IL NUOVO CIMENTO Vol. 28 C, N. 3 Maggio-Giugno 2005
DOI 10.1393/ncc/i2005-10154-9

Gamma-Ray Bursts in the Afterglow Era: 4th Workshop

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(ricevuto il 23 Maggio 2005; pubblicato online il 22 Settembre 2005)

Summary. — We introduce the volume that collects the papers presented at the 4th Workshop Gamma-Ray Bursts in the Afterglow Era, held in Rome on October 18-22, 2004. After a general introduction and description of the Workshop, we briefly review the hot topics in GRB science which were discussed during the conference and are the subject of many articles included in these proceedings. Finally, we focus on future prospects for GRB science at the beginning of the Swift era and beyond.

PACS 01.30.Cc – Conference proceedings.

1. – Introduction

This volume of *Il Nuovo Cimento C* contains the papers presented at the fourth Workshop on "Gamma-Ray Bursts (GRBs) in the Afterglow Era" held from 18 to 22 October 2004 at the Consiglio Nazionale delle Ricerche (CNR) Headquarters in Rome, Italy.

This was the last of a series of four very successful workshops on GRBs, held at the same location, started in 1998 at the dawn of the new "afterglow" era opened by BeppoSAX discoveries in 1997 and continued in 2000 and 2002. In particular, this edition marked the entering of GRB science in the new era just opened by the Swift satellite, which was successfully launched one month after the Workshop and is now providing the expected steps forward in the field.

The success of the previous three conferences on the same topic and the need to provide the scientific community with an exhaustive review on both observational and theoretical progress in GRB science just before the beginning of the Swift era prompted us to organize the fourth Workshop. As in the third conference, the organizers were Enrico Costa (INAF-IASF Rome), Filippo Frontera (Ferrara University and INAF-IASF Bologna), Luigi Piro (INAF-IASF Rome), who were also organizers of the first and second Workshops, and Guido Chincarini (Astronomical Observatory of Brera, Merate and Bicocca University, Milan), who is heavily involved in the Swift mission.

The Workshop was very successful, with more than 200 participants, 132 posters, 43 oral contributions, 11 solicited and 17 review talks. Despite seven years were already passed from the beginning of the "afterglow era", further relevant developments of the GRB science still occurred in the two years after the previous Rome workshop, mainly thanks to new observations provided by the satellites HETE-2, INTEGRAL, Konus-Wind, Chandra, XMM, and the largest optical (*e.g.*, VLT, HST, NTT) and radio (*e.g.*, VLA, NRAO, JCMT) telescopes in the world, to the continued exploitment of BATSE and BeppoSAX archival data and to the efforts of theorists.

In next two sections we briefly review the main observational and theoretical topics which were discussed during the conference and in the last section we review present and future GRB experiments which were presented at the workshop and are expected to provide new insights towards the solution of this intriguing astrophysical phenomenon.

2. – Observations

The talks and posters covered nearly all the observational aspects of GRB science. Nice reviews were given on X- and gamma-ray prompt emission properties, X-Ray Flashes (XRFs), X-ray afterglow properties, optical and radio counterparts, dark GRBs, host galaxies, GRB/SN connection, circum-burst environment.

Also "mission-based" reviews were presented, like the new results coming from systematic studies of data from HETE-2, INTEGRAL, Konus/WIND and the IPN, concerning prompt emission, and Chandra and XMM concerning X-ray afterglow emission.

One of the major improvements with respect the the 2002 Workshop concern the GRB/SN connection, with the detection and multi-wavelength study of GRB030329/ SN2003dh (detected by HETE-2), the GRB most clearly associated with a SN after GRB980425/SN1998bw, and of GRB031203/SN2003lw (detected by INTEGRAL/ ISGRI), the closest ($z \sim 0.1$) event after GRB980425 and the most similar to it under several respects.

Another interesting issue, also discussed at the conference, was that of polarization measurements, both of prompt emission (in particular the debated case of GRB021206) and afterglow emission.

A hot topic that gained interest in the last two years, thanks to the substantially increased number of GRBs with estimated redshift, and was the subject of reviews and discussions in the Workshop was that of correlations between GRBs intensity indicators (radiated energy, luminosity, peak luminosity) and temporal (time lag, variability) or spectral (peak energy) properties. Particular attention was given to spectral energy correlations (E_p-E_{iso} and E_p-E_γ) for their implications on GRB emission mechanisms and geometry and for their potential use to estimate cosmological parameters and/or build up redshift indicators.

Finally, it was shown that the exploitment of archival data is still providing new exciting results, like the bi-modality of the autocorrelation function of BATSE GRBs, the refined and completed analysis of BeppoSAX data of GRB990123, complemented by multi wavelength observations, and the X- to gamma-ray spectral evolution of BeppoSAX bursts.

3. – Theory

The hottest theoretical aspects of the GRB science were reviewed and discussed at the Workshop. The current emission models of the prompt and afterglow emission were widely discussed (internal and external shocks, magnetic acceleration, MHD winds from neutrons stars, cannonballs), with reviews of the most recent versions. The relevance of polarization studies for the understanding of GRB emission mechanisms and geometry was outlined. Particular attention was given to the early phases of the afterglow and the connection between prompt and afterglow emission, the investigation of which is one of the main goals of Swift. Also the long wavelength emission expected from the reverse shock was discussed, in view of the expectation that Swift will allow the prompt follow-up of several GRBs with optical and IR robotic telescopes.

The progenitor models of GRBs (*e.g.*, collapsar, supranova, coalescing compact binaries, EMBH) and their capabilities of explaining the observed prompt and delayed properties of GRBs have been widely discussed, including the formation of cocoons and the possible origin of precursors.

The jet structures of GRBs, the properties of the circum-burst environment and their implications were discussed by various speakers. In particular, in the last two years the growing observational evidence that GRBs and XRFs have a common origin imposes severe constraints on jet models. Comparisons between observations and the predictions of the main classes of jet and XRF/GRB unification models (uniform jets, universal structured jets, off-axis models) were presented and widely discussed; also new kinds of jet structure (like the structured Fisher jet) were proposed. Possible mechanisms for the origin of jets (*e.g.*, based on MHD or acceleration by muons and pairs) were also discussed.

One of the main and currently most debated topics was the possible use of GRBs as a tool, in particular for the estimate of cosmological parameters but also to trace the star formation rate of the universe. Another interesting discussed issue was the connection between SGR and GRBs, in particular the growing idea that short GRBs may be giant outbursts from very distant magnetars.

Finally, GRBs as possible sources of high-energy particles, cosmic rays, neutrinos and gravitational waves have been reviewed.

4. – Future experiments: the Swift era and beyond

The major attention was off course given to the Swift satellite, a project involving USA, UK and Italy for the hardware and management of the mission and several members of the GRB community worldwide for its full scientific exploitation, which was successfully launched on November 20, 2004, just one month after the workshop. The payload, science goals, mission management and data distribution and archival policy of Swift were exhaustively reported and discussed. Several talks concentrated also on the Swift follow-up with optical, IR, radio telescopes, focusing in particular on robotic telescopes like REM, BOOTES, PROMPT. The status and capabilities of GRB experiments on-board X-/gamma-ray astronomy missions underway (*e.g.*, ASTRO-E2, AGILE, GLAST) were highlighted at the workshop. Finally, some new concepts for GRB experiments for the next decade (*i.e.* after 2010-2015) were presented, like the ESTREMO project, ECLAIRS the GRB Monitor for Lobster-ISS.

TABLE I. – *Scientific Advisory Committee.*

R. Blandford	California Institute of Technology, USA
G. Chincarini (Co-chair)	Bicocca University, Milan
	Astronomical Observatory of Brera, Merate, Italy
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C. Dermer	US Naval Research Laboratory, USA
D. Frail	NRAO, Socorro, USA
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M. Rees	IoA, Cambridge University, United Kingdom
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G. Vedrenne	CESR/CNRS, Toulouse, France
M. Vietri	Scuola Normale Superiore, Pisa, Italy
R. Wijers	University of Amsterdam, the Netherlands
S. Woosley	UCSC, Santa Cruz, USA

TABLE II. – *Local Organizing Committee.*

G. Ardizzoia	CIFS, Italy
S. Covino	INAF, Oss. Brera, Italy
S. Di Cosimo	IASF/CNR, Rome, Italy
G. Di Persio	IASF/CNR, Rome, Italy
G. Gandolfi (Chair)	IASF/CNR, Rome, Italy
M. Orlandini	IASF/CNR, Bologna, Italy

The Workshop organization was managed by the INAF Institutes—Istituto di Astrofisica Spaziale e Fisica Cosmica (IASF), sections of Rome and Bologna, and Brera Astronomical Observatory, Merate, Italy, with a contribution from Consorzio Interuniversitario per la Fisica Spaziale (CIFS). Many people contributed to the success of the Fourth Workshop on GRBs. We wish to thank all the members of the Scientific Advisory (see table I) and the Local Organizing (see table II) Committees, in particular: the other organizers of the Workshop (E. COSTA, F. FRONTERA and G. CHINCARINI), S. DI COSIMO for his important contribution to the local organization, M. ORLANDINI, for managing the web page of the Workshop, G. DI PERSIO for managing the computer system and G. GANDOLFI for managing the local organization. We also thank for their help during the conference A. CORSI, V. D'ALESSIO, A. GALLI and L. VETERE.

We wish to thank ALDO SPIZZICHINO for his original design and skillful realization of the Workshop poster. We are grateful to our sponsor OLIDATA.