarily bright compared to the global data set despite its extreme energetics



GRB 221009A afterglow (corrected for Galactic extinction using SF11 (Schlafly & Finkbeiner 2011) and RF09 (Rowles & Froebrich, 2009) methods) in context of a large sample of GRB afterglows. All of them have been shifted to z=1 taking the individual spectral slopes beta and cosmological k-correction into account.