Research Article **Available online www.ijsrr.org** **ISSN: 2279–0543**

International Journal of Scientific Research and Reviews

Ultra Long GRBS and their comparison on the basis of Temporal and Spectral study

Rathore Pooja Singh*, Pareek Devendra, Motwani Veena and Jaaffery S.N.A.

Department of Physics, Bhupal Nobles' University, Udaipur, Rajasthan, India.
E-mail - poojajenupooja@gmail.com

ABSTRACT

Gamma-ray bursts (GRBs) are considered as one of the most energetic explosions in the universe that emits more energy than sun will emit in its entire lifetime. Ultra-long gamma ray bursts (ULGRBs) are a more unique and distinct class of GRBs characterized by durations of several thousands of seconds, or we can say about two orders of magnitude longer than those of normal standard long GRBs (LGRBs). The driving engine (source) of these events is yet to be discovered and creative research ideas range from magnetars, to tidal disruption events, to extended massive stars, such as blue super giants (BSG). Although a possible endpoint of stellar evolution, BSG are attractive for the relatively long free-fall times of their envelopes, allowing accretion to power a long-lasting central engine and hence creating a ULGRB. We report summaries, comparative study of both the temporal and spectral analysis of the characteristics of these well recognized seven ULGRBs, available till date.

Subject Headings: gamma rays: bursts — ULGRB, stars: massive, ultra long – GRB

***Corresponding Author**

Pooja Singh Rathore

Department of Physics,

Bhupal Nobles' University, Udaipur, Rajasthan, India.

E-mail - poojajenupooja@gmail.com

1. INTRODUCTION

GRBs are important in many aspects of astrophysics and cosmology. The remarkably large amount of energy released by GRBs in such a small scale of time provides a unique opportunity to study physics in an extreme space, and also challenges the available physical models of the progenitors. The long GRBs (bursts with duration longer than ∼ 2 s) are associated with the death of massive stars. On the other hand, the origin of short bursts (durations less than 2 s) remains mysterious[1]. Latest studies suggest that short GRBs are likely related to compact-object mergers and thus they are one of the candidate sources of gravitational waves and reference therein[2]. LIGO is working on it and have little beginner success as well.

In the last few decades, a number of GRB events with considerably ultra-long duration have been detected. These bursts, with long duration named Ultra Long GRBs (ULGRBs)[3]. Blue super giants (BSG) are considered as strong candidate as the source of these ULGRBs . BSG is a possible endpoint of stellar evolution of a star in which the material location sets perfect condition to create a ULGRB [4]. Because it's the location of this material within the star which decides its free-fall time, and ultimately influences the duration of the Long GRB, if the jet is able to emerge from the envelope.

In this paper we have done a comparative study of both the temporal and spectral analysis of the characteristics of ULGRBs. Among many LGRBs available we chose the well-recognized seven Ultra LGRBs. Section 2 begins by briefing the special characteristics of these ULGRBs. Light-curves were extracted by swift archived data. A graph between various characteristics that represents temporal and spectral study of these ULGRBs is available in section 3. Section 4 is dedicated for the results and discussion part.

2. DATA COLLECTION OF ULGRBS

The Ultra-long gamma-ray bursts duration distribution consists of a few tens of events which have been detected so far by the Burst Alert Telescope (BAT) aboard the Neil Gehrels Swift Observatory and some other instruments. These are the separate class, caused by the collapse of a blue supergiant star a tidal disruption event or a new-born magnetar. The most studied ultra-long events include GRB 101225A and GRB 111209A[5,6,7]. A 2013 study[8], on the other hand shows that the existing evidence for a separate ultra-long GRB population with a new type of progenitor is inconclusive, and further multi-wavelength observations are needed to draw a firmer conclusion. Additionally it is interesting to notice that the famous ULGRB, GRB 111209A, was associated with a very luminous supernova at redshift z=0.677. This is exactly the kind of phenomenon that requires a multi-wavelength follow-up from the detection of the burst on, and over several days. As of today, the few well studied ulGRBs have been detected by the Burst Alert Telescope (BAT) onboard the Neil Gehrels Swift Observatory [9,10]. Ultra-long Gamma-Ray Bursts are Gamma-Ray Bursts with an unusually long emission in X and gamma rays, reaching durations of thousands of seconds. The most studied ultra-long events include GRB 101225A and GRB 111209A.One of these bursts is GRB 111209A which was active for about 25000 s. GRBs with such highly a typical durations have been called ultra-long gamma-ray bursts (ulGRBs)[11]. It could be known as third class of GRBs.

With the help of redshift value one can understand that location of Gamma-Ray Bursts to be different galaxies. These results indicate that some of the Gamma Ray Bursts originate at cosmological distances. When redshifts are available, we also investigate GRB properties with redshifts[12]. Experimental studies of GRBs showed that the fading of x-rays, near infrared to millimetre and low frequency radio waves. Gamma Ray burst lasting from around 3 ms to over 10,000 sec, the x-rays last for days, optical and radio stay for weeks or months. This delayed emission of energy is called the Afterglow of the Gamma-ray burst.

Grb 121027A

GRB121027A is a part of a new class of gamma ray bursts, known as ultra-long gamma -ray bursts and caused by the collapse of low metallicity blue supergiant stars and is also is classified as ulGRB because of its long lasting X-ray emission. We have analysed that the light curve of GRB121027A is more typical form of classical long-GRBs. In this paper we discuss the recent GRB 121027A as a likely example of such an event also investigate the high-energy properties of GRB 121027A. The prompt emission was sufficient to provide a standard “rate” trigger of the BAT for GRB 121027A and it exhibits rather higher magnitude variability[13]. The burst is clearly detected in GRB 121027A by the UVOT and exposure obtained between 77 s and 1192 s post-burst i.e. T_{90-80}s. At z = 1.773 the bluest bands are also blueward of the Lyman limit also higher redshift suggests that such events can reach higher peak luminosities and represents $E_{iso} = 7.00\times10^{52}$ erg and $E_{\gamma} > 1.0 \times 10^{51}$ erg. The Gamma-ray duration is only 62.6± 4.8 s in Swift/ BAT band which express it is very typical for long GRBs [14,15].

Grb 101225A

GRB 101225A is a cosmic explosion and it was first detected by NASA's Swift Gamma-Ray Burst Mission at 18:38 UT on December 25, 2010. Because of this day it is also known as the "Christmas burst". GRB 101225A was first measured to have a T_{90} of 1088±20 s, After sometime studies measured a longer duration of up to 7000s based on the analysis of Gamma-ray data from Burst Alert Telescope (BAT) in subsequent Swift orbits .The event was caused by a comet crashing onto a neutron star within our own galaxy proposed by Sergio Campana's group and Christina Thone's group proposes a more conventional supernova mechanism , involving a merger between a helium star and a neutron star[16] . The Burst Alert Telescope (BAT) data refers Isotropic energy was estimated at $(7.8 \pm 1.6) \times 10^{50}$ erg and finding it to have a redshift z = 0.847 . The Gemini North Telescope to determine that GRB 101225A and Andrew Levan and his colleagues showed that the GRB 101225A was 7 billion light years distant much further than original estimates and also expressed that this greater distance gives it a much higher energy level[17,18]. For each burst yields isotropic energy releases of $E_{iso} = 1.20 \times 10^{52}$ erg and the BAT spectral slope is broadly consistent with that measured by the XRT and suggests a modest correction.

In the GRB 101225A light curve is a sharp rise at the beginning of the second orbit of observation, and a dip at the end of it. At a redshift of $z \approx 0.33$, based on a photometric fit to the late time light with a type Ic supernova, and the presence of significant X-ray absorption.

Grbs 111209A

It was first proposed that the progenitor of this event was a blue supergiant star with low metallicity detection all of the bands of the Swift Ultraviolet and Optical Telescope UVOT) observed on December 9, 2011.An analysis of the longest burst ever observed, GRB 111209A, which had a duration of 25000 seconds. This burst occurred at a redshift of z = 0.677 . Its duration is longer than 7 hours[19]. Only GRBs 111209A and 130925A have an exceedingly long Gamma-ray T_{90} i.e. >10,000 s and it lies at z = 0.677 show both absorption lines and emission lines from the host galaxy, providing a redshift of z = 0.677, $E_\gamma > 1.2 \times 10^{51}$ erg. In the case of GRB 111209A this image trigger criterion was actually reached on two separate occasions, making it one of very few bursts that have triggered the instrument multiple times It could be detected only out to $z \sim 1.4$, below the mean of GRBs. Based on the redshifts and light curves we can estimate the total energy of the bursts. $E_{iso} = 5.21 \times 10^{52}$ erg. In each case the detection by Swift was made as an “image trigger”. At z = 1.773 the bluest bands are also blueward of the Lyman limit[20].

Table 1. Data of different ulgrbs is summarised here in this table-

GRB	T_{90}	Redshift (z)	Energy	E_{iso}	source
1. GRB121027A	80	1.773	80 keV	$E_{iso} = 700\times10^{50}$ erg	EVIDENCE FOR FALL-BACK DISK ACCRETION.
2. GRB111215A	374	2.1	90 keV	$E_{iso} = 450\times10^{50}$ erg	
3. GRB111209A	811	0.677	770 keV	$E_{iso} = 521\times 10^{50}$ erg	Very luminous supernova
4. GRB101225A	1377	0.847	98 keV	$E_{iso} = 120 \times 10^{50}$ erg	Christmas-day burst
5. GRB100316D	522	0.059	30 keV	$E_{iso} \geq 39 \times 10^{50}$ erg	
6. GRB090417B	267	0.345	3.0 keV	$E_{iso} > 24\times 10^{50}$ erg	Dark GRB
7. GRB060218	602	0.0334	4.5 keV	$E_{iso} = 62\pm0.3 \times 10^{50}$ erg	

3. PLOTS AND LIGHT CURVES

Since the year GRB is discovered scientists are studying its various properties. We here are trying to analyse ulGRBs property using data collected from satellite data and various research done earlier in the field. Astronomical objects have always been mystery in its own way.

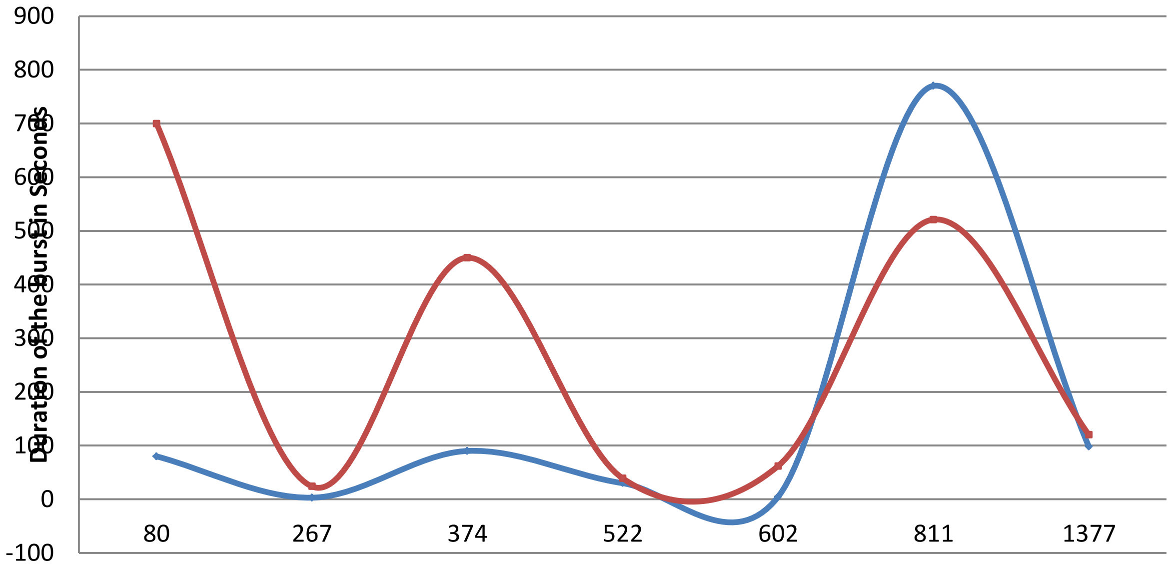

Figure 1. A plot between- total energy and isotropic energy with T_{90} of different burst.

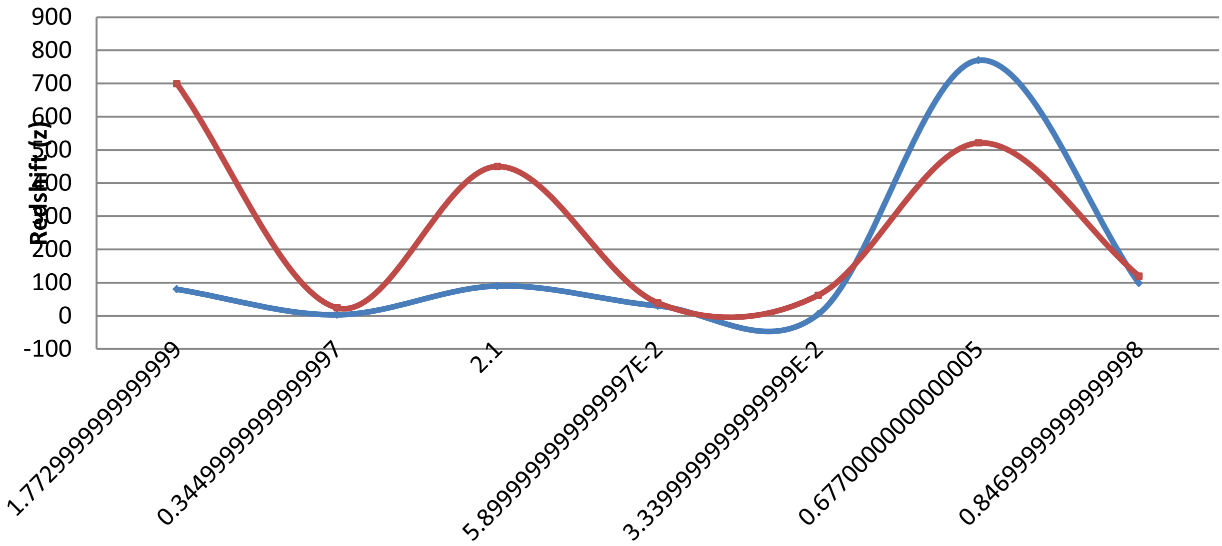

Figure 2. A plot between energy and isotropic energy with redshift of different ulgrbs.

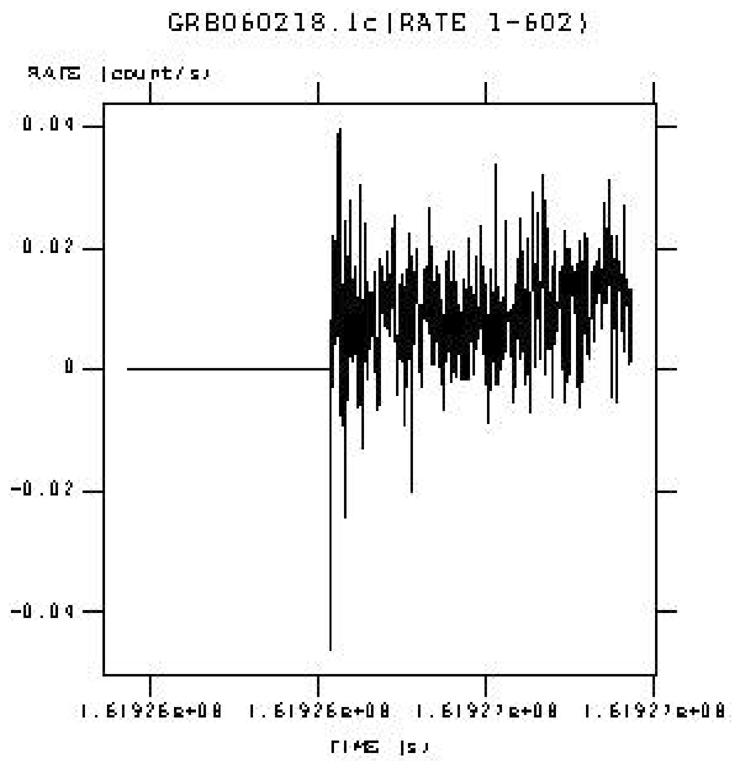

Figure 3. Light curve for GRB060218

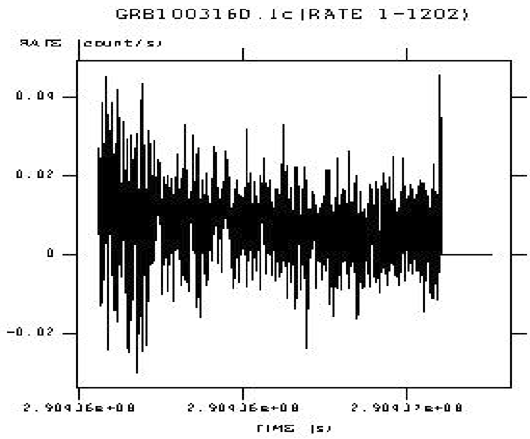

Figure 4. Light curve for GRB100316D

4. CONCLUSION

Fascinating graphs were plotted using the table of collected data. The graphs clearly indicate that GRB duration and redshift has no direct link with energy emitted. Whereas general studies can suggest that we can link them simultaneously by the fact that higher redshift burst can emit lower level of energy and comparatively longer duration burst will emit more energy. These graphs are showing a controversy by this normal prediction.

Further research and advancement of satellites can help us getting the precise data about the progenitors of GRB. That could actually resolve queries about this mysterious burst.

REFERENCES

1. Kumar Pawan, Zhang Bing et al. The physics of Gamma-Ray Bursts & relativistic jets. 2015; 561: 1-109.
2. Berger E, Cowie L, Kulkarni S R , Frail DA, Aussel H et al. A Submillimeter and Radio Survey of Gamma-Ray Burst Host Galaxies: A Glimpse into the Future of Star Formation Studies. The Astronomical Journal. 2003; 588: 99.
3. Dagoneau Nicolas, Schanne Stephane et al. Ultra-Long Gamma-Ray Bursts detection with SVOM/ECLAIRs . Experimental Astronomy. 2020; 50(1): 91-123.
4. Perna Rosalba, Lazzati Davide et al. Ultra-long Gamma-Ray Bursts from the Collapse of Blue Supergiant Stars. An End-to-end Simulation. The Astronomical Journal. 2018; 859(1).
5. Levan AJ, Tanvir NR , Wiersema K. et al. A new population of ultra-long duration gamma-ray bursts. The Astrophysical Journal. 2014; 781(1):13.
6. Boer Michel, Gendre Bruce, Stratta Giulia et al. Are Ultra-long Gamma-Ray Bursts different?. The Astrophyscal Journal. 2013; 800 (1):16.
7. Virgili FJ, Mundell CG, Pal'Shin V, Guidorzi C, Margutti R et al. GRB091024A and the Nature of

Ultra-Long Gamma-Ray Bursts. The Astrophysical Journal.2013;778 (1): 54.

8. Zhang Bin-Bin, Zhang Bing, Michael S et al. How Long does a Burst?. The Astrophysical Journal. 2014;787 (1):32.
9. Gehrels N et al. ,The Swift Gamma-Ray Burst Mission.The Astrophysical Journal.2004; 611:1005.
10. Barthelmy D Scott, Barbier M Louis, Cummings R Jay et al. The burst alert telescope (BAT) on the SWIFT midex mission. Space Science Reviews.2005; 120(3): 143-164.
11. Levan A J, Tanvir N R, Starling RLC et al. A new population of ultra-long duration . The Astronomical Journal. 2013;781(1):13.
12. Salveterra Ruben, et al. High redshift Gamma-Ray Bursts.High Energy Astrophysics. 2015; 7: 35-43.
13. Hou Shu Jin et al. The Astronomical Journal. Giant X-ray Bump in GRB 121027A: Evidence for Fall-back Disk Accretion. 2013; 767(2):36.
14. Suwa Yudai,Nakauchi Daisuke et al. Blue Supergiant Model for Ultra-long Gamma-Ray Burst with Superluminous-supernova-like Bump.The Astrophysical Journal, 2013;778(1) : 11.
15. O'Brien PT , Willingale R, Osborne J, et al. A new population of ultra-long duration gamma ray burst. The Astrophysical Journal;2006, 647(2),1213.
16. Campana S, Lodato G, d'Avanzo P et al. "The unusual gamma-ray burst GRB 101225A explained as a minor body falling onto a neutron star". Nature.2011; 480 (7375): 69–71
17. Fryer CL ,Thone CC et al. Nature.The unusual gamma-ray burst GRB101225A from a helium star/neutron star merger at redshift 0.33. 2011; 480(7375) :72-74.
18. Gendre B ,Stratta G , Atteia JL, Basa S, Boer ,Coward D M ,et al. The Ultra-Long Gamma-Ray Burst 111209A: The Collapse of a Blue Supergiant? . The Astrophysical Journal. 2013; 766 (1): 30.
19. Greiner J et al. A very luminous magnetar-powered supernova associated with an ultra-long γ-ray burst". Nature. 2015; 523 (7559): 189–192.
20. Gendre Bruce et al. The ultra-long GRB 111209A - II. Prompt to afterglow and afterglow properties. The Astrophysical Journal .2013;779(1):66.