Contribution ID: **261** Type: **Talk in a parallel session**

Understanding the Nature of the Optical Emission in Gamma-Ray Bursts

Thursday, 11 July 2024 17:40 (25 minutes)

We collected the optical light curve data of 227 gamma-ray bursts (GRBs) observed with the TAROT, COATLI, and RATIR telescopes. These consist of 133 detections and 94 upper limits. We constructed average light curves in the observer and rest frames in both X-rays (from {\itshape Swift}/XRT) and in the optical. Our analysis focused on investigating the observational and intrinsic properties of GRBs. Specifically, we examined observational properties, such as the optical brightness function of the GRBs at $T = 1000$ seconds after the trigger, as well as the temporal slope of the afterglow.
We also estimated the redshift distribution for the GRBs within our sample. Of the 227 GRBs analysed, we found that 116 had a measured redshift. Based on these data, we calculated a local rate of $\rho_0 = 0.2$ Gpc^{-3} yr^{-1} for these events with $z < 1$.
To explore the intrinsic properties of GRBs, we examined the average X-ray and optical light curves in the rest frame.
We use the {\scshape afterglowpy} library to generate synthetic curves to constrain the parameters typical of the bright GRB jet, such as energy ($\langle E_0 \rangle \sim 10^{53.6}$~erg), opening angle ($\langle \theta_{\rm core} \rangle \sim 0.2$~rad), and density ($\langle n_0 \rangle \sim 10^{-2.1}$ cm^{-3}). Furthermore, we analyse microphysical parameters, including the fraction of thermal energy in accelerated electrons ($\langle \epsilon_e \rangle \sim 10^{-1.37}$) and in the magnetic field ($\langle \epsilon_B \rangle \sim 10^{-2.26}$), and the power-law index of the population of non-thermal electrons ($\langle p \rangle \sim 2.2$).

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Session Classification: Gamma ray bursts relationships in multi-wavenths as cosmological tools

Track Classification: Gamma-Ray Bursts (GB): Gamma ray bursts relationships in multi-wavenths as cosmological tools