RevMexAA (Serie de Conferencias), **42**, 73–74 (2013)

THE ROLE OF GTC IN GAMMA-RAY BURST SCIENCE

A. de Ugarte Postigo,[1,2] J. Gorosabel,[1] C. C. Thöne,[1] R. Sánchez-Ramírez[1] on behalf of a larger collaboration

RESUMEN

Durante el último año, el telescopio GTC de 10.4 m ha reivindicado su lugar como una de las instalaciones punteras a nivel mundial en el estudio de las explosiones de rayos gamma (GRB). GTC es el uńico telescopio de clase 8–10 m en terreno europeo, lo que le coloca en una situación privilegiada para las observaciones de oportunidad. El hecho de que se opera fundamentalmente en modo de servicio lo hace óptimo para este tipo de observaciones. En este artículo presentamos una visión general de los estudios de GRBs que se han realizado desde el comienzo de las operaciones de GTC.

ABSTRACT

Over the last year the 10.4 m GTC telescope has claimed its role as one of the leading facilities for gamma-ray burst (GRB) research world wide. GTC is the only large telescope within European soil, giving it an outstanding position for fast target of opportunity observations. The predominant service mode operation, makes it specially well suited for these kind of observations. We give an overview of the results obtained in GRB studies since the beginning of scientific operations.

Key Words: gamma-ray burst: general

1. GAMMA-RAY BURSTS

Gamma-ray bursts (GRBs) are the most luminous explosions in the Universe, releasing isotropic equivalent energies in the range of 10^{51}–10^{54} erg in gamma-rays. In optical, they can reach, for a short period of time, luminosities 10^4 times brighter than typical quasars. Thanks to this, they have been observed at almost any redshift, from our nearby environment (GRB 980425 was the nearest one, at z=0.08, Galama et al. 1998) to the very distant Universe (GRB 090429 is the current record holder with a photometric redshift of z=9.4, Cucchiara et al. 2011, being GRB 090423 the furthest spectroscopically confirmed at z=8.2, Tanvir et al. 2009; Salvaterra et al. 2009). Their optical spectra is normally well reproduced by a clean, simple power law, making them not only great laboratories for extreme physics, but also ideal light houses to probe the material within the line of sight between the GRB and the observer. Here we give some examples of the ongoing work in the GRB field using the 10.4 m GTC.

2. FAST TARGET OF OPPORTUNITY OBSERVATIONS AT GTC

GTC has a very important role to play in target of opportunity observations, and in particular in the ones that require fast response, due to its privileged location. Almost all the 8–10 m class telescopes that are currently in operation are located between longitudes of 70 and 155 deg West. Only the SALT telescope is located at an eastern longitude from GTC. However, SALT can only observe objects on transit through a restricted elevation range. This leaves GTC with 3.5 hours advantage (and after a 15 hour gap) over any other 8–10 m class telescope, to rapidly observe any event that occurs during the night of the eastern Hemisphere. Furthermore the service mode, dominant at GTC, is optimal for ToO observations. As an example we show, in Figure 1 the spectrum of GRB 110503A, which was observed with GTC. Thanks to the rapid delivery of the prereduced data by the GTC staff, the redshift of the afterglow was published in an astronomical circular just 42 minutes after observing (de Ugarte Postigo et al. 2011a).

3. CURRENT WORK WITH GTC

The large aperture of GTC is well suited for obtaining spectroscopy of the afterglows and host galaxies of GRBs, as well as very deep imaging. Furthermore, the tuneable filters available in OSIRIS, allow us to observe the spatially resolved hosts of nearby GRBs. Here we give some examples of our work:

Spectroscopy of GRB afterglows is the most reliable way to determine the distance at which they happen, which is essential to convert observations

[1]Instituto de Astrofísica de Andalucía, Glorieta de la Astronomía, s/n, 18008, Granada, Spain (deugarte@iaa.es).
[2]Dark Cosmology Centre, Niels Bohr Institute, University of Copenhagen, 2100, Copenhagen Ø, Denmark).

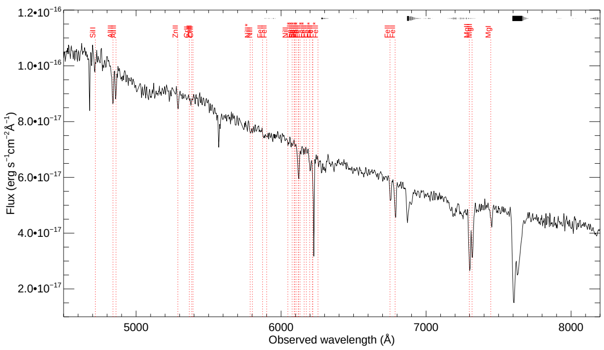

Fig. 1. Example of a spectrum of GRB 110503A at a redshift of z=1.613. The redshift was reported just 42 min after the observations were obtained.

into physical measurements (GRB 100816A, Gorosabel et al. 2010; GRB 110422A, de Ugarte Postigo et al. 2011a; GRB 110503A, de Ugarte Postigo et al. 2011b; GRB 110801A, Cabrera Lavers et al. 2011; GRB 100316A, Sánchez-Ramírez et al. 2012). As long GRBs are mainly produced in star forming regions and can be detected at any redshift, they are important tracers of the star formation history of the Universe. The study of absorption features allows us to study the local environment of the GRB, the interstellar medium of its host galaxy and the large scale structure of the Universe. The shape of the continuum provides us information of the physics of the central engine and the host galaxy extinction.

Deep imaging can help to detect high-redshift or highly extinguished GRBs (GRB 091202, de Ugarte Postigo et al. 2009; GRB 090709A, Cenko et al. 2010; GRB 100614A, Guziy et al. 2010; GRB 111022B, Gorosabel et al. 2011b). A major role will be played by GTC once that near infrared cameras, such as EMIR will be available (Gorosabel et al. 2004). In the time being we can still detect afterglows at $z<7$ and make strong constraints for the emission of higher redshift sources.

The study of the supernova components (or the lack of them, Fynbo et al. 2006) associated with GRBs can teach us about the nature of GRB progenitors (Vergani et al. 2011) and even discover new types of GRB phenomena (Levan et al. 2011; Thöne et al. 2011). Imaging of supernova components of GRB afterglows is feasible with GTC up to a redshift of $z\sim1$, while we have already been able to detect supernova features through spectroscopy at a redshift of 0.478 (de Ugarte Postigo et al. 2011c).

The high sensitivity of GTC has allowed to study very faint hosts galaxies of GRBs (like the one of GRB 111225A, at $g\sim27.2$ Thöne et al. 2011), very

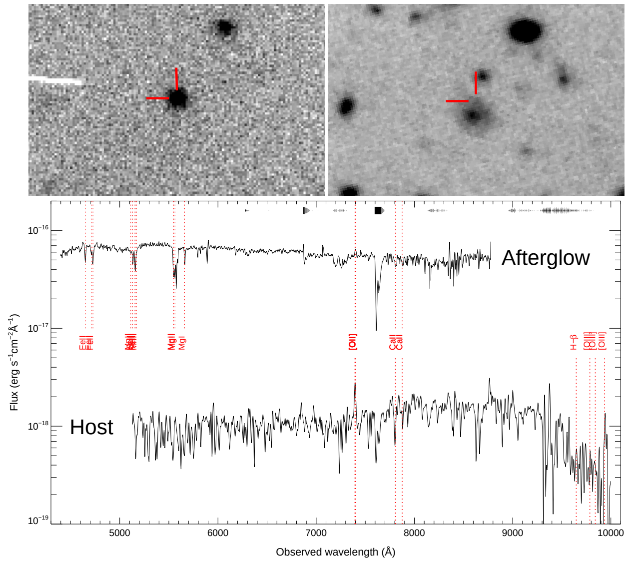

Fig. 2. GRB 110918A at z=0.478. The top panel shows, on the left, the afterglow of the GRB 2 days after the burst and on the right, the host galaxy 1.5 months later. The bottom panel compares the spectra of the afterglow of GRB 110918A and its host galaxy.

high redshift ones (Thöne et al. 2012), obtaining spectroscopy of some hosts (GRB 110918A, see Figure 2, Elliot et al. in preparation, GRB 100816A, Perez-Ramirez et al. in preparation) and in the nearest cases the resolved study of emission features through the use of tuneable filters (Gorosabel et al. 2011a).

REFERENCES

Cabrera Lavers, A., et al. 2011, GCN Circ., 12234
Cenko, S. B., et al. 2010, AJ, 140, 224
Cucchiara, A., et al. 2011, ApJ, 736, 7
Fynbo, J. P. U., et al. 2006, Nature, 444, 1047
Galama, T. J., et al. 1998, Nature, 395, 670
Gorosabel, J., et al. 2004, A&A, 427, 87
Gorosabel, J., et al. 2010, GCN Circ., 11125
Gorosabel, J., et al. 2011a, Adv. Space Res., 47, 1421
Gorosabel, J., et al. 2011b, GCN Circ.,12494
Guziy, S., et al. 2010, GCN Circ., 10967
Levan, A. J., et al. 2011, Science, 333, 199
Salvaterra, R., et al. 2009, Nature, 461, 1258
Sánchez-Ramírez, R., et al. 2013, RevMexAA (SC), 42, 113
Tanvir, N. R., et al. 2009, Nature, 461, 1254
Thöne, C. C., et al. 2011, Nature, 480, 72
Thöne, C. C., et al. 2012, A&A, submitted
de Ugarte Postigo, et al. 2009, GCN Circ., 10247
de Ugarte Postigo, A., et al. 2011a, GCN Circ., 11978
de Ugarte Postigo, A., et al. 2011b, GCN Circ., 11993
de Ugarte Postigo, A., et al. 2011c, GCN Circ., 12802
Vergani, S. D., et al. 2011, A&A, 535, A127