Can the Thermal Evolution of the Fireball alone explain the GRB 171227A?

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- Majority of GRBs spectra are well-fitted with an empirical Band function.
- We propose a multi-temperature blackbody (mBB) spectrum which manifests the photospheric emissions from the different radii and angles under the relativistic fireball formalism.
- To better understand the GRB evolutionary process, we perform a detailed study of this model with its temperature decreasing as a function of its radius.
- A numerical code developed under this scenario is employed to reproduce the spectrum of the GRB 171227A during its bright phase.
- The spectral fitting is performed by coupling this numerical model with the statistical fitting package XSpec.
- From the best-fit parameters, we analyze the evolutionary behaviour of the fireball and check for its physical consistency.

**EXPANDING FIREBALL**

- Considering the evolution of temperature with the radius (expansion)
- High Lorentz factor leads to the angle dependence of the Doppler shift
- The equator emission follows after the high latitude emission.
- Hence the off-axis emission will be hotter than the on-axis emission

**GRB 171227A SPECTRAL ANALYSIS**

- Data used: Fermi GBM
- Detectors: NaI 5 and BGO 1
- One of the Bright burst
- $T_{90}$: 35.0 sec burst ($T_{90}$=$T_{90}$+35.0)
- Unpolarised Burst reported by Chattopadhyay et al 2022

- We coupled the numerical mBB model with the XSpec and the fitting is performed for the GRB 171227A.

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**SUMMARY**

- Under the fireball interpretation of GRB, the spectral width of the time averaged spectrum can indicate the evolution of temperature.
- A numerical model is developed to imitate the expanding fireball model and applied on the bright GRB 171227A.
- The spectra of GRB 171227A is well fitted with the mBB model.
- There was degeneracy found between the photospheric temperature and bulk Lorentz factor.
- This supports the previous polarisation study by Chattopadhyay et al 2022, where this burst was reported to be unpolarised.
- The mBB model is capable to explain different shapes and widths of the spectrum.

**REFERENCES**

- Broadening of the thermal component of the prompt GRB emission due to rapid temperature evolution, Bharali et al. 2017
- Photospheric emission in gamma-ray burts, Peer et al., 2016
- Multi color Black body emission in GRB 081221, Hou et al, 2018

Further details about this work
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