Gamma-Ray Bursts (GRBs) and High Redshift Universe.

A.C. Eze, B.Sc. and R.N. Eze, Ph.D.

Department of Physics and Astronomy, University of Nigeria, Nsukka, Nigeria.

E-mail: ambjerry_combruzy@yahoo.com
romanus.eze@unn.edu.ng

ABSTRACT

Gamma-Ray Bursts (GRBs) are the brightest and most concentrated electromagnetic explosion in the universe. They are sudden, intense flashes of random distributed gamma-rays which for a few seconds completely outstrip all other sources of gamma-rays in the sky, including those coming from the sun. GRBs as the most luminous events exist as long-duration, soft-spectrum bursts which last for hundreds of seconds and short-duration, hard-spectrum bursts which last for a few milliseconds. GRBs are believed to occur as a result of the collapse of a massive star. It is expected that the GRB rate is approximately proportional to the star formation rate (SFR), and they could be used to find supernovae (SNe) at very high redshift. The high luminosity of the early afterglow and GRB transient nature makes GRBs powerful sources to study the metal enrichment and interstellar medium properties of their hosts and the correlations between GRB spectral properties and the collimation corrected energetic could be used to constrain cosmological parameters (Ω_m, Ω_Λ) which determine the geometry of the universe. GRBs and their afterglow acts as a new cosmological tool to trace metallicity, and this offer a unique explanation of large-scale structure (galaxies, clusters and super clusters), and as a probe of the high redshift universe.

(Keywords: GRB, bursts, universe, cosmology, large-scale structure)

INTRODUCTION

Gamma-Ray Bursts (GRBs) are bright flashes of radiation, that are detected appropriately 100 times per year (Wells et al., 2007). They were discovered in the late 1960s (Hartmann and Updike 2007, Klebesadel et al., 1973) by the US 'Vela' nuclear test detection satellites. The flashes of radiation from GRBs and how they are produced was a mystery (Melville, 2006) until 1997, when astronomers using the William Herschel Telescope discovered that GRBs show a so called "afterglow"; radiation in other wavelengths following the gamma-rays.

The only way to study GRBs and their afterglow details is to observe them as quickly as possible with the most sophisticated telescopes. It was of comparatively recently that GRBs became widely recognized as a unique tool for cosmological studies and exploring the early universe (Totani et al., 2006). Popular models for their central engine divide into two main classes: (i) the collapse of a massive star to a black hole (Macfdyen et al., 2001) and (ii) the coalescence of a binary system involving a Neutron Star (NS) as a companion (Janka et al., 1999; Bromm and Loeb, 2002).

GRBs lasting anywhere in space from a few milliseconds to several minutes, shine hundreds of times brighter than a typical supernova (the explosion marking the death of massive star and about a million trillion times as bright as the sun). This indicates that GRBs are immensely powerful, short-lived bursts and the brightest source of cosmic gamma-ray photons originating at cosmological distance in the observable universe.

PROBING THE EARLY UNIVERSE USING GRBs

GRBs are, in fact, highly isotropic or randomly distributed on the sky when it occurs, strongly suggesting their cosmological origin. Their large fluences and cosmological distances imply at face nature that GRBs release tremendous amount of energy of about 10^{51}erg or 10^{44}J, (Hartmann and Updike, 2007; Eze, 2007), in the gamma-ray band.

GRBs can be detected above the Earth-atmosphere, and if localized accurately and rapidly, their low-energy afterglow can be studied and these can serve as powerful tools to probe properties of the gas along the line of sight - revealing cosmic chemical evolution via absorption line spectroscopy during the first hours after an outburst. Regardless of the nature of their central engines, and their progenitors, both GRBs progenitors trace, more or less directly, the cosmic star formation history (Updike et al., 2007) and thus, offer a unique probe to the early universe (Lamb and Reichart, 2000; Eze, 2007; Ruiz et al., 2007; Tanvir, 2009), and GRBs high luminosities allow easy detection even at very large distances, and their optical afterglows provide a (rapidly decaying) light source that offers opportunities for spectroscopy studies of the interstellar gas in the evolving universe.

OBSERVATION OF GAMMA-RAY BURSTS

Observation of GRBs prompt astronomers to search for the emission spectrum from a host galaxies and their absorption spectra. There are different types of telescopes that can be used to observe GRBs but Swift space telescope can be used to detect and observe GRBs. Swift was specifically designed to study early GRBs emissions and to detect their afterglows. Swift satellites (Gehrels et al., 2004; Wells et al., 2007) consists of a wide-field burst alert telescope (BAT), that detects GRBs and positions them to arc-minute accuracy, the narrow-field X-ray telescope (XRT), and UV-Optical telescope that observe their afterglows and determine positions to arc-second accuracy, all within approximately 100s.

When GRBs occur, the BAT on-board detects the bursts and Swift satellite automatically slew to the bursts' emissions in the 15-350 keV energy range and autonomously re-point to bring the bursts within the field of view of the X-ray telescope (XRT) and the UV/Optical telescope (UVOT) and the Swift routinely provides prompt detections of GRBs and their afterglows and automatically transmits their locations and other information obtained from the three instruments (BAT, XRT, UV/OT) via the TDRSS satellites and the GRB Coordinate Network (GCN) to observers and robotic telescopes around the world (Gehrels et al., 2004; Wells et al., 2007; Eze, 2007) enabling both professional and amateur astronomers to make follow-up afterglow observation using ground based telescopes.

HIGH REDSHIFT GAMMA-RAY BURSTS

High redshift GRBs are the most distant gamma-ray bursts which are believed to be an ideal probe for the high redshift universe. As the most distant objects known in the universe, they are produced by rare types of massive stellar explosions, (Salvaterra et al., 2009; Tanvir et al., 2009; Grenier et al., 2009), and offer us the potential to probe early universe into the epoch of re-ionization. They can trace star formation and metallicity history of the universe (Lamb and Reichart, 2000; Bromm and Loeb, 2002; Lamb, 2002).

The redshifts of these bursts are determined by (i) taking a spectrum of the afterglow at early times, when the afterglow was still sufficiently bright and (ii) taking a spectrum of the host galaxy, if detected, at sufficiently late times, once the afterglow had faded. In the first aspect, one technically measures only a lower limit for the redshift of the burst, corresponding to the redshift of the first absorber likely host galaxies itself along the line of sight from the burst. In second aspect, one must establish that the positional coincidence between afterglow and the potential host galaxy is not accidental (Lamb and Reichart, 2000), the Identification of the host is best established using Hubble Space Telescope (HST) images.

TYPES OF GAMMA-RAY BURSTS

Long-Soft Duration Gamma-Ray Bursts

Long GRB process is, perhaps, a melodramatic as soon as an extremely massive, fast rotating star burns enough fuel, its core becomes so massive that it cannot withstand its own gravity, and it collapses and as result, more and more stellar materials are sucked into the core forming a block hole and vast amounts of energy are release during the process.

The long GRBs are generally found in small star-forming galaxies, and in some cases, they are positionally and temporarily associated with the onset of an anomalously broad- lined type Ic supernova (SN) which result from the core collapse of stars initially more massive than about

25 solar masses, which lost most of its outer envelope (Wolf-Rayet Stars).

Short-Hard Duration Gamma-Ray Bursts

Short gamma-ray bursts are believed to come from two neutron stars, or a neutron star and a black hole colliding under gravity. They would slowly rotate around and approach each other, emitting gravitational waves, losing energy and falling so close together, thus, crashing into each other, emitting a brief but gargantuan burst of gamma-rays. These bursts have duration between a few milliseconds and 2 seconds with an average duration of 300 milliseconds (Melvin, 2006). There is good evidence that short- GRBs are associated with old stellar populations, being found both in elliptical galaxies, galaxy clusters and spirals or irregular galaxies, the outskirts of younger galaxies (Paczynski, 1986; Eichler et al., 1989; Mészáros, 2008; Wells et al., 2009) and behaves like type 1a supernovae (Eze, 2007).

Hybrid Gamma-Ray Bursts

Hybrid GRBs (e.g., GRB 060614) phenomenon, which is about 1.66 billion light years away from us (Gehrel, 2006), was first observed with NASA's Swift satellite on 14 June 2006, and has since been studied with the Hubble Space Telescope and large ground-base observatories. The hybrid bursts emission lasts for 102 seconds but lacks the hallmark of a supernova, or star explosion and it is commonly seen shortly after long bursts.

The hybrid burst's host galaxy has a low star-formation rate with few stars massive enough to produce long GRBs and supernovae, but certain properties of the hybrid burst suggest that it behaves more like a short burst from a merger of stars than a long burst from a single collapsing star. Astronomers believed that hybrid GRBs was created like other long GRBs, but the star that collapsed experienced a weak (unobservable) or possibly non-existent supernova-"Under Luminous Supernova" and/or it was created like other short GRBs, through the convergence of two neutron stars, but the stars experienced a longer merger process than others that have been observed or it was created through a completely different and unknown process (Melville, 2006). Therefore, hybrid GRBs is still "mull" mystery Gamma-ray burst.

GENERAL PROPERTIES OF GAMMA-RAY BURSTS

(i) GRBs signal the most powerful explosion in the universe, yet they are random and fleeting, never appearing in the same place twice.

(ii) GRBs usually signal the birth of a new black hole.

(iii) The cosmological origin of GRBs implies that they are the most luminous sources of Gamma-rays in the sky.

(iv) GRBs are intense non-thermal bursts of ~ 100 Kev-1Mev photons.

(v) GRBs release ~ 10^{51}ergs or more energy in a few seconds and in the generic picture of a cosmological GRB model (Sari and Piran, 1997; Mészáros and Rees, 1997; Barbiellini and Longo; 2003), observed rays are emitted when an ultra-relativistic energy flow is converted to radiation.

(vi) GRBs observed durations vary from several milliseconds to several thousand seconds (Fishman and Meegan, 1995), and the distribution of burst duration is bimodal – long bursts with duration longer than 2s and short bursts with total duration less than 2s (Kouveliotou et al., 1993; Barbiellini and Longo, 2003).

(viii) GRBs constitute a unique cosmological population that can be observed in the sky and each observed GRBs have a redshift which could be an ideal tool to explore the universe.

(ix) The angular distribution of GRB positions in the sky, (as observed with BATSE), is perfectly isotropic and their limiting fluence (energy per unit area) is ≈ 10^{-7} erg/cm^2 although the actual fluence of the strongest bursts is larger by two or three orders in magnitude.

(x) GRBs results to a fading or a quiescent counterpart called "afterglow" which can be detected outside gamma-ray in electromagnetic spectrum, that is, afterglow can be detected in X-ray region with Swift Satellite (Gehrels et al., 2005; Romano et al., 2005) and with HETE 11 (Villasenor et al., 2005) and in some cases, Optical (Castro-Tirado et al., 2005; Fox et al., 2005; Hjort et al., 2005; Jensen et al., 2005; Piran et al., 2005; Wiersema et al., 2005; Bloom et al.,

2006; Covino et al., 2006) and radio (Berger et al., 2005; Cameron and Frail, 2005; Eze, 2007).

(xi) The most intriguing about GRBs is that they have a link or association with supernovae, for example, the observed GRB 980425 (Galama et al., 1998; Barbiellini and Longo, 2003) whose position and time of occurrence were both consistent with an Optical supernova, 1998bw.

HOST GALAXIES OF GAMMA-RAY BURSTS

A galaxy is a massive, gravitationally bound system that consists of star remnants, an interstellar medium of gas and dust. Galaxies are classified into elliptical, spirals, barred spirals and irregular galaxies based on Hubble's classification. The elliptical galaxies are classified according to their degree of ellipticity, Hubble denoted the spherical galaxies by E_0 and the most highly flattened by E_7, while classes E_1 through E_6 are used for galaxies of intermediate ellipticity.

For spirals, Hubble classified the normal spiral as Sa, S_b, Sc and the barred spirals as SBa, SB_b, SBc and our milky-way galaxy is classified as S_b. The subscript a, b and c denotes the extent of the nucleus and the tightness with which the spiral arms are coiled. The irregular galaxies are the Large and Small Magellanic Clouds. There are also active galaxies in which Seyfert (SF) galaxies and Peculiar galaxies belong. For GRBs to be produce from a galaxy, the stars that make up the galaxy should have both great mass and low metallicity (Fruchter, 2008). It is believed that GRBs host galaxies are too faint (magnitudes of about 25) for detailed spectroscopic study (Price et al., 2007) and short-duration GRBs are found in almost all types of galaxies whereas the host galaxies of long GRBs tend to be Oddballs, small and irregular, instead of "regular" Spirals galaxies like our own Milk-way(Fruchter, 2008).

LINK BETWEEN SUPERNOVAE AND GAMMA-RAY BURSTS

Supernovae as the explosion of massive stars are extremely important for understanding our galaxy, as they heat up the interstellar medium, distributes heavy elements throughout the galaxy, and accelerate cosmic rays, which is in accordance with GRBs phenomenon. A supernova explosion will occur when there is no longer enough fuel for the fusion process in the core of the star to create an outward pressure which combats the inward gravitational pull of the star's great mass and these are what astronomers also believed for GRBs to occur.

Long-duration GRBs and type 1b/c supernovae (SN 1b/c) are two of nature's most magnificent explosions. Both can be seen over cosmological distances, and are products of collapsing massive stars. The study of the measured metallicities of SN with and without GRBs indicates that low metallicity (less than ~ 1/3 solar) might be the key factor for producing SN-GRBs.

The evidence that GRBs were linked to SNe came with study of GRB 980425 which was tentatively linked to a supernova, 1998bw (Galama et al., 1998; Eze, 2007). The definitive proof of the supernova link, at least in the case of those GRBs with an afterglow, is GRB 030329 whose Optical spectrum was nearly identical to a supernova, SN 2003dh (Hjorth et al.,2003; Stanek et al., 2003; Eze, 2007). GRB 030528 with SN 2003iw (Malesani et al., 2004) and GRBs 020903, 050416, 050824 which are placed in X-ray flashes category are also a correlations and GRB 060218 detected with Swift satellite provided considerable new information on the connection between SNe and GRBs.

Moreover, different SNe-GRBs research indicated that several GRBs reveal a re-brightening in a late afterglow curve, for instance, GRB 980323 (Bloom et al., 1999), which resembles an underling SN (Galama et al., 2000). In more recent study it was found that there could be a sign of an underlying SN in all GRB Optical afterglow of red-shift less than 0.7 (Zeh et al., 2005; Eze, 2007).

GAMMA RAY BURSTS AND THEIR AFTERGLOWS

Gamma-ray burst afterglow is the fading debris that tells so much about a burst, including its distance. The luminous afterglow of most distant GRBs would be redshifted all the way into the infrared (Gehrels, 2008). Afterglow is believed to be a progressive less energetic photons emission after GRBs, starting with X-rays and then visible light, radio waves and, perhaps, infrared. The afterglow phase can last for days or even weeks. With the collapsar model point of view, both the GRB and the afterglow can be detected when the

Earth happens to lie along or very near the axes of the blast, although, the probability that there are many more GRBs detected simply because we are not favorable aligned to see them could be one. Observation of GRBs and afterglow are simultaneous event and with Swift satellite, details have been explained earlier.

WHAT IS REDSHIFT AND HIGH REDSHIFT UNIVERSE

A redshift is how much the wavelength of light is stretched when it travels to us across the expanding universe. The farther away an object is, the more its light is stretched, and the greater the redshift. It is the relative difference between the observed and emitted wavelengths (or frequency) of an object divided by the emitted wavelength, that is, Z = (observed wavelength – emitted wavelength) / (emitted wavelength), that is, spectral shift, $Z = (\lambda_{obs} - \lambda_{em} / \lambda_{em})$, where λ_{obs} = wavelength measured by an observer moving relatively to the source with velocity, V, λ_{em} = wavelength of a spectral line in the rest frame of its source.

Different types of redshifts have different causes:

(i) Doppler redshift which results from the relative motion of the light emitting object and observer. If the source of light is moving away from observer, then the wavelength of the light is stretched - the light is redshifted towards the red region of the electromagnetic spectrum (z>0).

(ii) Cosmological redshift is a redshift caused by the expansion of space (universe). The wavelength of light increases as it traverses the expanding universe between its point of emission and its point of detection by the same amount that space has expanded during the crossing time.

(iii) Gravitational redshift is a shift in the frequency of a photon to lower energy as the light climbs out of a gravitational field.

High redshift universe is also called cosmological redshift which is a redshift caused by the all that exists in space and time, that is, redshift produced by the expansion of the universe and most galaxies in the universe have redshifts.

PROSPECT OF USING GRBs AS A NEW COSMOLOGICAL TOOL

GRB is as a new tool are promising for cosmology because they cover a very wide redshift range presently extending up to Z ≥ 8.2 (Tanvir et al., 2009) and their detection is free from the typical limitation due to dust extinction in the Optical band (Ghirlanda et al., 2006). GRBs can be used to constrain the geometry of the present day universe and the nature and evolution of Dark energy by testing the cosmological models in a redshift range hardly achievable by other cosmological probes like quasars.

The use of GRBs as cosmological tools could unveil the ionization history of the universe, the intergalactic medium, (IGM), properties beyond the present quasi-static object, (QSO), limits (Z ~ 6) and the formation of massive stars in the early universe. GRBs can be potentially detected at any redshift and they might contribute to study the distribution and the properties of matter observed in absorption along the line of sight of these distant powerful sources. The high luminosity of the early afterglow and the GRB transient nature makes GRBs powerful sources to study the metal enrichment and interstellar medium, (ISM), properties of their own hosts and the correlations between GRB spectral properties and collimation corrected energetic can be used to constrain the universe dark energy.

GRBs represent a unique probe of the initial mass function and of the formation of massive stars at very high redshifts if they correspond to the death of very massive star (Ghirlanda et al., 2006) and perhaps, almost all of them are as a result of collapse of massive stars since short-duration bursts are rare.

GRBs AS A MEANS OF FINDING SUPERNOVAE (SNe) AT VERY HIGH REDSHIFT

GRBs can be used to reveal the locations of SNe at redshift (Z > 1). This was achieved by taking the best-fit V-band light curve of the typical early afterglow of GRB 970228 (Reichart, 1999) and add to it the V-band (or peak spectral flux) light curve of SN 1998bw (Galama et al., 1998; Mckenzie and Schaefer, 1999) which was used as a template.

The two light curves was corrected for galactic extinction and transformed to redshifts of Z = 1.2, 3.0, 7.7 and 20. At higher redshifts, SNe could be detected with near infrared, (NIR), observations at frequencies above the peak frequency of the SN in the observer's frame, decreases rapidly with increasing redshift since this portion of the SN spectrum is very red. The chance of detecting a SN component depends on (i) how bright the afterglow is in the band of observation at the time of observation, (ii) how much galactic extinction there is in the direction of the GRB in the band of observation, (iii) how bright the host galaxy, if detected, is in the band of observation.

TRACING THE METALLICITY OF THE UNIVERSE USING GRBs AFTERGLOW

The recent studies of absorption-line system in GRB afterglow spectra have contributed immensely to the understanding of the metallicity history of the universe and can also allow a comparison between the metallicity history of the hydrogen clouds along the line of sight to the burst and the metallicity history of the star-forming regions and/or disks of the burst host galaxies and the globular cluster-sized objects in which GRBs may occur, at higher redshifts.

Since the redshift of GRBs can be determined via both observation, (Yolk, 1999), and theoretical calculations, (Lamb and Reichart, 2000), these suggest that the metallicity of the universe decreases with increasing redshift, especially beyond Z >~ 3. This metallicity history is consistent with an early universal contamination of primordial gas by massive stars, followed by a delay in forming additional heavy elements until Z ≈ 3,(Timmes, Lauroesch, and Truran, 1995), and finally, a rise to $0.1M_\odot$ abundances at Z = 2 (Lamb and Reichart, 2000). This is similar to recent studies of Quasi-Static Objects (Quasars) absorption lines associated with damped Lyman-alpha, (Lyα), systems, (Lu et al., 1996; Prochaska and Wolfe, 1997; Pettini et al., 1997a, 1997b), which provide strong evidence that the metallicity of the universe decreases with increasing redshift and decreases dramatically beyond Z ≈ 3.

Core-collapse SNe, (type 1b/1c SNe), with which GRBs may be associated, produce different relative abundances of various metals which are thought to be caused by the thermonuclear disruptions of White dwarfs (Woosely and Weaver, 1986), since in space any element greater than hydrogen is regard as a metal exhibited absorption lines reflecting the production of substantial amount of oxygen ,O, chromium ,Cr, as well as magnesium II, Mg II, Fe, Ca, Si, and some surphur ,S, (Iwamoto et al., 1998; Mazzoli et al.,2000; Lamb and Reichart, 2000).

GRBs AFTERGLOW AS A PROBE OF STAR FORMATION

GRBs could be ideal tracers of the average star formation density due to their brightness, independently of dust extinction and the fact that they originate from a single (or double) stellar progenitor, (Wijers et al., 1998). High luminosities of GRBs are very useful in probing star formation, making them promising tools for exploration of the high-redshift universe (Jankobsson et al., 2006; Eze, 2007).

GRB afterglows pinpoint their host galaxies, provide redshifts for them, and in some cases measures of their metallicity, gas density and dynamical state, and this provides a route to identify and study the types of galaxies that are responsible for the bulk of the star formation, and hence for the bulk of the (re-) ionization of the universe (Ruiz-Velasco et al., 2007).

The positional coincidences between burst afterglows and the bright blue regions of the host galaxies, (Sahu et al., 1997; Kulkarini et al., 1998; 1999; Frutcher et al., 1999; 1999a), and the evidence for extinction by dust of some burst afterglows (Reichart, 1998; Lamb et al., 1999) lends support to the idea that GRBs are associated with star formation. If GRBs are related to the collapse of massive stars, one expects the GRB rate to be approximately proportional to the star formation rate, (SFR), and observational estimates, (Gallego et al., 1995; Lilly et al., 1996; Connolly et al., 1997 Madau, Pozzetti, and Dickinson 1998; Lamb and Reichart, 2000), indicate that the star formation rate, (SFR), in the universe was about 15 times larger at a redshift Z ≈ 1.

GRBs AS STANDARD CANDLES TO CONSTRAIN COSMOLOGICAL PARAMETER

The cosmological origin of GRBs has been confirmed by several spectroscopic measurements of their redshifts and these

properties makes them very appealing to investigate the far universe, thus, they can be used to constrain the geometry of the present day universe and the nature, and evolution of Dark Energy by testing the cosmological models in a redshift range hardly achievable by other cosmological probes. There are correlations among some observed quantities which allow us to know the total energy or the peak luminosity emitted by a specific burst with a great accuracy and through these correlations, GRBs becomes "known" candles, and tools to constrain the cosmological parameters.

The methods that have been used to fit the cosmological parameters through GRBs are:

(a) the scatter method which is by fitting the correlation for every choice of the cosmological parameters that we want to constrain, example $(\Omega_m, \Omega_\Lambda)$ a χ^2 surface, (as a function of these parameters), is built, that is, the best cosmological model corresponds to the minimum scatter around the correlation and is identified by the minimum of the χ^2 $(\Omega_m, \Omega_\Lambda)$ surface, (Ghirlanda et al., 2004).

(b) the luminosity distance method: the main steps are**;(i)** choose a cosmology and fit the E_{peak} - E_γ correlation, **(ii)** from the best fit correlation, the term E_γ is estimated ($E_\gamma = f. E_{iso}$),where **f= 1- cosθ_jet** **,(iii)** compute the luminosity distance $D_{L,C}$ **(iv)** build a χ^2 surface by comparing $D_{L,C}$ with that derived from the cosmological model, D_L. By repeating these steps for every choice of the cosmological parameter, a χ^2 $(\Omega_m, \Omega_\Lambda)$ surface is derived and minimum χ^2 represents the best cosmology,(Ghirlanda et al., 2004; Dai, Liang and Xu, 2004; Liang and Zhang, 2005).

(c) the Bayesian method which is based on the Bayes theorem, (Wall and Jenkins, 2003), the basic steps are: **(i)** choose a cosmology, Ω, and fit the correlation, **(ii)** test this correlation (that is, keep it fixed) in all the possible cosmologies, Ω, and derive conditioned probability surface ,ρ(Ω / Ώ), which represents a "weight" for the starting cosmology, Ώ**, (iii)** by repeating these steps for different starting cosmologies, Ώ, and combining at each step, the new conditioned probability surface is found whose maximum represents the best cosmological model, (Firmani et al., 2005; Ghirlanda et al., 2006). The first two methods are based on the concept that a correlation exists between two variables E_{peak} and E_γ as highlighted follows: the correlation between the rest frames

peak spectral energy E_{peak} and the total energy emitted in gamma- rays, E_γ, properly corrected for the collimation factor and the empirical correlation that relates the total GRB peak energy, its isotropic energy and its jet break time correlation have been used to find constraints on Ω_m and Ω_Λ, which are found to be consistent with the concordance model.

GRB AND THEIR AFTERGLOW AS A PROBE OF LARGE- SCALE STRUCTURE

Galaxies and their clusters are the largest gravitationally-bound objects in the universe, and they themselves are grouped into super-clusters, perhaps joined by filaments and walls of galaxies and in-between this "foam like" structure are large voids which may be probably 50Mpc across. Therefore, the various forms of structure in the universe are often collectively referred to as large-scale structure.

When GRBs occur, galaxies, clusters and super-clusters are completely transparent to gamma-rays in that the interstellar and intergalactic media properties of the large - scale structures could be studied. These suggest that GRBs can be used to probe the large-scale structure of luminous matter in the universe (Lamb and Quashnock, 1993; Quashnock, 1996) and the advantage of this is that GRBs occur and are detectable out to very high redshifts, if they are related to the collapse of massive stars, (Lamb and Reichart, 2000).

It is possible to use the metal absorption lines and Lymann-alpha (Lyα) forest seen in the optical and infrared spectra of GRB afterglows to probe the clustering of matter on the largest scales, as has been done using the same lines in the optical spectra of QSOs (Quashnock et al., 1996; Quashnock and Vanden Berk, 1998; Quashnock and Stein, 1999).

GRBs and their afterglows are expected to occur and to be detectable out to very high redshifts (VHRs; Z > 5) far larger than redshifts expected for the most distant Quasars, therefore, the observation of absorption-line systems and damped Lyα systems in the optical and infrared spectra of GRB afterglows offers an opportunity to probe the properties of these systems (large-scale structures) and their clustering at very high redshifts (Lamb and Reichart, 2000).

DISCUSSION AND CONCLUSION

GRBs are the most powerful, sudden, brief flashes of known gamma-rays explosions in the universe, that occur about once in a day at random positions in the sky. GRB and its afterglows emits energetic photons which can penetrate the interstellar medium and intergalactic medium so deep, revealing the isotropic and homogeneity of the early universe and the feasibility of this is because when GRBs occurs, the photons are distributed randomly and this makes an equipped astronomers or cosmologists to observe the nature of the early universe before the present epoch, (matter dominated era).

GRB and its afterglow are used to trace the existence of metals in the early universe and this is achieved by searching for absorption lines, emission line or other variations in light intensity of the afterglow spectrum and if found, these features can be compared with known features in the spectrum of various chemical compounds found in experiments where that compound is located on earth. So, if spectrum of originally featureless light shine through hydrogen, spectrum specific to hydrogen that has features at regular intervals will be observed and if the same pattern of intervals is seen in an observed spectrum from a distant sources but occurring at shifted wavelength, such spectrum can be identified as hydrogen spectrum.

The same techniques are applied in tracing other metals in the universe since any element greater than hydrogen is regarded as metal. GRBs associated with SNe produce different relative abundances of various metals (oxygen, chromium, magnesium II, iron, calcium, silicon; Mazzoli et al., 2000; Lamb and Reichart, 2000). GRBs are unique cosmological tool used in exploring the universe. It has been used to find SNe at very high redshift and this was achieved, observationally, by taking the best-fit V-band light curve of the typical early afterglow of GRB 970228 (Reichart, 1999) and add to it the V-band (or peak spectral flux) light curve of SN 1998bw (Galama et al., 1998; Mckenzie and Schaefer 1999) which was used as a template. The two light curves was corrected for galactic extinction and transformed to redshifts of Z = 1.2, 3.0, 7.7, and 20.0.

GRB is believed to occur as a result of collapse of massive stars, it is expected that GRB rate is

approximately proportional to the star formation rate, (SFR), and observational estimates (Gallego et al., 1995; Madau et al., 1998; Lamb and Reichart, 2000) indicated that the star formation rate in the universe was about 15 times larger at a redshift $Z \approx 1$.

GRBs are also used as a probe of black-hole formation in that when a massive star collapse, its core becomes so massive that it cannot withstand its own gravity, thus, more and more stellar materials are sucked into the core forming a black-hole and a vast amount of energy are released in forms of radiation during the process. GRBs as a probe of large-scale structures is very remarkable in that when it occurs, galaxies, its clusters and other distant objects are completely transparent to gamma-rays and this makes GRBs a good cosmological probe of luminous matter. Observationally, this is achieved by using the metal absorption lines and Lymann-alpha (Lyα) forest seen in the optical and infrared spectral of GRB afterglows to probe the clustering of matters and its properties on the largest scales at very high redshift, as has been done using the same lines in the optical spectral of QSOs (Quqshnock et al., 1996; Quashnock and Vanden Berk, 1998; Quashnock and Stein, 1999; Lamb and Reichart, 2000).

The high luminosity of the early afterglow and the GRB transient nature makes GRBs powerful sources to study the metal enrichment and interstellar medium, (ISM), properties of their own hosts. The correlations between GRB spectral properties and the collimation corrected energetic could be used to constrain the universe's cosmological parameters, dark matter and energy content (Ω_m, Ω_Λ) and the nature of dark energy (Ghirlanda et al., 2006) and also determine the geometry of the universe in that when Ω_m and Ω_Λ (density parameters due to matter and energy) are constrained, they determine the value of the overall density parameter Ω which in turn determine the fate of the universe ($0 < \Omega < 1 \rightarrow$ open universe, $\Omega=1 \rightarrow$ flate universe, $\Omega >1 \rightarrow$ closed universe).

The spectroscopic study of GRBs reveals that there could be possibility of defining the properties of intergalactic medium, (IGM), beyond the present Quasi-Static Object, (QSO), limits (Z~ 6) and consequently, to study the epoch of re-ionization. If GRBs corresponds to the death of very massive stars, they represents a unique probe of the initial mass function and of the star

formation of massive stars at very high redshifts, (Ghirland, et al., 2006) and perhaps, almost all of them are as a result of collapse of massive stars since short-duration bursts are rare.

There are large numbers of GRBs with peak photon number fluxes related to the collapse of massive stars. They are melodramatic events detectable at a very high redshift which would give us first information about the earliest generations of stars. GRBs and their afterglows are used as a beacons to locate core-collapse supernovae at redshift Z >>1 and to study the properties of these supernovae. The expected properties of the absorption-line system and the Lymann-alpha, (Lyα), forest in the spectra of GRB afterglows can also be used to trace the evolution of metallicity in the universe and to probe the large-scale structure of the universe at very high redshifts. The best ways to find and study black-hole formations (and thus star formations) in the early universe is through GRB detection. GRBs as a new cosmological tool is an ideal and yardstick standard candles that will foster the study of cosmology in future generations; in that GRBs and their afterglows can be used as a powerful probe of many aspects of the very high redshift universe.

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ABOUT THE AUTHORS

Ambrose C. Eze, B.Sc. is a graduate of Physics and Astronomy at the University of Nigeria, Nsukka and a prospective postgraduate student to Dr. Romanus N. Eze. Mr. Eze has professional research interests in aeronautical science/engineering, space science, ICT, and space science instrumentation. Contact information: Mr. Ambrose C. Eze, Department of Physics and Astronomy, University of Nigeria, Nsukka, Enugu State, Nigeria, Mobile Phone: +234806211865.

Romanus N.C. Eze, Ph.D., presently serves as a Senior Lecturer in the Department of Physics and Astronomy at the University of Nigeria, Nsukka. He holds a doctorate in Physics and Astronomy from the University of Nigeria. His professional research interests are in astrophysical accretion and gamma-ray bursts. Contact information: Dr. Romanus Eze Department of Physics and Astronomy, University of Nigeria, Nsukka, Enugu State, Nigeria, Mobile Phone: +2348062111865.

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