Eighth Huntsville Gamma-Ray Burst Symposium

October 24–28, 2016 • Huntsville, Alabama

Organizers

Institutional Support

Universities Space Research Association (USRA)
NASA Goddard Space Flight Center, Fermi and Swift Missions
Center for Space Plasma and Aeronomic Research (CSPAR), University of Alabama in Huntsville

Conveners

Valerie Connaughton, *Universities Space Research Association*
Adam Goldstein, *Universities Space Research Association*
Neil Gehrels, *NASA Goddard Space Flight Center*

Lunar and Planetary Institute   3600 Bay Area Boulevard   Houston TX 77058-1113

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Abstracts for this sumposium are available via the symposium website at

www.hou.usra.edu/meetings/gammaray2016/

Abstracts can be cited as

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Monday, October 24, 2016
WELCOME
9:00 a.m. Mediterranean 1–3

9:00 a.m. Connaughton V. *
Welcome

9:05 a.m. Gehrels N. *
Introduction to the Eighth Huntsville Gamma-Ray Burst Symposium

Monday, October 24, 2016
PROMPT GAMMA-RAY BURST EMISSION I
9:15 a.m. Mediterranean 1–3

9:15 a.m. Yu H.-F. *
Time-Resolved Spectral Shapes of Gamma-Ray Bursts **[#4109]**
I will review the recent research advancements about the physical mechanism of GRB prompt emission, focusing on the constraints placed on conventional theories by the recent study of the sharpness angle of GBM GRB time-resolved spectra.

9:40 a.m. Ryde F. * Acuner Z. Iyyani S. Pe'er A.
Manifestation of the Jet Photosphere in GRB Spectra **[#4083]**
We will discuss recent progress in our understanding of the emission mechanisms underlying the prompt phase in GRBs. We will show that subphotospheric dissipation is a strong candidate for explaining the observed spectral shapes and evolutions.

9:55 a.m. Golkhou V. Z. * Butler N. R. Littlejohns O. M.
The Fastest Fermi GRBs **[#4104]**
We constrain the minimum variability timescales for 938 GRBs observed by the Fermi/GBM instrument prior to July 11, 2012. The tightest constraints on progenitor radii derived from these timescales are obtained from light curves in the hardest energy channel.

10:10 a.m. Kawakubo Y. K. * Yoshida A. Y. Sakamoto T. S. CALET Collaboration
First Year Observations of GRBs with CALET Gamma Ray Burst Monitor **[#4038]**
CALET Gamma ray Burst Monitor (CGBM) detected 30 GRBs since October 2015. We will report the systematic analysis of the CGBM detected GRBs. Furthermore, we will highlight several GRBs.

10:25 a.m. *Coffee Break and Poster Viewing*

Monday, October 24, 2016
PROMPT GAMMA-RAY BURST EMISSION II
10:55 a.m. Mediterranean 1–3

10:55 a.m. Lien A. * Sakamoto T. Barthelmy S. D. Baumgartner W. H. Cannizzo J. K. Chen K. Collins N. R. Cummings J. R. Gehrels N. Graziani C. Krimm H. A. Markwardt C. B. Palmer D. M. Stamatikos M. Troja E. Ukwatta T. N.
Gamma-Ray Bursts from the Swift Burst Alert Telescope: Instrumental Sensitivity and Implication on the High-Redshift GRBs **[#4112]**
We present the analyses of the Swift/BAT GRBs for the past ~11 years. In particular, we discuss the instrumental sensitivity and selection effects of the BAT GRB detections, and its implication on the observations of high-redshift bursts.

11:20 a.m. Bernardini M. G. * Piron F. Bregeon J. Fermi/LAT Team
Testing the Energy Dependency of the Spectral Lag of GRBs with Fermi/GBM and LAT **[#4041]**
We analyse the rest frame spectral lag as a function of the energy for a sample of GRBs detected by Fermi/GBM and LAT within the internal shock scenario, to identify the radiation processes and the different configurations for the jet microphysics.

11:35 a.m. Hakkila J. * Horvath I. Preece R. D.
Structure in the Light Curves of Short Gamma-Ray Burst Pulses **[#4068]**
The light curves of Short BATSE gamma-ray burst (GRB) pulses exhibit triple-peaked pulse shapes similar to those found in Long GRB pulses, suggesting that a similar physical mechanism produces the pulses found in Long, Intermediate, and Short GRBs.

11:50 a.m. Kocevski D. * Racusin J.
Investigating the Nature of Late-Time GeV Emission in GRBs Through Joint Fermi/Swift Observations **[#4087]**
We use joint spectral fits of simultaneous XRT and LAT observations to investigate the nature of the delayed and long-lived high-energy emission from gamma-ray bursts detected by the Fermi-LAT.

12:15 p.m. *Lunch*

Monday, October 24, 2016
HIGH ENERGY AND MULTI-MESSENGER I
1:45 p.m. Mediterranean 1–3

1:45 p.m. Kocevski D. Longo F. *
Fermi-LAT Observations of GRB 160509A. **[#4092]**
We present preliminary results of the Fermi Large Area Telescope (LAT) observations of GRB 160509A. The burst was well detected by the LAT and serves as an example of a GRB with a clear transition from internal to external shock dominated emission.

2:00 p.m. Omodei N. * Vianello G. Fermi/LAT Collaboration
Features of > 130 Gamma-Ray Bursts at High Energy: Towards the 2nd Fermi/LAT GRB Catalog **[#4080]**
We present here the most extensive search for GRBs performed so far above 30 MeV, returning more than 130 detections. With this sample, we are able to assess the characteristics of the population of GRBs at high energy with unprecedented sensitivity.

2:15 p.m. Wood J. *
Prospects for Ground-Based Detection of Very High Energy Emission from GRBs **[#4108]**
We present the prospects for detection of very high energy emission around 100 GeV from gamma-ray bursts with the newest generation of ground-based gamma-ray telescopes.

2:40 p.m. Lennarz D. * Taboada I.
The HAWC GRB Programme **[#4075]**
HAWC is a very-high-energy gamma-ray extensive air shower detector located in central Mexico at an altitude of 4,100 m above sea level. This contribution summarises recent results of the HAWC GRB programme.

2:55 p.m. Carosi A. * Antonelli L. A.
GRB's and Other VHE Transients with Magic **[#4117]**
In this talk I will present the motivations for high-energy observations of transients, the current situation with respect to the MAGIC telescope, and the prospects for the next decade, with particular reference to the major next-generation high-energy observatory CTA.

3:10 p.m. Bustamante M. *
Multi-Messenger Light Curves from Gamma-Ray Bursts **[#4085]**
GRBs are potential sources of UHE cosmic rays and high-energy neutrinos. Recent results from IceCube imply the relation between these particles is not trivial. We provide updated neutrino predictions based on realistic models.

3:25 p.m. *Coffee Break and Poster Viewing*

Monday, October 24, 2016
HIGH ENERGY AND MULTI-MESSENGER II
3:55 p.m. Mediterranean 1–3

3:55 p.m. *To be Determined*

4:20 p.m. Dornic D. * ANTARES Collaboration
Search for High Energy Neutrino from GRBs with the ANTARES Telescope **[#4024]**
ANTARES is the largest neutrino telescope in the northern hemisphere primarily sensitive to astrophysical neutrinos in the TeV-PeV energy. We review the recent results of the searches for high-energy neutrinos from GRB using multi-messenger analysis.

4:35 p.m. Briggs M. S. * Hamburg R. Veres P. Burns E. Hui C. M. Connaughton V. Goldstein A.
Detecting Fainter Short GRBs with the Fermi Gamma-Ray Burst Monitor **[#4097]**
We report on an undirected search of the GBM data for faint short GRBs. Short GRBs are most likely caused by mergers of binary neutron stars, which are also produce gravitational waves that are likely to be detected by LIGO and Virgo.

4:50 p.m. Baret B. *
Searches for Joint Sources of Gravitational Waves and High Energy Neutrinos with the ANTARES Neutrino Telescopes and Gravitational Waves Interferometers **[#4045]**
We will describe the joint GW+HEN searches performed using data taken with the ANTARES telescope from the initial searches with first common data taking period to the follow-up of the detected events of the first scientific run of LIGO.

Tuesday, October 25, 2016
GAMMA-RAY BURSTS AND GRAVITATIONAL WAVES I
9:00 a.m. Mediterranean 1–3

9:00 a.m. Cadonati L. *
To be Determined

9:25 a.m. Goldstein A. * Connaughton V. Burns E. Blackburn L.
GBM Observations of GW150914 **[#4101]**
Detail the process of the transient discovery, analysis, and ruling out possible sources.

9:40 a.m. Greiner J. * Burgess J. M. Savchenko V. Yu H.-F.
On the Fermi GBM Event 0.4 sec After GW 150914 **[#4008]**
We demonstrate that the Fermi-GBM event at 0.4 sec after GW 150914 is likely not due to an astrophysical source, but consistent with a background fluctuation.

9:55 a.m. Pozanenko A. * Minaev P. Barkov M. Toropov M.
Comparison of SPI-ACS/INTEGRAL and GBM/FERMI Data Around a Time of Detection of the LIGO Gravitational Wave Events **[#4071]**
We investigate the data obtained with SPI-ACS/INTEGRAL detector around a time of detection of the LIGO gravitational wave events GW150914, GW151226 and candidate LVT151012.

10:10 a.m. Zhang B. *
Electromagnetic Counterparts of Gravitational Wave Sources **[#4086]**
I will discuss possible electromagnetic counterparts of gravitational wave sources (NS-BH, NS-NS, BH-BH mergers). The signals include short GRBs and afterglows, kilo-nova (merger-nova) and afterglows, and a possible connection with fast radio bursts.

10:25 a.m. *Coffee Break and Poster Viewing*

Tuesday, October 25, 2016
GAMMA-RAY BURSTS AND GRAVITATIONAL WAVES II
10:55 a.m.   Mediterranean 1–3

10:55 a.m.   Nissanke, S. *
To be Determined

11:20 a.m.   Hotokezaka K. H. *
R-process Kilonova/Macronova **[#4113]**
A kilonova/macronova is an optical/infrared transient associated with neutron star mergers. I will talk the characteristic features of kilonovae/macronovae. Their roles as counterparts to LIGO/Virgo's GW events will also be discussed.

11:45 a.m.   Lamb G. P. *   Kobayashi S.
On and Off Axis Orphan Afterglow from Low Lorentz Factor Jets — Candidate Electromagnetic Counterparts to Gravitational Wave Sources **[#4015]**
If relativistic jets from NS-NS/BH mergers have a negative index Lorentz-factor distribution, low gamma jets will dominate. Gamma <30 will not produce prompt gamma-rays but bright on-axis orphan afterglow. These make good EM counterparts to GW sources.

12:00 p.m.   Siellez K. *   Carullo G.   Forsyth S.   Cadonati L.   Briggs M.   Connaughton V.
The Untriggered GRBs from Fermi-GBM in Coincidence with LIGO **[#4103]**
The Untriggered GRB search in coincidence with the LIGO detection would help to open a new multi-messenger area in Astrophysics in the next couple of years.

12:15 p.m.   *Lunch*

Tuesday, October 25, 2016
GAMMA-RAY BURSTS AND GRAVITATIONAL WAVES III
1:45 p.m. Mediterranean 1–3

1:45 p.m. Shawhan P. *
To be Determined

2:10 p.m. Talukder D. * LIGO Scientific Collaboration
Advanced LIGO Searches for Gravitational Waves Associated with Gamma-Ray Busrts **[#4018]**
Presenting advanced LIGO searches for gravitational waves associated with gamma-ray bursts.

2:25 p.m. Coyne R. * Corsi A. Owen B. J.
Multi-Messenger Observations of GRBs in the Magnetar Scenario **[#4076]**
Despite the progress made in our understanding of GRBs direct proof of their progenitors is still missing. In this context, we describe a novel gravitational wave search technique optimized for detecting long-lived GW transients associated with GRBs.

2:40 p.m. D'Avanzo P. * Ghirlanda G.
Short GRB Properties and Rate in the Gravitational Wave Era **[#4031]**
The SBAT4 is a sample of bright Swift short GRB (SGRBs), with the highest completeness in z. We use the sample to derive rest-frame properties, luminosity function, redshift distribution and estimate the rate of SGRBs within the aLIGO/Virgo horizon.

3:05 p.m. Zhang T. X. * Naka P. Guggilla P.
Energy and Spectra of Gamma-Ray Bursts from Mergers of Binary Black Holes **[#4028]**
Energy and spectrum of the GRB from the merger of binary black holes that produced the LIGO detected GWs are investigated according to the black hole model of the universe. Results obtained are consistent with the measurement in order of magnitude.

3:20 p.m. *Coffee Break and Poster Viewing*

Tuesday, October 25, 2016
SHORT GAMMA-RAY BURSTS
3:50 p.m. Mediterranean 1–3

3:50 p.m. Lazzati D. * Deich A. Morsony B. J.
Wide Angle Emission of Short Duration Gamma-Ray Bursts and Their GW Counterparts **[#4052]**
Wide angle emission from short gamma-ray bursts is computed to show that electromagnetic counterparts of LIGO binary NS mergers are detectable even if the short GRB jet is misaligned.

4:05 p.m. Svinkin D. * Frederiks D. Aptekar R. Golenetskii S. Ulanov M. Cline T. Hurley K.
Konus-Wind Observations of Short Gamma-Ray Bursts **[#4002]**
We present the results of spectral and temporal analysis of about 400 short gamma-ray bursts (GRBs) detected by Konus-Wind. We consider the results obtained in the context of the Type I (merger-origin)/Type II (collapsar origin) classification.

4:20 p.m. Knust F. * Greiner J. Van Eerten H. J.
GRB 130912A and GRB 150424A: Two Short Gamma Ray Bursts with a Plateau Phase in the Optical After-Glow Challenge the Compact Binary Merger Scenario **[#4027]**
We present two very rare cases of short GRBs with a shallow decay phase in the optical afterglow: GRB 130912A and GRB 150424A. We interpret the light curves and SEDs in the context of the fireball model.

4:35 p.m. Burns E. * Connaughton V. Preece R. Goldstein A.
Time Resolved Studies of Bright Short Gamma Ray Bursts in the Fermi Gamma Ray Burst Monitor **[#4091]**
We present preliminary results on using a Bayesian Block representation of Fermi GBM data to select intervals for time resolved analysis of short GRBs. Additionally, we search for possible precursor and extended emission in short GRBs.

Wednesday, October 26, 2016
GAMMA-RAY BURST AFTERGLOW I
9:00 a.m. Mediterranean 1–3

9:00 a.m. Cenko B. *
To be Determined

9:25 a.m. Laskar T. * Alexander K. D. Berger E.
A Reverse Shock in GRB 160509A **[#4105]**
Through detailed multi-wavelength observations and modeling, we present the discovery and characterization a reverse shock in GRB 160509A. This result highlights the unique power of radio observations in the study of GRB reverse shocks.

9:40 a.m. Alexander K. D. * Laskar T. Fong W. Berger E. Zauderer B. A.
New Insights into Gamma-Ray Burst Shock Physics with the Very Large Array **[#4022]**
I will discuss recent results from our extensive radio follow-up of 9 long GRBs with the Very Large Array. We detect reverse shocks, large interstellar scintillation effects, and an unexpected radio brightening in GRB 151027A four days post-trigger.

9:55 a.m. Morsony B. J. * Lazzati D. Workman J. C.
Localizing Gravitational Wave Events with GRB Afterglows **[#4017]**
Based on properties of observed short GRB jets, we model short GRB afterglows as a function of observer angle. We then determine the detectability of these afterglows in radio, optical, and X-ray searches.

10:10 a.m. Fruchter A. S. * Gompertz B. P. Misra K. Pe'er A. Hounsell R. Cenko S. B. Racusin J. L. Cucchiara A.
The Nature of the Largely Unbreakable LAT Bursts **[#4094]**
We have used Chandra, HST and the VLA to observe a sample of extremely energetic gamma-ray bursts detected by the Large Area Telescope (LAT) In a large fraction of cases the burst afterglows show no sign of a jet-break. More to follow.

10:25 a.m. *Coffee Break and Poster Viewing*

Wednesday, October 26, 2016
GAMMA-RAY BURST AFTERGLOW II
10:55 a.m. Mediterranean 1–3

10:55 a.m. Oates S. R. * Racusin J. L. De Pasquale M.
Exploring the Behaviour of Long Gamma-Ray Bursts with Intrinsic Afterglow Correlations **[#4060]**
We present and examine a correlation observed in both the optical and X-ray afterglows of long duration Swift Gamma-Ray Bursts, between the initial luminosity, measured at rest frame 200s, and average afterglow decay rate.

11:20 a.m. Kazanas D. * Racusin J. L. Sultana J. Mastichiadis A.
The Statistics of BAT-to-XRT Flux Ratio in GRB: Evidence for a Characteristic Value and its Implications **[#4106]**
We present the statistics of the luminosity ratio R between the prompt emission and the GRB afterglow plateau to show that R has a characteristic value ~ 2000 close the proton/electron mass ratio as suggested by an earlier model of ours.

11:35 a.m. De Pasquale M. Page M. J. Oates S. R. *
The 80 Ms Follow Up of the X-Ray Afterglow of GRB 130427A: Consequences for the Proposed Models and the Forward Shock Scenario **[#4062]**
We present observations of the X-ray afterglow of the exceptional GRB 130427A, performed by XMM-Newton and Chandra over a record-breaking baseline of 80 Ms. We show the consequences for the proposed models and the forward shock scenario.

11:50 a.m. *Lunch*

Wednesday, October 26, 2016
GAMMA-RAY BURST PROMPT THEORY I
1:30 p.m. Mediterranean 1–3

1:30 p.m. Veres P. *
Central Engines and Radiation Mechanisms of Gamma-Ray Bursts **[#4111]**
I will review the implications of new observational windows (electromagnetic, gravitational wave and neutrino) on gamma-ray burst models.

1:55 p.m. Mochkovitch R. *
Finding Critical Observables to Constrain the Prompt Mechanism in GRBs **[#4013]**
I will present a few observables that could help to constrain the dissipation radius, the degree of magnetization or indicate the presence of shocks in the relativistic ejecta of gamma-ray bursts.

2:10 p.m. Deng W. * Zhang B. Li H. Zhang H. Li S.
MHD Simulations of Collision-Induced Magnetic Reconnection in Poynting-Flux-Dominated Jets and a Unified Interpretation of Polarization Properties of GRBs and Blazars **[#4078]**
Study of the collision-induced magnetic reconnection and dissipation models in the Poynting-flux-dominated jet from the energy dissipation efficiency, the mini-jets generation and the polarization observation point of view for both GRBs and blazars.

2:25 p.m. Preece R. D. * Hakkila J.
An Impulsive Model for GRB Spectral and Temporal Evolution **[#4065]**
Observations of spectral lag, pulse width broadening and spectral evolution in bright GRBs have suggested an impulsive mini-jet model of pulse energization.

2:40 p.m. Nishikawa K.-I. * Mizuno Y. Niemiec J. Kobzar O. Pohl M. Gomez J. L. Dutam I. Pe'er A. Frederiksen J. T. Nordlund A. Meli A. Sol H. Hardee P. E. Hartmann D. H.
Particle-in-Cell Simulations of Global Relativistic Jets with Helical Magnetic Fields **[#4035]**
We study the interaction of relativistic jets with their environment, using 3-dimensional relativistic particle-in-cell simulations for two cases of jet composition. We have found that new types of instabilities (kink instability; reconnection) grow.

2:55 p.m. *Coffee Break and Poster Viewing*

Wednesday, October 26, 2016
GAMMA-RAY BURST PROMPT THEORY II
3:25 p.m. Mediterranean 1–3

3:25 p.m. Lazzati D. *
Global Numerical Simulations of Gamma-Ray Burst Jet Dynamics and Radiation Properties **[#4005]**
I will present the results of hydrodynamic and radiation transfer simulations of long- and short-duration GRBs and compare the results with observations. I will discuss how to use numerical simulations to predict the bursts multimessenger signal.

3:40 p.m. Kyutoku K. * Kiuchi K. Sekiguchi Y. Shibata M. Taniguchi K.
Neutrino Transport in Black Hole-Neutron Star Binaries: Dynamical Mass Ejection and Neutrino-Driven Wind **[#4059]**
We present our recent results of numerical-relativity simulations of black hole-neutron star binary mergers incorporating approximate neutrino transport. We in particular discuss dynamical mass ejection and neutrino-driven wind.

3:55 p.m. Nagakura H. * Richers S. Ott C. D. Iwakami W. Furusawa S. Sumiyoshi K. Yamada S. Matsufuru H. Imakura A.
Multi-Dimensional Full Boltzmann-Neutrino-Radiation Hydrodynamic Simulations and Their Detailed Comparisons with Monte-Carlo Methods in Core Collapse Supernovae **[#4037]**
We have developed a 7-dimensional Full Boltzmann-neutrino-radiation-hydrodynamical code and carried out ab-initio axisymmetric CCSNe simulations. I will talk about main results of our simulations and also discuss current ongoing projects.

4:10 p.m. Gottlieb O. * Nakar E.
Cocoon Emission from Long Gamma-Ray Bursts **[#4047]**
The jet radiation can only be discovered in a small angle, while the cocoon’s can be discovered in any. We show the observational importance of the cocoon radiation at it is distributed isotropically, and deduce its potentially detected light curve.

4:25 p.m. Barniol Duran R. * Leng M. Giannios D.
An Anisotropic Minijets Model for the GRB Prompt Emission **[#4019]**
To explain the rapid light-curve variability of the GRB prompt emission, we propose the presence of relativistic “minijets” that form primarily perpendicular relative to the main flow of the jet. This yields robust features realized in observations.

4:40 p.m. Ellison D. C. * Warren D. C.
Electron and Ion Acceleration in Relativistic and Trans-Relativistic Shocks **[#4036]**
Fermi shock acceleration of ions and electrons by relativistic shocks: changes in overall acceleration efficiency produce a non-monotonic variation in the accelerated electron to ion ratio impacting the photon emission expected from GRB afterglows.

Thursday, October 27, 2016
INSTRUMENTS I
9:00 a.m. Mediterranean 1–3

9:00 a.m. Piron F. * SVOM Consortium
The SVOM Gamma-Ray Burst Mission **[#4058]**
We will present the scientific objectives of the SVOM mission, the operations, the instruments and their expected performance for GRB studies.

9:15 a.m. Amati L. *
The Transient High-Energy Sky and Early Universe Surveyor (THESEUS) **[#4070]**
THESEUS is a mission concept by a large international collaboration aimed at exploiting GRBs for investigating the early universe and at vastly increasing the discovery space of the high energy transient phenomena over the entire cosmic history.

9:30 a.m. Racusin J. L. * TAO Team
Transient Astrophysics Observatory (TAO) **[#4081]**
The Transient Astrophysics Observatory (TAO) is a NASA MidEx mission concept (formerly known as Lobster) designed to provide simultaneous wide-field gamma-ray, X-ray, and near-infrared observations of the sky.

9:45 a.m. Perkins J. S. * Racusin J. L. Briggs M. S. de Nolfo G. Krizmanic J. McEnery J. E. Shawhan P. Morris D. Connaughton V.
BurstCube: A CubeSat for Gravitational Wave Counterparts **[#4088]**
BurstCube is a CubeSat that will detect and localize GRBs. It will complement existing facilities in the short term, and provide a means for detection, localization, and characterization in the interim time before a next generation future mission.

10:00 a.m. *Coffee Break and Poster Viewing*

Thursday, October 27, 2016
INSTRUMENTS II
11:00 a.m. Mediterranean 1–3

11:00 a.m. Yuan W. Sun J. Zhang C. Zhang S.-N. Zhang B. *
The POLAR and the Einstein Probe Missions **[#4115]**
Two China-led future missions will be presented, POLAR and Einstein Probe.

11:15 a.m. O'Brien P. *
Athena - To be Determined

11:30 a.m. McConnell M. L. * LEAP Collaboration
LEAP — A LargE Area Burst Polarimeter for the ISS **[#4051]**
The LargE Area burst Polarimeter (LEAP) is a mission concept for a 50–500 keV Compton scatter polarimeter instrument that would be deployed on the ISS. It will be proposed as an astrophysics Mission of Opportunity (MoO) in late 2016.

11:45 a.m. McEnery J. E. *
Compton-Pair Production Gamma-Ray Telescope (ComPair): A Wide Field Discovery Mission for the MeV Band **[#4098]**
We describe a wide-aperture discovery mission concept, Compton-Pair Production Space Telescope (ComPair) and discuss the science that it will address.

12:00 p.m. *Lunch*

Thursday, October 27, 2016
HIGH ENERGY TRANSIENT PHENOMENA
1:30 p.m.   Mediterranean 1–3

1:30 p.m.	Zauderer A. * *To be Determined*
1:55 p.m.	Kaspi V. * *To be Determined*
2:20 p.m.	Fox D. * *To be Determined*

Thursday, October 27, 2016
BANQUET AND GUEST LECTURE
6:30 p.m. Hotel Courtyard

Banquet with Guest Lecture

Invited Speaker: Fishman G. J. *
The Origin, Development, and Launch of the Burst and Transient Source Experiment **[#4030]**
Highlights of some elements of the BATSE origin, along with some details of its design and development, will be presented.

Gerald Jay (Jerry) Fishman *is a research astrophysicist, specializing in gamma-ray astronomy. His research interests also include space and nuclear instrumentation and radiation in space. A native of St. Louis, Missouri, Fishman obtained a B.S. with Honors degree in Physics from the University of Missouri in 1965, followed by M.S. and Ph.D. degrees in Space Science from Rice University in 1968 and 1970, respectively.*

While in graduate school at Rice University in Houston, Texas, Fishman served as a Research Assistant/Research Associate in the Space Science Department. He was involved in balloon-borne observations of high-energy radiation from space, and the research group was the first to detect gamma-rays originating from the Crab Nebula. Further observations showed that a large fraction of this radiation was from the pulsar in this nebula.

In 1969, Fishman began his professional career as a Senior Scientist working on aerospace projects at the Research Laboratories of Teledyne Brown Engineering in Huntsville, Alabama. This research operation had been instigated by Milton K. Cummings, for whom the Cummings Research Park, the second largest in America, was named.

Fishman joined NASA at the Marshall Space Flight Center in Huntsville as a Research Scientist in 1974. From the start, he worked in high-energy astrophysics, and his interest soon centered on gamma-ray astronomy. Gamma-rays are generated by celestial events including supernova explosions, creation of black holes, destruction of positrons, and radioactive decay of the atomic nucleus of matter in space. Therefore, the detection and analysis of gamma-rays provide an insight on the fundamental nature of the universe.

During 1978–79, Fishman took an assignment with NASA Headquarters as a Staff Scientist in the Astrophysics Division of the Office of Space Science. Upon returning to MSFC, he continued his work in gamma-ray astronomy. He was the Principal Investigator of the Burst and Transient Source Experiment (BATSE) on the Compton Gamma Ray Observatory (CGRO). This observatory was the second (after Hubble) of NASA's four Great Observatories in space. After14 years in development, CGRO was launched by the Space Shuttle Atlantis in April 1991 (STS-37). When one of the gyroscopes on CGRO failed, NASA decided that a controlled crash into the Pacific Ocean was preferable to letting the craft come down on its own at random; it was then intentionally de-orbited in June 2000.

The primary objective of the BATSE experiment was the study of gamma-ray bursts. The BATSE experiment also serendipitously discovered terrestrial gamma-ray flashes above thunderstorms. The Gamma-Ray Astrophysics Team at the National Space Science and Technology Center in Huntsville continues to examine data from BATSE. Fishman is currently a Co-Investigator of the Gamma-ray Burst Monitor (GBM) on the Fermi Gamma-ray Space Telescope, launched in 2008. The 2011 Shaw Prize – commonly called the Asian Nobel Prize – was shared by Fishman and Italian astronomer Enrico Costa for their gamma-ray research.

Friday, October 28, 2016
PROGENITORS
9:00 a.m. Mediterranean 1–3

9:00 a.m. Cano Z. *
The Observer's Guide to the Gamma-Ray Burst-Supernova Connection **[#4116]**
In this invited talk I will give an up-to-date progress report of the connection between long-duration (and their various sub-classes) gamma-ray bursts (GRBs) and their accompanying supernovae (SNe).

9:25 a.m. Pejcha O. * Thompson T. A. Prieto J. L.
The Rugged Landscape of the Core-Collapse Supernova Explosions **[#4016]**
We show that the core-collapse supernova explosions are intertwined with failures in a complex pattern unrelated to the progenitor initial mass. We present a new method to extract the supernova parameters from light curves and expansion velocities.

9:40 a.m. Wiggins B. K. * Fryer C. L. Smidt J. M. Hartmann D. H.
Binary Neutron Star Mergers Throughout the Evolving Universe **[#4077]**
We provide constraints on circum-merger densities of binary neutron star mergers by combining cosmological calculations with population synthesis models to determine merger locations on the cosmic web.

9:55 a.m. Perley D. *
The Host Galaxy Population of Long-Duration Gamma-Ray Bursts **[#4001]**
We can learn about the progenitors of gamma-ray bursts by observing the types of galaxies that typically produce them.

10:20 a.m. *Coffee Break and Poster Viewing*

Friday, October 28, 2016
HOSTS
10:50 a.m. Mediterranean 1–3

10:55 a.m. Graham J. F. * Schady P. Krühler T.
A Curious Lack of Evolution in the LGRB Host Metallicity Distribution **[#4090]**
We then find a curious consistency in the metallicity destruction across different redshifts. This is at odds with the general evolution in the mass metallicity relation, which becomes progressively more metal poor with increasing redshift.

11:20 a.m. Niino Y. * Aoki K. Hashimoto T. Hattori T. Ishikawa S. Kashikawa N. Kosugi G. Onoue M. Toshikawa J. Yabe K.
The Redshift Selected Sample of Long Gamma-Ray Busrt Host Galaxies: The Complete Metallicity Measurements at z ≤ 0.41 **[#4039]**
We present host galaxy metallicities of all long GRBs with low spectroscopic redshifts. We compare the metallicity distribution of the low-redshift sample to the model predictions, and constrain the relation between metallicity and GRB occurrence.

11:35 a.m. Hatsukade B. * Ohta K. Kohno K. Nakanishi K. Tamura Y. Endo A. Hashimoto T.
Molecular Gas in the Host Galaxies of Long-Duration Gamma-Ray Bursts **[#4026]**
We conducted CO observations in 10 GRB hosts with ALMA and detected in 6 hosts (z = 1–2). We found the hosts have a star-formation efficiency similar to normal star-forming galaxies at z~1–2, suggesting that GRBs occur in normal environments at z~1–2.

11:50 a.m. McGuire J. T. W. *
Dissecting High-Redshift Galaxies with GRBs: Three Hosts at z~6 Observed with HST **[#4021]**
The first detection of three GRB hosts at z~6 is presented, along with their comparison to Lyman-break galaxies, potential star formation histories and a brief look at their impact on the high-redshift galaxy luminosity function.

Friday, October 28, 2016
POSTERS
Mediterranean 4–6

Posters will Remain on Display Throughout the Entire Symposium

AFTERGLOWS

Warren D. C.   Ellison D. C.   Barkov M. V.   Nagataki S.
Nonlinear Cosmic Ray Acceleration During Gamma-Ray Burst Afterglows **[#4025]**
We present an evolutionary model for GRB afterglows that includes (1) thermal particles and (2) interaction between the shock and accelerated cosmic rays. We will comment on observational signatures of this model compared to the traditional approach.

Murthy S. N.   Resmi L.   Roy R.   Misra K.   Pai A.   Nandi S.   Biju K. G.
Multi-Wavelength Modelling of GRB 081007 **[#4055]**
We carry out extensive multi-wavelength modelling of the afterglow of GRB081007 based on the standard afterglow paradigm. We implement a Markov Chain Monte Carlo parameter estimation technique and obtain bounds on the model parameters.

Hakkila J.   Hanley J. A.   Baron J.   Morris D.   Racusin J. L.   Lien A.
Structure in X-Ray Flare Light Curves Found in Gamma-Ray Burst Afterglows **[#4069]**
Light curve variations suggest that X-ray flares observed by Swift's XRT are late, low-energy, long-duration counterparts of prompt GRB pulses. Flare light curves exhibit stronger precursor peaks and weaker decay peaks than typical prompt GRB pulses.

Pozanenko A.   Mazaeva E.   Volnova A.   Elenin L.   Inasaridze R.   Aivazyan V.   Reva I.   Kusakin A.   Tungalag N.   Schmalz S.   Chornaya E.   Matkin A.   Erofeeva A.   Litvinenko E.   Polyakov K.   Nevski V.   Ivanov A.   Krugly Yu.   Paronyan G.   Voropaev V.   Molotov I.
GRB Afterglow Observations by International Scientific Optical Network (ISON) **[#4074]**
We provide details of the International Scientific Optical Network (ISON) and results of GRB follow up observations.

Kathirgamaraju A. K.   Duran R. B. D.   Giannios D. G.
GRB Off-Axis Afterglows and the Emission from the Accompanying Supernovae **[#4020]**
I will discuss the prospect of detecting orphan afterglows with upcoming radio surveys. Using simulations generated by the Afterglow Library and using data from 75 GRB afterglows. We also discuss how emission from SNe and other components affect our results.

COSMOLOGY WITH GAMMA-RAY BURSTS

Horvath I.
Gamma-Ray Bursts Spatial Distribution **[#4004]**
We report here two structures defined by gamma-ray bursts. One is a ring with a diameter of 1700 Mpc, the second one is even larger with a diameter of 3000 Mpc, exceeding the transition scale by factor of at least seven.

Wang F. Y.   Dai Z. G.
Probing the Properties of High-Redshift Universe Using GRBs **[#4014]**
I will present recent progress on probing the properties of Universe from GRBs.

Burgess J. M.
A Bayesian Analysis of the Golenetskii Relation **[#4033]**
I introduce a Bayesian analysis of the GRB Golenetskii correlation to assess its validity as an indicator of physical processes and as a redshift estimator. I find that the correlation is unable to estimate known redshifts.

Pizzichini G.
Search for Peculiar Properties of Gamma-Ray Bursts at High Redshift **[#4040]**
I shall report on my search for particular properties of Gamma-Ray Bursts at high redshift.

D'Avanzo P.   Vergani S. D.
Clues from the Host Galaxies of the Swift/BAT6 Complete Sample of Long GRBs **[#4048]**
I will present the results of our studies on the z<2 host galaxy properties of the Swift/BAT6 complete sample of GRB. Using this sample makes these results not affected by possible biases that could influence past results based on incomplete samples.

Rice J.   Zhang B.
Cosmological Evolution of Primordial Black Holes **[#4114]**
The cosmological evolution of primordial black holes (PBHs) is considered.

DATA ANALYSIS TECHNIQUES

Bagoly Z.   Horvath I.   Szecsi D.   Balazs L. G.   Csabai I.   Dobos L.   Lichtenberger J.   Toth L. V.
The Automatized Detector Weight Optimization (ADWO) Method for Searching Weak Electromagnetic Counterparts of Gravitational Waves **[#4009]**
We developed Automatized Detector Weight Optimization (ADWO), a detector analysis tool for multi-channel multi-detector signals for looking electromagnetic transients in a given time interval. We applied it to GRB150522B, GW150914 and LVT151012.

Burgess J. M.   Yu H. F.   Greiner J.
Awakening the BALROG: A New Paradigm in GRB Spectral Analysis and Localization **[#4032]**
We introduce a new paradigm, the Bayesian Location Reconstruction of GRBs (BALROG) that both accurately localizes GBM GRBs as well as introduces the variance in location to the spectral likelihood. We demonstrate the algorithm on several of GRBs.

Yu H.-F.   Burgess J. M.   Greiner J.
An Exploration of Issues with GBM GRB Spectroscopy **[#4064]**
We found in conventional spectral fitting unexpectedly large discrepancy in the observed photon flux between different pairs of GBM detectors. We demonstrate these issues using the BAyesian Location Reconstruction of GRBs (BALROG).

Toelge K.   Greiner J.
Geometry-Based Physical Modelling of the Fermi GBM Background **[#4084]**
We have implemented a geometry-based background fitting algorithm for daily data files of the Fermi GBM. With only five main background components we are able to explain and subtract a high fraction of the regular background variations.

Burgess J. M.   Vianello G.
The Multi-Mission Maximum Likelihood Framework (3ML) **[#4110]**
We introduce a new tool for multi-messenger astronomy capable of fitting data from multiple instruments properly via the use of independent likelihood plugins. 3ML represents a step forward in spectral and spatial analysis across all wavelengths.

GAMMA-RAY BURSTS AND GRAVITATIONAL WAVES

Sakamoto T. Asaoka Y. Nakahira S. CALET Collaboration
CALET Upper Limits on X-Ray and Gamma-Ray Counterparts of GW 151226 **[#4056]**
We present upper limits in the hard X-ray and gamma-ray bands at the time of the LIGO gravitational- wave event GW 151226 derived from the CALorimetric Electron Telescope(CALET) observation.

Veres P. Preece R. D. Goldstein A. Meszaros P. Burns E. Connaughton V.
Gravitational Wave Observations can Constrain Gamma-Ray Busrt Models: The Case of GW 150914 – GBM **[#4067]**
Assuming a common origin for the GW150914 gravitational wave and the GW150914-GBM event, we present the implications of joint observations on leading gamma-ray burst models (photospheric, internal- and external shocks).

Burns E. Connaughton V. Briggs M. S. Goldstein A. Hamburg R. Littenberg T.
Expectations for Joint Gravitational Wave-Electromagnetic Detections with Advanced LIGO/Virgo and the Fermi Gamma Ray Burst Monitor **[#4095]**
We estimate the fraction of GBM detected short GRBs that should be detectable by Advanced LIGO/Virgo. We also look at the fraction of GW localizations that should be visible to GBM, as well as area reduction by using joint localizations.

Troja E. Lien A.
The Rate of Short Duration GRBs from Swift Observations **[#4096]**
We used Swift observations of short GRBs to estimate their jet opening angles, luminosity function, and intrinsic rate of events. Monte Carlo simulations were used to model the complex selection effects affecting the observed sample.

GAMMA-RAY BURST THEORY

Zhang J. Liang E. W. Sun X. N. Zhang B. Lu Y. Zhang S. N.
Radiation Mechanism and Jet Composition of Gamma-Ray Bursts and GeV–TeV-Selected Radio-Loud Active Galactic Nuclei **[#4029]**
Based on the analogy between GRBs and FSRQs, we suggest that the prompt gamma-ray emission of GRBs is likely produced by the synchrotron process in a magnetized jet with high radiation efficiency, similar to FSRQs.

Bégué D. P. Pe'er A. Lyubarski Y.
Radiative Striped Wind Model for Gamma-Ray Busrts **[#4061]**
I will show how the inclusion of radiation in the striped wind model changes the dynamics and the radial evolution of the hydrodynamical parameters. I will conclude by discussing the implications for gamma-ray bursts.

Chhotray A. Lazzati D.
Monte Carlo Simulations of Radiative Acceleration of Jets **[#4079]**
We present Monte Carlo simulations of Compton scattering driven radiative acceleration and relativistic expansion of GRB jets, compare our results with the fireball model and discuss other quantities that our code can obtain.

Uhm Z. L.
Evidence of Bulk Acceleration in GRB Prompt Emission and X-Ray Flares **[#4102]**
I will present the recent discovery on two independent observational evidence of bulk acceleration in GRB prompt emission and X-ray flares.

Kochemasov G. G.
Gamma-ray Emission in the Universe — A Possible Explanation by the Wave Modulation **[#4107]**
The gamma-ray emission and other short wave emissions in the universe can be produced by a wave modulation of high orbiting frequencies (planets, satellites) by low orbiting frequencies (galaxies and so on) as cosmic bodies move in several orbits.

Wang X. G. Zhang B. Liang E. W. Lu R. J.
Gamma-Ray Burst Jets Revisited **[#4050]**
Gamma-ray bursts (GRBs) are believed collimated, we using a large optical afterglow sample f to investigate the jet break phenomenons in GRBs. We also use the jet break candidates to test the typical experimental luminosity correlations.

Parsotan T. Lazzati D.
MCRaT Simulations of Long Gamma Ray Burst Spectra and Light Curves **[#4053]**
We present the results of the Monte Carlo Radiation Transfer, MCRaT, simulations of long gamma ray bursts from a variety of stellar progenitors and jet properties, including variable engines. We also compare the resulting spectra to observed data.

INSTRUMENTATION

Kawai N. Yatsu Y. Isobe N. Sugita S. Harita S. Tomida H. Ueno S. Ebisawa K. Dotani T. Mihara T. Serino M. Arimoto M. Tsunemi H. Sakamoto T. Kohmura T. Negoro H. Ueda Y. Nakamura T. Tanaka T. Tsuboi Y. Morii M. Yoshida M. Kanda N. Vagins M.
iWF-MAXI (iSEEP Wide Field MAXI): Soft X-Ray Transient Monitor on ISS **[#4003]**
iSEEP Wide Field MAXI (iWF-MAXI) is a proposed mission on the ISS/JEM to monitor a major fraction of the sky for detecting and localizing soft X-ray transients, starting at the end of 2010's.

Atteia J-L. Godet O. Guillemot P. Lachaud C. Schanne S. SVOM/ECLAIRs Team
ECLAIRs: A Hard X-Ray Coded-Mask Imaging and Trigger Telescope Onboard SVOM **[#4007]**
We present the main characteristics and the expected scientific performance of ECLAIRs, the hard X-ray coded-mask imaging and trigger telescope that will fly onboard the Sino-French SVOM mission early in the next decade.

Lachaud C. SVOM Consortium
SVOM Observing Strategy **[#4010]**
We will present the observing strategy developed to optimize the scientific return of the SVOM mission. We will review the attitude law, the communication processes and the different observation programs (Core Program, ToO and General Program).

Schanne S. Antier S. Breschi I. Château F. Cordier B. Daly F. Götz D. Gros A. Le Provost H. Lachaud C. Daigne F. Atteia J.-L. Guillemot Ph. Perraud L.
The Gamma-Ray Burst Trigger System onboard SVOM/ECLAIRs, Design and Simulations **[#4011]**
We present the design and simulations of the real-time Scientific Trigger Unit of the gamma-ray coded-mask imager ECLAIRs onboard the future mission SVOM, which will localize GRBs and allow their follow-up observations by X-ray and visible telescopes.

Dornic D. SVOM Consortium
Optimized Synergy Between Space and Ground Instruments in the SVOM Mission **[#4023]**
SVOM will be a Chinese-French space mission dedicated to study GRBs. We present the synergy between space and ground instruments together with the pointing strategy of the satellite, one of the key of success for the scientific return of the mission.

Bernardini M. G. Piron F. Atteia J.-L. Sizun P. Dong Y. Xie F. Cordier B.
Scientific Prospects for Spectroscopy of the GRB Prompt Emission with SVOM **[#4042]**
We describe how the excellent performance for spectroscopy of GRB of the ECLAIRs and GRM instruments onboard SVOM will permit to provide direct insights on the physical mechanisms responsible for the prompt emission at high energy.

Götz D.
The MXT X-Ray Telescope on Board the SVOM Mission **[#4046]**
We present the Microchannel X-ray Telescope to be flown on the SVOM mission. The MXT telescope is a compact an light focussing X-ray (0.2–10 keV) instrument based on the coupling of a micropore optics in a narrow field "Lobster -Eye" and a pn CCD.

Yamaoka K. CALET Collaboration
In-Orbit Performance of the CALET Gamma-Ray Burst Monitor **[#4057]**
This poster presentation describes in-orbit operation and performance of the CALET Gamma-ray Burst Monitor (CGBM) which has been operated for about one year since October 2015 on the International Space Station (ISS).

Yoshida A. CALET Collaboration
Calorimetric Electron Telescope (CALET): Mission and Overview **[#4066]**
We will present the operational status of the CALET and scientific results during the first year of its successful operation.

Yamada Y. Sakamoto T. Yoshida A. CALET Collaboration
Energy Response Function of CALET Gamma Ray Burst Monitor **[#4043]**
We will explain the development of the CGBM energy response function. We will also show the spectral analysis results of CGBM using our developed energy response function for simultaneously detected bright GRBs by other GRB detectors.

PROMPT GAMMA-RAY BURST EMISSION

Katsukura D. Sakamoto T. Yoshida A.
Multi-Wavelength Analysis of X-Ray Flush Observed by Swift **[#4006]**
In my poster, we report the results of systematic analysis from the prompt emissions to afterglows of XRFs.

Zhang B.-B.
GRB 160625B: A Burst of Three **[#4012]**
GRB 160625B is a peculiar GRB which consists three dramatically different isolated sub-bursts. We discuss several possible physical pictures that can form this particular burst and the implication of the origin of other GRBs.

von Kienlin A. Meegan C. A. Paciesas W. S.
The Fourth Fermi GBM Gamma-Ray Burst Catalog: The First Eight Years **[#4034]**
The poster will advertise the fourth Fermi GBM Gamma-Ray Burst Catalog, which will extend the six-year GBM GRB catalog by two more years.

Yassine M. Piron F. Mochkovitch R. Daigne F.
Time Evolution of the Spectral Break in the High-Energy Extra Component of GRB 090926A **[#4044]**
Time evolution of the spectral break in the high-energy extra component of GRB 090926A.

Lu R. J. Lv J. Wang X. G. Liang E. W. Yi T. F. Lin D. B. Lv H. J. Zhang B.
A Comprehensive Analysis of Fermi Gamma-Ray Burst Data: IV. On the Spectral Lag and Possible Physical Origin **[#4054]**
Statistical analyses of individual pulses reveal that hard-to-soft pulses have different energy dependent of spectral lag from the tracking pulses. Possible correlations between the spectral lag and other observed properties are also investigated.

Myers B. Stamatikos M.
Investigating the Precursor and Prompt Emission of Swift Gamma-Ray Bursts (GRBs) **[#4072]**
We analyze the spectral lag, i.e. the arrival offset of high and low energy photons, for both the precursor and prompt emission of Swift-BAT GRBs, to probe if the precursor emission is an early activation of the progenitor's central engine activity.

Minaev P. Pozanenko A.
Precursors of Short GRBs Registered by SPI-ACS/INTEGRAL **[#4073]**
We have searched for precursors in light curves of short gamma-ray bursts registered by SPI-ACS/INTEGRAL in 2002–2014. The portion of short bursts with precursor activity will be less than 0.4% from all short bursts registered by SPI-ACS.

Jeong S. Castro-Tirado A. J. Lipunov V. Pozanenko A. S. Park I. H. Uhm Z. L. Zhang B.
Observation of Spectral Lags Among Gamma-Ray, X-Ray and Optical Bands in X-Ray Flares of GRB 140304A **[#4082]**
We report an interesting detection of optical and X-ray flares taking place simultaneously in GRB140304A at z = 5.282, which enables of the measurement of spectral lags and spectral index, together with associated polarisation measurement on flares.

Lien A. Yamaoka K. Krimm H. Kim A. Urata Y. Sakamoto T.
Joint Spectral Analysis of Gamma-Ray Bursts from Swift/BAT and Suzaku/WAM **[#4093]**
We present the results from joint spectral analysis of 245 gamma-ray bursts detected by both Swift/BAT and Suzaku/WAM, which is an extension of previous work by Krimm et al. (2009).

Hamburg R. Goldstein A.
Investigating T90 Distributions of Gamma-Ray Bursts **[#4099]**
We explore the dependence of T90 on spectral parameters, such as hardness ratio and Epeak, and compare T90 probability distributions between GRBs observed by Fermi GBM and Swift BAT.

Goldstein A. Bhat N.
Spectral Lags from Photon Flux Lightcurves of Bright GBM GRBs **[#4100]**
Finely time-resolved spectral fitting using different functions to estimate the spectral lag in GRBs as a function of energy.

Sonbas E. Dhuga K. S. MacLachlan G. A. Landay J.
The Hurst Exponent of Gamma-Ray Bursts **[#4089]**
Using a wavelet technique, we have extracted the Hurst exponent for a sample of long and short GRBs detected by the Swift satellite. The Hurst exponent is a scaling parameter that can be used to gauge the long-range behavior in a time series.

Moretti E. Axelsson M. Fermi-LAT Collaboration
Signs of Magnetic Acceleration and Multi-Zone Emission in GRB 080825C **[#4063]**
Practically all bright GRBs detected by Fermi show deviations from a pure Band function. Here we present signs of a new high energy component in GRB080825C, peaking at a few MeV, in addition to the bulk of emission peaking at few hundreds of keV.

McConnell M. L. Anderson H. Collmar W. Zoglauer A.
GRB Polarimetry with CGRO/COMPTEL **[#4049]**
We have embarked on a program to analyze CGRO/COMPTEL data in search of evidence for 1–30 MeV polarization in all GRBs that took place within the COMPTEL FoV. Here we present a status report on this effort.

NEW INSIGHTS INTO GAMMA-RAY BURST SHOCK PHYSICS WITH THE VERY LARGE ARRAY.

Kate D. Alexander[1], T. Laskar[2,3], W. Fong[4,5], E. Berger[1] and B. A. Zauderer[6] on behalf of a larger collaboration, [1]Department of Astronomy, Harvard University (60 Garden Street, Cambridge, MA 02138, USA, kalexander@cfa.harvard.edu), [2]National Radio Astronomy Observatory (520 Edgemont Road, Charlottesville, VA 22903, USA), [3]Department of Astronomy, University of California Berkeley (501 Campbell Hall, Berkeley, CA 94720-3411, USA), [4]Einstein Fellow, [5]Steward Observatory, University of Arizona (933 N. Cherry Ave, Tucson, AZ 85721, USA), [6]Physics Department, New York University (4 Washington Place, New York, NY 10003, USA).

Abstract: Radio observations are crucial for the study of gamma-ray burst (GRB) afterglows, as they break important parameter degeneracies encountered when modeling higher frequency data alone. The radio band uniquely probes the peak of the afterglow spectrum at ≥1 day, as well as the self-absorption frequency, which probes the circumburst density. In combination with infrared, optical, ultraviolet, and X-ray data, radio observations can accurately determine the energy scale, explosion geometry, and circumburst environments of both long and short GRBs (e.g. [1-7]). In cases where a reverse shock is observed, radio observations can also probe the Lorentz factor and composition (magnetic or baryonic) of the GRB ejecta, which sheds light on the nature of the central engine [5,8-11].

In 2015, our group was awarded over 200 hours of time on the Karl G. Jansky Very Large Array (VLA) to conduct in-depth multi-frequency radio follow-up of GRB afterglows. Over the past year and a half, we have observed 13 short GRBs and 9 long GRBs at frequencies of 1.4 - 36 GHz, allowing us to place new constraints on the properties of these objects. I will discuss a selection of recent exciting results from our observations of long GRBs. These include the detection of reverse shocks [11], large interstellar scintillation effects, and an unexpected low-frequency radio brightening in GRB 151027A four days post-trigger. Our efforts highlight the importance of high-quality multi-band radio follow-up in understanding shock physics in long GRBs.

References: [1] Berger, E. et al. (2000) *ApJ*, *545*, 56. [2] Frail, D. et al. (2001) *ApJ*, *562*, L55. [3] Berger, E. et al. (2003) *Nature*, *426*, 154. [4] Berger, E. et al. (2003) *ApJ*, *590*, 379. [5] Laskar, T. et al. (2013) *ApJ*, *776*, 119. [6] Fong, W. et al. (2012) *ApJ*, *756*, 189 [7] Fong, W. et al. (2014) *ApJ*, *780*, 118. [8] Meszaros, P. and Rees, M. (1999) *MNRAS*, *306*, L39. [9] Sari, R. and Piran, T. (1999) *ApJ*, *517*, L109. [10] Perley, D. A., et al. (2014) *ApJ*, *781*, 37. [11] Laskar, T. et al. (2016) *ApJ submitted,* arXiv:1606.08873.

THE TRANSIENT HIGH ENERGY SKY AND EARLY UNIEVRSE EXPLORER (THESEUS). L. Amati[1] and THESEUS Collaboration[2], [1]INAF – IASF Bologna, via P. Gobetti 101, I-40129 Bologna, ITALY, amati@iasfbo.inaf.it, [2]http://www.isdc.unige.ch/theseus/.

Introduction: The Transient High Energy Sky and Early Universe Surveyor (THESEUS) is a mission concept under development by a large international collaboration aimed at exploiting gamma-ray bursts for investigating the early Universe. The main scientific objectives of THESEUS include: investigating the star formation rate and metallicity evolution of the ISM and IGM up to redshift _9–10, detecting the first generation (pop III) of stars, studying the sources and physics of re-ionization, detecting the faint end of galaxies luminosity function. These goals will be achieved through a unique combination of instruments allowing GRB detection and arcmin localization over a broad FOV (more than 1sr) and an energy band extending from several MeVs down to 0.3 keV with unprecedented sensitivity, as well as on-board prompt (few minutes) follow-up with a 0.6m class IR telescope with both imaging and spectroscopic capabilities. Such instrumentation will also allow THESEUS to unveil and study the population of soft and sub-energetic GRBs, and, more in general, to perform monitoring and survey of the X-ray sky with unprecedented sensitivity.

Scientific goals of the mission: THESEUS is designed to vastly increase the discovery space of the high energy transient phenomena over the entirety of cosmic history. The main scientific goals of the proposed mission are to:

<u>a) Explore the Early Universe</u> (cosmic dawn and reionization era) by unveiling a complete census of the Gamma-Ray Burst (GRBs) population in the first billion years. Specifically to:

- Perform unprecedented studies of the star formation history of the Universe up to z ~ 10 and possibly beyond;
- Detect and study the primordial (pop III) star population: when did the first stars form and how did the earliest pop III and pop II stars influence their environments?
- Investigate the re-ionization epoch, the interstellar medium (ISM) and the intergalactic medium (IGM) up to z ~ 8 – 10-
- Investigate the properties of the early galaxies and determine the galaxies global star formation in the re-ionization era.

<u>b) Perform an unprecedented deep monitoring of the X-ray transient Universe</u> in order to:

- Provide real time trigger and accurate (~1 arcmin within a few seconds; ~1'' within a few minutes) location of (long/short) GRBs and high-energy transients for follow-up with next-generation optical-NIR (E-ELT, JWST if still operating), radio (SKA), X-rays (ATHENA), TeV (CTA) or neutrino telescopes and identify electromagnetic counterpart of detections by next generation gravitational wave detectors;
- Provide a fundamental step forward in the comprehension of the physics of various classes of Galactic and extra-Galactic transients, e.g.: tidal disruption events (TDE), magnetars /SGRs, SN shock break-outs, Soft X-ray Transients SFXTS, thermonuclear bursts from accreting neutron stars, Novae, dwarf novae, stellar flares, AGNs and Blazars;
- Provide unprecedented insights into the physics and progenitors of GRBs and their connection with peculiar core-collapse SNe and substantially increase the detection rate and characterization of sub-energetic GRBs and X-Ray Flashes;

By satisfying the requirements coming from the above main science drivers, the THESEUS payload will also automatically enable excellent observatory science opportunities, including, e.g., performing IR observatory science, especially providing capability for response to external triggers, thus allowing a strong community involvement.

Instruments and configuration: The payload of THESEUS includes the following instrumentation:

- Soft X-ray Imager (SXI, 0.3 – 6 keV): a set of 5 lobster-eye telescopes units, covering a total FOV of ~0.9sr with source location accuracy < 1-2';
- InfraRed Telescope (IRT, 0.7 – 1.8 μm): a 0.7m class IR telescope with 6'x6' FOV, for fast response, with both imaging and spectroscopy capabilities;
- X-Gamma rays Spectrometer (XGS, 1 keV – 10 MeV): a set of slat collimated monolithic X-gamma rays detectors based on bars of Silicon diodes coupled with CsI crystal scintillator, granting a ~2sr FOV and a broad energy band.

The mission profile includes a spacecraft slewing capability of ~10°/min and the the capability of promptly transmitting to ground the trigger time and position of GRBs (and other transients of interest).

ECLAIRs: a hard X-ray coded-mask imaging and trigger telescope onboard SVOM.

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ECLAIRs is the hard X-ray coded-mask imaging and trigger telescope that will fly onboard the Sino-French mission SVOM at the beginning of the next decade. We present the main characteristics of the instrument, its operation on-board SVOM, and its expected scientific performance. The description of the instrument is complemented with in-serts showing the measured performance of various instrumental subsystems that are currently under realization.

THE AUTOMATIZED DETECTOR WEIGHT OPTIMIZATION (ADWO) METHOD FOR SEARCHING WEAK ELECTROMAGNETIC COUNTERPARTS OF GRAVITATIONAL WAVES. Zsolt Bagoly[1], Istvan Horvath[2], Dorottya Szecsi[3], Lajos G. Balazs[1,4], Istvan Csabai[1], Laszlo Dobos[1], Janos Lichtenberger[1,5], L. Viktor Toth[1], [1]Eotvos University, Budapest, Hungary, zsolt.bagoly@elte.hu [2]National University of Public Service, Hungary Horvath.Istvan@uni-nke.hu, [3]Argelander-Institut fur Astronomie der Universitat Bonn, Germany, [4]Konkoly Observatory, RCAES, Hungarian Academy of Sciences, Hungary , [5]Geodetic and Geophysical Institute, RCAES, Hungarian Academy of Sciences, Hungary.

Introduction: We developed Automatized Detector Weight Optimization (ADWO) method[1], a detector analysis tool for multi-channel multi-detector signals for looking electromagnetic transients in a given time interval. ADWO method combines the data of all available detectors and energy channels, identifying those with the strongest signal. This way, is able to separate potential events from the background noise and gives the statistical probability of a false alarm. ADWO works the best if the trigger time is given, therefore it is ideal to search for electromagnetic counterparts of gravitational wave events. In addition, with a sliding search window it is possible to apply ADWO to look for missed triggers, e.g. non-triggered short gamma-ray bursts (SGRBs)[2].

Automatized Detector Weight Optimization: Here we generalize the Detector Response Matrix and our goal is to find the strongest weights and the best time position in this interval using a weighted signal from the multi-detector multi-channel continuous data. We give different weights to different energy channels (e_i) and detectors (d_j), and optimize the Signal's Peak to Background's Peak Ratio (SPBPR). The weights are positive and normalized to 1. If the background subtracted intensity in the jth detector's ith energy channel is $C_{ij}(t)$, we define our composite signal as $S(t)=\Sigma_{i,j}e_i d_j C_{ij}(t)$. The Signal's Peak is the maximum of S(t) within the given time interval, and the Background's Peak is the maximum of S(t) outside this interval. The best weights will maximize the ratio of these two maximums.

We used all the 12 NaI(Tl) and both BGO Fermi GBM detectors in the analysis, the CTTE 2μs data were grouped with energy limits of 27, 50, 100, 290, 540, 980 and 2000 keV (e3-e8, resp.). The event data was filtered with a 64ms wide moving average filter at 1ms steps, while a 6th order polynomial background fit was subtracted. The weights were optimized by Matlab/Octave's fminsearch to provide the maximum SPBPR.

To determine the significance we generated a Poisson-distributed synthetic signal, and repeated ADWO for 10000 Monte-Carlo (MC) simulations with the same time window.

From a theoretical point of view, electromagnetic counterparts such as short duration gamma-ray bursts associated with GW events are not excluded [3,4]. As our ADWO method is independently developed, and only relies on the raw data of the satellite, it can provide a strong, independent test to any future signal.

GRB150522B: the CTTE data of (-137,476) is analyzed with a 6s window. ADWO gave SPBPR=3.12, and from the MC simulation we estimate the false alarm probability to be below $2.8 \cdot 10^{-5}$, analogously to [5].

GW150914 [6]: Here we investigate a 684 s time background interval that adds up as 195s before and 495s after the time of the possible event. ADWO has converged and obtained the maximal SPBPR of 1.911, 474 ms after the GW trigger. The MC simulations gave a false alarm probability of 0.0075, which is higher than 0.0022, the value given by [5,7].

LVT151012 [6]: The (-195,495) s interval with a 6s signal window were used. ADWO gave a SPBPR of 1.805, from the MC simulations the false alarm probability is estimated to be 0.037. No TGF candidates (storm activity) was found within 500km of the spacecraft position and +-900s around the peak.

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Searches for joint sources of gravitational waves and high energy neutrinos with the ANTARES neutrino telescopes and gravitational waves interferometers. B. Baret[1] on behalf of the ANTARES collaboration, [1]Laboratoire Astroparticule et Cosmologie, 10 Rue Alice Domon et Léonie Duquet, 75013 Paris, France

Cataclysmic cosmic events can be plausible sources of both gravitational waves (GW) and high energy neutrinos (HEN), alternative cosmic messengers carrying information from the innermost regions of the astrophysical engines. Possible sources include long and short gamma-ray bursts (GRBs) but also low-luminosity or choked GRBs, with no or low gamma-ray emissions.

The ANTARES Neutrino Telescope can determine accurately the time and direction of high energy neutrino events, and the Virgo/LIGO network of gravitational wave interferometers can provide timing/directional information for gravitational wave bursts. Combining these informations through GW+HEN coincidences provides a novel way of constraining the processes at play in the sources, and also enables to improve the sensitivity of both channels relying on the independence of backgrounds of each experiment.

We will describe the joint GW+HEN searches performed using data taken with the ANTARES telescope from the initial searches with first common data taking period to the follow-up of the detected events GW150914 and GW151226 of the first scientific run of Ligo.

An anisotropic minijets model for the GRB prompt emission. Rodolfo Barniol Duran[1], Mingbin Leng[2] and Dimitrios Giannios[1], [1]Department of Physics and Astronomy, Purdue University, 525 Northwestern Avenue, 47907 West Lafayette, IN, USA, [2]Department of Physics, Brown University, 02912 Providence, RI, USA.

Introduction: In order to explain the rapid light-curve variability of the gamma-ray burst (GRB) prompt emission, several authors have proposed the presence of "minijets" that move relativistically relative to the main flow of the jet, e.g., [1,2]. The minijets appear as the jet dissipates its energy at a large emission radius, and produce a variable light curve without the need of a variable central engine.

In the simplest model, these minijets are distributed isotropically in the comoving frame of the jet. We consider the possibility that minijets form primarily perpendicular to the direction of the flow, as magnetohydro-dynamical instabilities responsible for dissipation in the jet may favor layers perpendicular to the jet propagation [3].

This simple yet realistic modification yields two robust features (discussed in the context of the afterglow emission by, e.g., [4]). (1) The prompt emission is significantly delayed compared with the isotropic case. This delay allows for the peak of the afterglow emission (ascribed to the external shock) to appear during the prompt phase, in contrast to the simplest isotropic minijets model, where the afterglow peak appears at or after the end of the prompt phase. (2) The decay of the prompt emission light curve at the end of this phase is steeper than the isotropic case. We find that these two features are realized in GRB observations. (1) The peak of most GeV light curves (likely produced in the external shock, e.g, [5]) appears during the prompt emission phase. (2) Many early X-ray light curves exhibit a steep decay phase, which is steeper than that predicted by the standard isotropic case. The gamma-ray generation mechanism in GRBs, and possibly in other relativistic flows, may therefore be anisotropic.

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RADIATIVE STRIPED WIND MODEL FOR GAMMA-RAY BURSTS. D. P. Bégué[1], A. Pe'er[2] and Y. Lyubarski[3], [1]KTH Royal Institute of Technology (AlbaNova University Center, SE-106 91 Stockholm, Sweden, damienb@kth.se), [2]University College Cork (Cork, Ireland, a.peer@ucc.ie), [3]Ben-Gurion University (P.O.B 653, Beer-Sheva 84105 Israel, lyub@bgu.ac.il).

Introduction: Striped winds are expected to be produced by the central engine of gamma-ray bursts, provided that they are highly magnetized. I will discuss a model of the striped wind in which radiation is treated as an independent hydrodynamic component. I will show how different assumptions on the distribution of radiation within the striped wind change the dynamics and the evolution of the density, magnetic field and temperature. Finally, I will discuss the implications of this model for the physics of gamma-ray bursts.

SCIENTIFIC PROSPECTS FOR SPECTROSCOPY OF THE GRB PROMPT EMISSION WITH SVOM.
M. G. Bernardini[1], F. Piron[1], J.-L. Atteia[2], P. Sizun[3], Y. Dong[4], F. Xie[4], and B. Cordier[3], [1]LUPM, Montpellier, France (bernardini@lupm.in2p3.fr, piron@lupm.in2p3.fr) [2]IRAP, Toulouse, France (Jean-Luc.Atteia@irap.omp.eu) [3]CEA, Saclay, France (patrick.sizun@cea.fr, bertrand.cordier@cea.fr) [4]IHEP, Beijing, China (dongyw@ihep.ac.cn, xief@ihep.ac.cn).

SVOM (Space-based multiband astronomical Variable Objects Monitor) is a Chinese-French space mission dedicated to the study of Gamma-Ray Bursts (GRBs) in the next decade, capable to detect and localize the GRB emission and follow its evolution in the high-energy, visible and NIR band, and in X-rays. The satellite carries two wide field high energy instruments: a coded-mask gamma-ray imager (ECLAIRs; 4-150 keV), and a gamma-ray spectrometer (GRM; 15-5500 keV) that, together with the ground-based wide angle cameras (GWAC; 500-850 nm), will be extremely valuable to fully characterize the GRB spectral shape over a wide energy range. We describe how the excellent performance of the ECLAIRs and GRM instruments, in particular the low energy threshold of 4 keV and the high sensitivity at MeV energies, will permit to provide direct insights on the physical mechanisms responsible for the prompt emission at high energy by constraining its spectral parameters with good precision. In addition, we show how these two instruments will be particularly useful to identify possible blackbody components in the prompt emission spectrum, and to constraint the spectral shape of short GRBs with extended emission.

TESTING THE ENERGY DEPENDENCY OF THE SPECTRAL LAG OF GRBS WITH FERMI/GBM AND LAT. M. G. Bernardini[1], F. Piron[1], J. Bregeon[1], on behalf of the Fermi LAT collaboration, [1]LUPM, Montpellier, France (bernardini@lupm.in2p3.fr, piron@lupm.in2p3.fr, johan.bregeon@lupm.in2p3.fr).

We present the analysis of the the rest frame spectral lag of a sample of GRBs detected by both Fermi/GBM and LAT and its dependency upon the energy. The wide energy coverage of these two instruments (8 keV - 40 MeV and > 20 MeV, respectively) allows us to characterize phenomenologically the energy dependence of the spectral lag up to very high energy, where an additional component to the prompt emission spectrum is occasionally observed. We discuss our results in the framework of the internal shock scenario and we use the spectral lags at keV-MeV energies as a diagnostic to identify the gamma-ray radiation processes and to distinguish among different configurations for the jet microphysics.

Detecting fainter short GRBs with the Fermi Gamma-ray Burst Monitor. M. S. Briggs[1], Rachel Hamburg[1], Peter Veres[1], Eric Burns[1], C. M. Hui[2], Valerie Connaughton[3], and Adam Goldstein[3], [1]The Center for Space Plasma and Aeronomic Research (CSPAR) and the Department of Space Science at The University of Alabama in Huntsville (Michael.Briggs@uah.edu), [2]NASA/MSFC, [3]USRA.

To support multi-wavelength and multi-messenger observations, the Fermi GBM team has developed two methods to detect short GRBs that are below the threshold for detection in orbit. Here we report on the undirected search, which automatically fits a background model to the GBM Continuous Time-Tagged Event (CTTE) data and scans for excess signals simultaneously present in multiple detectors. In contrast to the other technique, the search does not use information from detections from other instruments and searches all times and directions. The data is binned and searched for excesses on timescales from 64 ms to 32 s. The primary goal is to expand the GBM short GRB sample, providing other instruments with low-latency detections to correlate with their data. In particular, short GRBs are most likely cause by mergers of binary neutron stars, which are also sources of gravitational waves that are likely to be detected with LIGO and Virgo. A rapid detection of a sGRB might enable the detection of a weak gravitational wave signal or improve the localization, thereby increasing the chance of detections in other wavelengths. Secondary goals are to detect faint, long GRBs and non-GRB short transients. The first version of the search, running since January, has provided several sGRB candidates per month that are published at http://gammaray.nsstc.nasa.gov/gbm/science/sgrb_search.html. An improved version of the search will have lower latency for detections by further automation of the analysis and process, and will have additional algorithms to improve the sensitivity and sGRB detection rate.

A Bayesian Analysis of The Golenetskii Relation. J. Michael Burgess[1] [1]KTH Royal Institue of Technology (Stockholm, Sweden jamesb@kth.se)

Introduction: Gamma-ray bursts (GRBs) are characterized by a strong correlation between the instantaneous luminosity and the spectral peak energy within a burst. This correlation, which is known as the hardness-intensity correlation or the Golenetskii correlation, not only holds important clues to the physics of GRBs but is thought to have the potential to determine redshifts of bursts. I use a hierarchical Bayesian model to study the universality of the rest-frame Golenetskii correlation and in particular I assess its use as a redshift estimator for GRBs. I find that, using a power law prescription of the correlation, the power law indices cluster near a common value, but have a broader variance than previously reported ($\sim 1-2$). Furthermore, I find evidence that there is spread in intrinsic rest-frame correlation normalizations for the GRBs in our sample ($\sim 10^{51} - 10^{53}$ erg/s). This points towards variable physical settings of the emission (magnetic field strength, number of emitting electrons, photospheric radius, viewing angle, etc.). Subsequently, these results eliminate the Golenetskii correlation as a useful tool for redshift determination and hence a cosmological probe. Nevertheless, the Bayesian method introduced in this work allows for a better determination of the rest frame properties of the correlation, which in turn allows for more stringent limitations for physical models of the emission to be set.

The Multi-Mission Maximum Likelihood Framework (3ML). J. Michael Burgess[1] Giacomo Vianello[2] [1]KTH Royal Institue of Technology (Stockholm, Sweden jamesb@kth.se) [2]Stanford University (Stanford, CA giacomov@stanford.edu)

Introduction: The age of multi messenger astronomy has arrived and with it, new tools are needed to properly analyze data from multiple instruments. The Multi-Mission Maximum Likelihood framework (3ML) provides this functionality via the novel use of instrument plugins which allow for every instrument's unique data to be treated independently with an appropriate likelihood. Under the 3ML framework, users can design plugins that handle instrument specific data routines transparently in the background. When multiple instruments are used together, their independent likelihoods are treated under a common minimization or Bayesian sampling framework. 3ML provides a multitude of minimization algorithm for maximum likelihood estimation (MLE) as well as several popular Bayesian posterior samplers. The entire framework is provided via a modern Python interface that allows of easy parallel implementation providing the user with a fast, modern, and easily transportable analysis framework well suited for multi-messenger astronomy. We demonstrate the frame work with a simple joint fit of Fermi GBM and LAT data that properly utilizes the likelihood of each instrument.

Awakening the BALROG: A new paradigm in GRB spectral analysis and localization. J. Michael Burgess[1] , H. Yu[2] and J. Greiner[2], [1]KTH Royal Institue of Technology (Stockholm, Sweden jamesb@kth.se), [2] Max Planck Institute for Extraterrestrial Physics (Garching, Germany).

Introduction: As we enter the era of multi-messanger astronomy with gamma-ray burst (GRBs) via Swift/iPTF/ZTF, gravitational waves from ALIGO/Virgo, and astrophysical neutrinos from IceCube, the Fermi Gamma-ray Burst Monitor (GBM) plays a crucial role in both localizing gamma-ray emission, most notably from GRBs, as well as determining their spectra. We introduce a new paradigm, called the Bayesian Location Reconstruction of GRBs (BALROG) to this process that both accurately localizes GRBs as well as properly introduces the variance in location to the spectral likelihood. Through a reanalysis of well localized GRBs detected by both GBM and Swift, we demonstrate the ability of the BALROG to practically remove the systemactics in GBM localizations. Additionally, we reanalyze GRB 080916C including the variance in location and find that the reduced location freedom helps to reject models and that complex multi-component spectra are not required to explain the data.

EXPECTATIONS FOR JOINT GRAVITATIONAL WAVE-ELECTROMAGNETIC DETECTIONS WITH ADVANCED LIGO/VIRGO AND THE FERMI GAMMA RAY BURST MONITOR. E. Burns[1], V. Connaughton[2], M. S. Briggs[3], A. Goldstein[2], R. Hamburg[3], and T. Littenberg[2]; [1]University of Alabama in Huntsville, 320 Sparkman Dr., Huntsville, AL 35899, USA (eb0016@uah.edu), [2]Universities Space Research Association, 320 Sparkman Dr. Huntsville, AL 35806, USA, [3]Department of Space Science, University of Alabama in Huntsville, 320 Sparkman Dr., Huntsville, AL 35899, USA

Introduction: With the first detection of gravitational waves (GWs) we can now look for the joint detection of a single event with both gravitational waves and electromagnetic (EM) radiation. The merging of two neutron stars is thought to cause both short gamma-ray bursts (GRBs) as well as signature GW radiation. Owing to its large field of view, high uptime, spectral and temporal information, and localization ability, the Fermi Gamma-ray Burst Monitor (GBM) is the instrument most likely to detect and prove EM emission from an Advanced LIGO/Virgo source.

Using the observed Swift short GRB redshift distribution we predict the rate of GBM short GRBs that are detectable by Advanced LIGO/Virgo, assuming neutron star-neutron star mergers. We also discuss the expected fraction of GW skymaps visible by GBM and the improvement in location achieved by combining the separate localizations together.

TIME RESOLVED STUDIES OF BRIGHT SHORT GAMMA RAY BURSTS IN THE FERMI GAMMA RAY BURST MONITOR. E. Burns[1], V. Connaughton[2], R. Preece[3], and A. Goldstein[2], [1]University of Alabama in Huntsville, 320 Sparkman Dr., Huntsville, AL 35899, USA (eb0016@uah.edu), [2]Universities Space Research Association, 320 Sparkman Dr. Huntsville, AL 35806, USA, [3]Department of Space Science, University of Alabama in Huntsville, 320 Sparkman Dr., Huntsville, AL 35899, USA

Introduction: To inform our understanding of short gamma-ray bursts (GRBs) in the gravitational wave era we investigated the temporal structure and spectral properties of the brightest short GRBs detected by the Fermi Gamma-ray Burst Monitor (GBM). GBM is the most prolific, active detector of short GRBs with a large field of view and broad energy range. Here we present preliminary results on using a Bayesian Block representation of the individual photon (time-tagged event) data, we split the burst emission into separate intervals to perform spectral analysis using PGstat. Additionally, we search for possible precursor and extended emission in short GRBs which is traditionally difficult in GBM as it is a background dominated experiment.

Multi-messenger light curves from gamma-ray bursts. M. Bustamante[1], [1]Center for Cosmology and AstroParticle Physics (CCAPP) and Department of Physics, The Ohio State University, Columbus, OH 43210, bustamanteramirez.1@osu.edu

Gamma-ray bursts (GRBs) have long been considered potential sources of high-energy (> 100 TeV) neutrinos and ultra-high-energy (> 10^9 GeV) cosmic rays (UHECRs). They are promising point-source targets to look for correlated high-energy electromagnetic and neutrino emission, and may be the sources of UHECRs. The lack of correlation between neutrino arrival directions and the positions and times of known GRBs has motivated revisions of the joint multi-messenger emission mechanism in GRBs – gamma rays, UHECRs, and neutrinos. By embedding said mechanism in a simulation of multiple internal collisions within a GRB jet, we obtain a robust prediction of a minimal diffuse GRB neutrino flux, likely within reach of the planned detectors. Our simulations generate realistic, synthetic gamma-ray light curves, with features that reflect the behavior of the central engine. By looking for specific features in the light curve – broad time-pulses and time delays between energy bands – one can assess whether a particular GRB is likely to be an intense neutrino emitter. Our results could be exploited in targeted GRB neutrino searches to cull a catalog of GRBs that are likely to be strong neutrino sources.

THE OBSERVER'S GUIDE TO THE GAMMA-RAY BURST-SUPERNOVA CONNECTION

Zach Cano

In this invited talk I will give an up-to-date progress report of the connection between long-duration (and their various sub-classes) gamma-ray bursts (GRBs) and their accompanying supernovae (SNe). The talk will be presented from the point of view of an observer, with much of the emphasis placed on how observations, and the modelling of observations, have constrained what we known about GRB-SNe. As such, I will discuss their photometric and spectroscopic properties, their role as cosmological probes, including their measured luminosity-decline relationships, and how they can be used to measure the Hubble constant. I will present a statistical analysis of their bolometric properties, and use this to determine the properties of the "average" GRB-SNe. I will briefly discuss their geometry, as constrained from observations, and what conclude with what we think powers the luminosity of GRB-SNe, and whether differences exist between GRB-SNe and ULGRB-SNe such as 111209A/SN2011kl.

GRB'S AND OTHER VHE TRANSIENTS WITH MAGIC

A. Carosi and L. Angelo Antonelli (INAF - Astronomical Observatory of Rome AND ASDC)

Cosmic photons at energies > 10 GeV offer a powerful probe of the underlying physical mechanisms of cosmic explosions, and a tool for exploring fundamental physics with these systems also in a multi-messenger context. In this talk I will present the motivations for high-energy observations of transients, the current situation with respect to the MAGIC telescope, and the prospects for the next decade, with particular reference to the major next-generation high-energy observatory CTA.

Monte Carlo simulations of radiative acceleration of jets. Atul Chhotray[1] and Davide Lazzati[2], [1,2]Department of Physics, Oregon State University, Corvallis OR 97331 USA, E-mail[1]: chhotraa@oregonstate.edu.

Introduction: The GRB paradigm primarily revolves around the idea that outflows producing radiation are ultra-relativisitic in nature and attain Lorentz factors ~ 100+. Radiation and/or magnetic fields are believed to be responsible for jet acceleration, however the details of how the jet accelerates and attains speeds close to the speed of light are not well understood. In this work we demonstrate using first principles the effect of radiation on jet acceleration. We present Monte Carlo simulations where we self-consistently evolve a jet via Compton scattering and show the scattering induced radiative acceleration and relativistic expansion. We compare our results with the fireball model of GRBs and discuss several quantities of interest that can be obtained from the code (e.g. light curves, spectra).

MULTI-MESSENGER OBSERVATIONS OF GRBS IN THE MAGNETAR SCENARIO. R. Coyne[1] and A. Corsi[1] and B. J. Owen[1], [1]Department of Physics, Texas Tech University, Lubbock, Texas 79409-1051, USA, rob.coyne@ttu.edu.

Introduction: The progress made in our understanding of gamma-ray bursts (GRBs) since the discovery of their afterglows has been spectacular. Despite this, direct proof of GRB progenitors is still missing. Over the last several years evidence for a long-lived and sustained central engine in GRBs has mounted. This has called attention to the so-called millisecond-magnetar model, which proposes that a highly magnetized, rapidly-rotating neutron star may exist at the heart of some of these events. And with the recent ground-breaking detection of gravitational waves (GWs) by Advanced LIGO, we stand on the cusp of a new era in multimessenger astronomy in which we may finally be able to probe directly the nature of GRB progenitors and their byproducts.

In this context, we describe a novel application of a generalized cross-correlation technique [1,2] optimized for the detection of a new class of "intermediate-duration" GW signals (up to 10^4 s), including those that may be associated with bar-like deformations of GRB magnetars. Previous GW searches have targeted transient events such as these [3,4], but the work presented here is amongst the first designed *specifically* with intermediate-duration signals in mind. The detection of these GW signals in coincidence with GRBs would allow us to answer some of the most intriguing questions on the nature of the progenitors, and serve as a starting point for a new class of GW searches.

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SHORT GRB PROPERTIES AND RATE IN THE GRAVITATIONAL WAVE ERA. P. D'Avanzo[1], G. Ghirlanda[1], [1]INAF-Osservatorio Astronomico di Brera, via Bianchi 46, 23807, Merate (LC), Italy (paolo.davanzo@brera.inaf.it, giancarlo.ghirlanda@brera.inaf.it).

The SBAT4 is a carefully selected sample of short gamma-ray bursts (SGRBs) observed by the Swift satellite. The sample, consisting now of 27 SGRBs, is complete in flux and has the highest completeness in redshift with respect to the SGRB samples presented in the literature to date. Being free of selection effects (except for the flux limit), this sample provides a robust base for the study of the energetics, redshift distribution and environment of the Swift population of SGRBs. For all the events of the sample, we derive the prompt and afterglow emission rest-frame properties and test the consistency with the correlations valid for long GRBs. Using all the available observer-frame constraints of the large population of Fermi SGRBs and the rest-frame properties of the SBAT4 sample, we derive the luminosity function and redshift distribution of SGRBs. These constraints are satisfied for a relatively flat luminosity function and a redshift distribution of SGRBs peaking at z~1.5-2. We estimate that, within ~200 Mpc horizon for the detection of GW produced by NS-NS merger events by aLIGO/Virgo, 0.007-0.03 SGRBs yr^{-1} should be detectable as gamma-ray events. Assuming current estimates of NS-NS merger rates and that all NS-NS mergers lead to a SGRB event, we derive an estimate of the average opening angle of SGRBs of theta_jet~9-17 deg. Our luminosity function implies an average luminosity nearly two orders of magnitude higher than previous findings, which greatly enhances the chance of observing SGRB "orphan" afterglows. Efforts should go in the direction of finding and identifying such orphan afterglows as counterparts of GW events.

CLUES FROM THE HOST GALAXIES OF THE SWIFT/BAT6 COMPLETE SAMPLE OF LONG GRBS.
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Gamma-ray bursts (GRBs) allow galaxies to be selected independently of their brightnesses and dust content at any wavelength. The association of Long GRBs (LGRBs) with the death of massive stars, makes this class of GRBs a tool to understand the evolution of star-formation and galaxies, complementary to current galaxy surveys, up to the highest redshifts. However, the progenitor star conditions necessary to produce LGRBs can affect the relation between the LGRB rate and star formation. In order to properly use LGRBs as an independent probe of galaxy and star formation evolution across the Universe, we must use complete samples of GRBs to determine the LGRB rate - SFR efficiency. I will present the results of our photometric and spectroscopic studies on the z<2 host galaxy properties (stellar masses, star-formation rates, metallicities) of the Swift/BAT6 complete sample of LGRBs. We investigate the factors affecting the LGRB rate - SFR efficiency and we constrain LGRB progenitor models. The use of the BAT6 complete sample makes these results not affected by possible biases that could influence past results based on incomplete samples.

MHD simulations of collision-induced magnetic reconnection in Poynting-flux-dominated jets and a unified interpretation of polarization properties of GRBs and blazars. Wei Deng[1,2], Bing Zhang[1], Hui Li[2], Haocheng Zhang[2], and Shengtai, Li[2]. [1]Department of Physics and Astronomy, University of Nevada Las Vegas, Las Vegas, NV 89154, USA, deng@physics.unlv.edu, [2]Los Alamos National Laboratory, Los Alamos, NM 87545, USA.

Introduction: The energy composition in the jet/outflow of astrophysical systems is an important and fundamental question. Recently, the collision-induced magnetic reconnection and dissipation models in the Poynting-flux-dominated (PFD) environment become more attractive to overcome some criticisms in the traditional matter-flux-dominated (MFD) models and interpret new observations. Here, we perform 3D relativistic MHD simulations to study the collisions between high-sigma (PFD) blobs to mimic the above considerations. Our results strongly support these considerations from the energy dissipation efficiency (> 35%) and the mini-jets generation point of view [1]. On the other hand, polarization observation is another important and independent information to constrain the energy environment and physical models. Here we study the polarization feature based on the magnetic field evolution from our above simulations, and find that the same numerical model with different input parameters can reproduce well the observational data of both GRBs and blazars [2], especially the 90 degrees polarization angle (PA) change in GRB 100826A (Fig. 2) and the 180 degrees PA swing in Blazar 3C279 (Fig. 3). This supports a unified model for GRB and blazar jets, suggesting that collision-induced magnetic reconnection is a common physical mechanism to power the relativistic jet emission from events with very different black hole masses.

Figures:

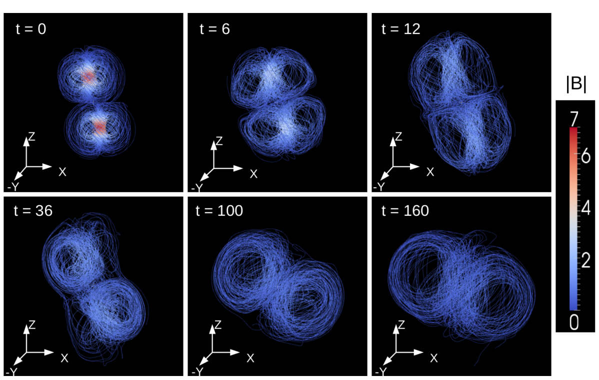

Figure 1- The evolution of the field lines during the collision-induced magnetic reconnection process. The two blobs merge into one larger blob (extracted from [1] Deng et al. 2015, ApJ).

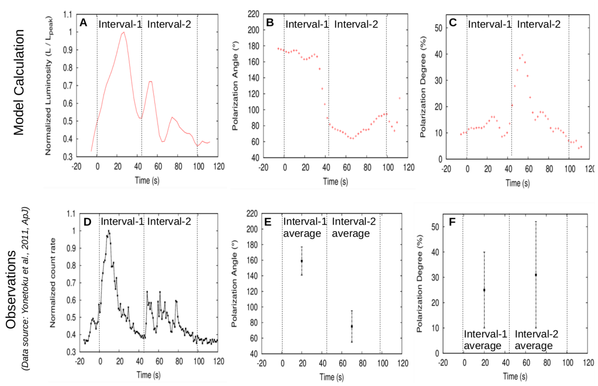

Figure 2- Comparison between our results and the observations of GRB 100826A in 70-300 KeV energy band (extracted from [2] Deng et al. 2016, ApJL). Following observational features are successfully reproduced from our model: 1. multiple global pulses; 2. the 90° change of polarization angle between the two intervals of the light curve; and 3. the trend of increasing polarization degree between the two intervals.

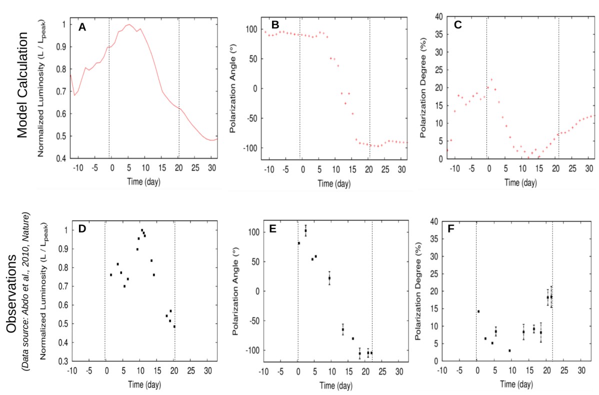

Figure 3- Comparison between our results and the observations of Blazar 3C279 in R band (extracted from [2] Deng et al. 2016, ApJL). Following observational features are successfully reproduced from our model: 1. single broad pulse light curve with a lower background after the flare; 2. 180° polarization angle swing; and 3. nearly zero polarization degree around the flare's peak time (t ~10 days).

References:

[1] Deng, W. et al. (2015), ApJ, 805, 163.
[2] Deng, W. et al. (2016), ApJ, 821, L12.

THE 80 MS FOLLOW UP OF THE X-RAY AFTERGLOW OF GRB 130427A: CONSEQUENCES FOR THE PROPOSED MODELS AND THE FORWARD SHOCK SCENARIO.

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Abstract: GRB 130427A was the brightest gamma-ray burst detected in the last 30 years. It had an isotropic energy output of 8.5×10^{53} erg and redshift of 0.34, blending very high energetics with a relative proximity to Earth in an unprecedented way.

In this presentation, we show the results of observations of the X-ray afterglow carried out by sensitive X-ray observatories such as XMM-Newton and Chandra over a record-breaking baseline longer than 80 million seconds. We find that the light-curve displays a simple power-law over more than three decades in time.

We also explore the consequences of this result for a few models proposed to interpret GRB 130427A, analyzing separately the models in stellar wind and constant density medium. More generally, we discuss the implications in the context of the standard forward shock model.

Finally, we illustrate how the X-ray afterglow of 130427A will still be detectable by present observatories for a few years to come, and by new generation X-ray facilities such as Athena in the late 2020's. Such observations will greatly contribute to shed light further on the Physics of GRBs.

SEARCH FOR HIGH ENERGY NEUTRINO FROM GRBs WITH THE ANTARES TELESCOPE. D. Dornic[1] on behalf the ANTARES Collaboration, [1]Aix-Marseille Université, CNRS/IN2P3, CPPM UMR 7346, 13288 Marseille, France (dornic@cppm.in2p3.fr).

Introduction: ANTARES is the largest neutrino telescope in the Northern hemisphere primarily sensitive to astrophysical neutrinos in the TeV-PeV energy range and completely operational since 2008. Gamma-Ray Bursts (GRBs) are still promising targets since neutrinos may be produced in the interactions of cosmic rays in the jets during the prompt emission of the burst. Multi-messenger programs offer a unique opportunity to detect these transient sources. The results of time-dependent searches for high-energy neutrinos with the detected gamma-ray emission are presented for the brightest observed GRBs. Since no events have been detected in time and space coincidence with these bursts, upper limits on the expected neutrinos fluxes are derived. Such non detections allow us to directly constrain some parameters used in the modelisation of the neutrino emission, as the bulk Lorentz factor and the baryon loading of the jet.

In addition, real-time analysis based on the follow-up of high-energy neutrino alerts are in operation since 2009. This program triggers optical, x-ray, radio and gamma-ray telescopes within a delay of few seconds after the neutrino detection. By combining the information provided by the ANTARES neutrino telescope with information coming from other observatories, the probability of detecting a source is enhanced, allowing the possibility of identifying a neutrino progenitor from a single detected event. No optical, x-ray or radio counterparts associated to the neutrino triggers have been identified. The derived upper limits permit to compute the probability to reject the GRB origin hypothesis for individual neutrinos.

OPTIMIZED SYNERGY BETWEEN SPACE AND GROUND INSTRUMENTS IN THE SVOM MISSION.

D. Dornic[1] on behalf the SVOM Consortium, [1]Aix-Marseille Université, CNRS/IN2P3, CPPM UMR 7346, 13288 Marseille, France (dornic@cppm.in2p3.fr).

Introduction: SVOM (Space-based multi-band astronomical Variable Objects Monitor) is a Chinese-French space mission dedicated to the study of Gamma-Ray Bursts (GRBs) in the next decade. The SVOM mission encompasses a satellite carrying four instruments to detect and localize the prompt GRB emission and measure the evolution of the afterglow in the visible band and in x-rays, a VHF communication system enabling the fast transmission of SVOM alerts to the ground, and a ground segment including wide angle cameras and two dedicated follow-up telescopes. The robotic telescope in San Pedro Mártir Observatory will be equipped with two visible and one NIR arms to study the panchromatic evolution of the afterglow and to identify GRBs with very high-redshift.

The pointing strategy of the satellite is optimized to favor the detection of GRBs located in the night hemisphere which enables the study of the optical emission in the first minutes after the GRB with robotic observatories and the early spectroscopy of the optical afterglow with large telescopes to measure the redshifts. We will present in this contribution this space/ground synergy, one of the key of success for the scientific return of the mission together with the three dedicated ground instruments.

Electron and Ion Acceleration in Relativistic and Trans-Relativistic Shocks.

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Abstract: We describe models of nonlinear Fermi shock acceleration of ions and electrons by relativistic and trans-relativistic shocks. Using a Monte Carlo technique that determines the absolute normalization of the particle distributions, we are able to calculate the resulting synchrotron, inverse-Compton, and pion-decay emission in an internally self-consistent manner. By varying the overall acceleration efficiency, we show that nonlinear effects from efficient ion acceleration can influence the accelerated electron to proton ratio in a non-monotonic fashion, i.e., less efficient proton acceleration can result in more efficient electron acceleration. We believe this is the first time such an effect has been noted. The Monte Carlo simulation is computational fast and flexible and can be used with a wide range of parameters typical of gamma-ray burst (GRB) afterglows and trans-relativistic shocks in supernova remnants.

THE ORIGIN, DEVELOPMENT, AND LAUNCH OF BATSE. Gerald (Jerry) Fishman, NASA-MSFC (Ret.) and Univ. Ala. in Huntsville, ZP12, NASA-MSFC, Huntsville, AL 35812, fishmgj@gmail.com and Jerry.Fishman@msfc.nasa.gov.

Abstract: The initial observations of GRBs with large-area crystal scintillation detectors were made with a series of balloon flight observations conducted by NASA-MSFC investigators in the mid-1970s.

An announcement of opportunity to propose for instruments as part of a large gamma-ray observatory (GRO) was released in 1977.

A proposal was developed by the MSFC group for an all-sky monitor of GRBs using detectors that were of a similar type and size as the balloon-detectors previously flown. They would be space-qualified and would use a much more versatile and redundant data system. Smaller, but thicker spectroscopy detectors were added a few years later in order to extend the energy response to higher energies and to have better energy resolution than the large-area detectors.

Development of the BATSE detectors, flight instrumentation, and the GRO space-craft took over ten years. The shuttle flight to carry and deploy GRO was also delayed due to the shuttle hiatus following the Challenger accident in 1986.

The Gamma-Ray Observatory was finally launched in April 1991 from the Space Shuttle *Atlantis*, as the second Great Observatory, following the Hubble Space Telescope a year earlier. It was re-named the Compton Gamma-Ray Observatory when it became operational a month later.

Some details of the BATSE design, development and capabilities that are little-known to the younger generation of GRB investigators will be described.

THE NATURE OF THE LARGELY UNBREAKABLE LAT BURSTS Andrew Fruchter[1], Benjamin Gompertz[1], Kuntal Misra[2], Asaf Pe'er[3]. Rebekah Hounsell[1,4], Brad Cenko[5], Judith Racusin[5], Antonino Cucchiara[1,5] et al., [1]Space Telescope Science Institute, [2]Aryabhatta Research Institute of Observations Sciences, [3]University College Cork, [4]University of Illinois, [5]Goddard Space Flight Center

We have used *Chandra, HST* and the VLA to observe a sample of extremely energetic gamma-ray bursts (E_{iso} > 5x10^{53} erg) detected by the Large Area Telescope (LAT) on the *Fermi* satellite. In a large fraction of cases the burst afterglows show no sign of a jet-break as long as we have been able to follow them (between months and years after outburst). This implies the bursts generally possess great true total energies (~ 10^{52} erg) and often go off in very tenuous media. Indeed, a study of the early afterglows of the entire LAT sample shows that in the majority of cases these bursts are found in a medium with a wind profile, rather than an ISM, and the density of the wind is often dramatically below levels that have typically been expected of LGRB progenitors. It is this characteristic which may largely be responsible for the unbreakable nature of so many LAT bursts.

Spectral Lags from Photon Flux Lightcurves of Bright GBM GRBs A. Goldstein[1] and N. Bhat[2], [1]Universities Space Research Association, 320 Sparkman Dr. Huntsville, AL 35806, USA, [2]University of Alabama in Huntsville, 320 Sparkman Dr., Huntsville, AL 35899, USA.

Introduction: A known observation of GRB lightcurves is that the low energy lightcurve of a GRB tends to lag behind the higher energy lightcurve. Additionally, this lag has been observed to evolve as a function of energy. Numerous physical explanations have been proposed to explain this observation, including the behavior of the propagating jet kinematics, internal shock cooling, and hydrodynamic or magnetic variations. Current methods use the GRB count rate lightcurves, which makes the interpretation of results more difficult because they ignore the detector physics modeled in the detector response. Furthermore, different spectral components (e.g., photospheric and non-thermal) are not considered when studying the lag. For these reasons, we study a sample of the brightest GRBs that have been observed by GBM and perform a time-resolved spectral analysis using different spectroscopic functions. This results in deconvolved photon flux lightcurves which are then investigated for spectral lag. In this way, we study the spectral lags of GRBs and determine the evolution of different components with energy.

GBM Observations of GW150914 A. Goldstein[1], V. Connaughton[1], E. Burns[2], L. Blackburn[3] [1]Universities Space Research Association, 320 Sparkman Dr. Huntsville, AL 35806, USA, [2]University of Alabama in Huntsville, 320 Sparkman Dr., Huntsville, AL 35899, USA, [3]Harvard-Smithsonian Center for Astrophysics, 60 Garden St, Cambridge, MA 02138, USA

Introduction: We report on the GBM observations and analysis of a weak, short transient found ~0.4 s after the first LIGO gravitational wave trigger GW150914.

Title: The Fastest Fermi GRBs

V. Z. Golkhou, N. R. Butler, O. M. Littlejohns

Abstract:
We constrain the minimum variability timescales for 938 GRBs observed by the Fermi/GBM instrument prior to July 11, 2012. The tightest constraints on progenitor radii derived from these timescales are obtained from light curves in the hardest energy channel. In the softer bands -- or from measurements of the same GRBs in the hard X-rays from Swift -- we show that variability timescales tend to be a factor 2--3 longer. Applying a survival analysis to account for detections and upper limits, we find median minimum timescale in the rest frame for long-duration and short-duration GRBs of 45 ms and 10 ms, respectively. Fewer than 10% of GRBs show evidence for variability on timescales below 2 ms. These shortest timescales require Lorentz factors >~ 400 and imply typical emission radii R ~ 1 X 10^14 cm for long-duration GRBs and R ~ 3 X 10^13 cm for short-duration GRBs. We discuss implications for the GRB fireball model and investigate whether GRB minimum timescales evolve with cosmic time.

COCOON EMISSION FROM LONG GAMMA-RAY BURSTS. Ore Gottlieb[1] and Ehud Nakar[1], [1]School of Physics and Astronomy and the Wise Observatory, The Raymond And Beverly Sackler Faculty of Exact Sciences, Tel-Aviv University, Tel-Aviv 6997801, Israel.

Introduction: When a jet propagates inside an external medium, a forward-reverse shock structure is created at its head. Matter that interacts with the shock is then pushed around the jet to form a hot cocoon which applies pressure on the jet and collimates it.

In the afterglow phase of Long Gamma-Ray Bursts (LGRBs), radiation is emitted as a result of the interaction between the ambient medium and the burst outflow. This radiation has been extensively examined, but mostly by considering just the jet contribution, rather than the radiation that is released from the cocoon. The former can only be discovered when facing the small angle covered by the jet, whereas the latter can potentially be discovered regardless of the observer's angle in respect to the jet.

By using relativistic hydrodynamic simulations of the collapsar model, we present preliminary numerical results which describe the cocoon evolution and emission. Our results show the importance of its radiation which is prominent from hours to days after the breakout. We find that it is distributed isotropically, and we derive an estimation of its light curve and radiation spectrum which is located in the range of x-ray to visible.

We predict that the cocoon radiation can be detected observationally in future surveys, possibly even in present-day ones. Those observations can be used as probes of the total LGRBs rate, and also indicate the progenitor and jet characteristics.

THE MXT X-RAY TELESCOPE ON BOARD THE SVOM MISSION D. Götz[1], on behalf of the MXT collaboration

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The Microchannel X-ray Telescope is a small and compact focussing instrument that will be flown on the Sino-French mission SVOM (to be launched in 2021) dedicated to Gamma-Ray Bursts (GRBs) studies and time domain and multi-messenger astronomy.
SVOM will carry a multi wavelength payload including a wide field coded-mask telescope, ECLAIRs, operating in the 4-250 keV energy band, a set of non-imaging gamma-ray spectrometers, GRM, sensitive in the 20 kev-5 MeV energy band, a visible telescope, VT, and the MXT.
MXT is based on a narrow-field « Lobster Eye » optics made of micropores of 40 microns of side. The MXT field of view will be of about 1 square degree with a pretty uniform sensitivity. The focal length of the telescope will be 1.15 m, and the focal plane of MXT will be built around a DUO pn CCD of 256x256 pixels of 75 microns, fully depleted over 450 microns, and cooled below -65° C. The MXT will be operated in the 0.2-10 keV energy range with the bulk of its effective area around between 1.0 and 2.0 keV due to the short focal length. Its point spread function is expected to be of about 4.5 arcmin (FWHM) at 1.5 keV, and its (5 sigma) sensitivity of the order of a few 10^{-12} erg/cmsq/s for a 10 ks exposure.
MXT will complete its phase B in November 2016, and will report about its design status and its expected performances: the MXT main goal is to reduce the ECLAIRs error box for GRBs and other transients from a few arc minutes to below the arc minute size radius. Preliminary simulations indicate that for at least 50% of the GRBs detected by ECLAIRs this will be possible after five minutes of observation after the stabilization following the satellite slew.

A Curious Lack of Evolution in the LGRB Host Metallicity Distribution. J. F. Graham[1] and P. Schady[1] and T. Krühler[1], [1]Max-Planck-Institut für extraterrestrische Physik (Giessenbachstrasse 1, 85748 Garching, GERMANY).

Recent improvements in the population of Long-duration Gamma Ray Burst host galaxies with measured metallicities and host masses allows us to investigate how the distributions of both these properties change with redshift. First we examine possible biases in the populations caused by the efficiency of obtaining mass and metallicity measurements at different redshifts. In comparing the redshift distributions of a variety of LGRB populations we find no biases out to a redshift of 2.5 with the exception of a reduced metallicity sampling at redshifts high enough to require a separate IR spectrum ($z < 0.5$). However observations using X-shooter (which allow for obtaining metallicities across a wide range of redshifts) do not show this bias. We also compare the observed LGRB redshift distribution with recent predictions and find good agreement.

Having established that the mass and metallicity samples are unbiased we then find a curious consistency in the metallicity destruction across different redshifts. This is at odds with the general evolution in the mass metallicity relation, which becomes progressively more metal poor with increasing redshift. We do however find that the LGRB host galaxy mass distribution increases with redshift so as to preserve the LGRB metallicity destruction. In fact, converting the measured LGRB host masses to their expected metallicities reproduces reasonably consistent metallicity distribution.

ON THE FERMI GBM EVENT 0.4 SEC AFTER GW 150914. J. Greiner[1,2], J.M. Burgess[3,4], V. Savchenko[5] and H.-F. Yu[1,2], [1]Max Planck Institute for Extraterrestrial Physics, Giessenbachstrasse, 85748 Garching, Germany, [2]Excellence Cluster Universe, Technische Universität München, Boltzmannstrasse 2, 85748, Garching, Germany, [3]Oskar Klein Centre for Cosmoparticle Physics, SE-10691 Stockholm, Sweden, [4]Dept. of Physics, KTH Royal Institute of Technology, AlbaNova, SE-10691 Stockholm, Sweden, [5]Francois Arago Centre, APC, Universit\'{e} Paris Diderot, CNRS/IN2P3, CEA/Irfu, Observatoire Paris, Sorbonne Paris Cite, 10 rue Alice Domon et Leonie Duquet, 75205 Paris Cedex 13, France

In view of the recent report by [1], we analyse continuous TTE data of Fermi-GBM around the time of the gravitational wave event GW 150914. We find that after proper accounting for low count statistics, the GBM transient event at 0.4 s after GW 150914 is likely not due to an astrophysical source, but consistent with a background fluctuation, removing the tension between the INTEGRAL/ACS non-detection [2] and GBM.

Additionally, reanalysis of other short GRBs shows that without proper statistical modeling the fluence of faint events is over-predicted, as verified for some joint GBM-ACS detections of short GRBs. We detail the statistical procedure to correct these biases. As a result, faint short GRBs, verified by ACS detections, with significances in the broad-band light curve even smaller than that of the GBM-GW150914 event are recovered as proper non-zero source, while the GBM-GW150914 event is consistent with zero fluence.

References:

[1] Connaughton V. et al. (2016) *ApJ, 826,* L6.
[2] Savchenko V. et al. (2016) *ApJ., 820,* L36.

STRUCTURE IN X-RAY FLARE LIGHT CURVES FOUND IN GAMMA-RAY BURST AFTERGLOWS.

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Introduction: Using evidence based on variability in x-ray flare light curves observed by Swift's XRT, we present evidence that x-ray flares are late, low-energy, long-duration counterparts of prompt GRB pulses. Flare light curves show some similarities with prompt light curves yet are different in important ways: they exhibit large residuals relative to the Norris et al. [1] model, indicating that this model by itself (a good representation of prompt GRB pulses) is generally less adequate in describing them. Flare residuals exhibit triple-peaked structures similar to those found in prompt GRB pulses, suggesting a link between the two forms of pulsed emission. However, in contrast with prompt GRB pulses, x-ray flares have less-pronounced decay peaks, longer central peak plateaus relative to the pulse duration, and brighter precursor peaks.

References: [1] Norris J. P. et al. (2005) *Astrophys. J.*, 627, 324-345.

STRUCTURE IN THE LIGHT CURVES OF SHORT GAMMA-RAY BURST PULSES.
J. Hakkila[1], I. Horváth[2], and R. D. Preece[3], [1]University of Charleston, SC, at the College of Charleston (Graduate School, 66 George St., Charleston, SC 29466, hakkilaj@cofc.edu) and Department of Physics and Astronomy, College of Charleston, SC, [2]National University of Public Service, Budapest, Hungary, [3]Space Science Department, The University of Alabama in Huntsville.

Introduction: The light curves of Short gamma-ray burst (GRB) pulses exhibit triple-peaked pulse shapes similar to those found in Long GRB pulses, based on a sample of 200 BATSE TTE GRB pulses (along with a few Short GBM pulses) fitted to both the Norris et al. [1] pulse shape and the Hakkila and Preece [2] residual fitting function. These findings suggest that a similar physical mechanism is responsible for producing the pulses found in Long, Intermediate, and Short GRBs: this mechanism works over seven orders of magnitude in duration, represents hard-to-soft emission, and appears to be independent of the progenitor event.

References: [1] Norris J. P. et al. (2005) *Astrophys. J.*, 627, 324-345. [2] Hakkila J. and Preece R.D. (2014) Astrophys. J., 783:88 (18 pp).

INVESTIGATING T90 DISTRIBUTIONS OF GAMMA-RAY BURSTS. R. Hamburg[1] and A. Goldstein[2], [1]University of Alabama in Huntsville, 320 Sparkman Dr., Huntsville, AL 35899, USA (rkh007@uah.edu), [2]Universities Space Research Association, 320 Sparkman Dr. Huntsville, AL 35806, USA.

Introduction: One of the primary observed properties used in classifying GRBs is the T90 duration. Defined as the time during which 5%-95% of the burst fluence are observed, T90 is used to classify GRBs as short (T90 < 2s) or long (T90 > 2s). The T90 duration has been shown to be a bimodal distribution, indicative of two different progenitors (i.e., core-collapse supernovae which produce long bursts and compact binary mergers which produce short bursts). However, these underlying distributions have significant overlap, are energy dependent, and vary between instruments, making accurate predictions of GRB progenitors difficult. In this study, we explore the dependence of T90 on spectral parameters, such as hardness ratio and Epeak, and compare T90 probability distributions between GRBs observed by Fermi GBM and Swift BAT.

Molecular Gas in the Host Galaxies of Long-duration Gamma-ray Bursts.
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Introduction: Long-duration gamma-ray bursts (GRBs) have been shown to be associated with the explosions of massive and short-lived stars (e.g., [1]), and are expected to trace galaxies with ongoing star formation. Because GRBs are bright enough to be observable in the cosmological distances (e.g., [2], [3]), they are expected to be a new tool to probe the star-forming activity in the distant universe (e.g., [4], [5]). However, whether GRBs can be used as an unbiased tool to trace star formation in the universe is still a subject of debate. To establish the link between GRBs and star-forming activity, it is necessary to understand the properties of GRB host in terms of molecular gas, which is the fuel of star formation. While molecular hydrogen has been detected in absorption in the spectra of GRB afterglows (e.g., [6]), the detected column density probes only one sight line in front of the GRB. In order to measure the molecular gas content, molecular lines need to be detected in emission.

After numerous unsuccessful searches of CO line emission ([7], [8], [9], [10], [11]), which is a tracer of molecular gas, we successfully detected in two GRB hosts for the first time among GRB hosts ([12]). A third detection of CO emission in a GRB host was reported ([13]). However, only a handful of GRB hosts have been observed with CO, and only three of them have a CO detection. In order to understand the properties of GRB hosts, it is necessary to increase the number of GRB hosts with CO observations.

Observations and Results: We conducted CO observations toward 10 GRB hosts at z = 0.1-2.5 by using Atacama Large Millimeter/submillimeter Array (ALMA). This is the first CO survey for GRB hosts, providing the largest sample with CO observations. We selected the targets with high star-formation rates (SFRs) in literature in order to obtain tight constraint on molecular gas mass. Our observations provide molecular gas properties in GRB hosts with high star-forming activity. The targets have been studied at multi-wavelengths, allowing us to compare their physical quantities (such as SFR, stellar mass, star formation efficiency, and gas consumption timescale) with other galaxy populations.

The ALMA data were recently delivered and we obtained preliminary results. We successfully detected CO emission in 6 GRB hosts (z = 1-2). This triples the sample size of GRB hosts with CO detection. The molecular gas mass of the hosts ranges $5 \times 10^9 – 9 \times 10^{10}$ $M_{\rm sun}$ by assuming a Galactic CO-to-H_2 conversion factor. We found that the hosts with CO detection at z = 1-2 have a star-formation efficiency similar to normal star-forming galaxies at z ~ 1-2. This is in contrast to the previous results, where GRB hosts at z < 1 show higher star-formation efficiency compared to local star-forming galaxies. The similarity between the GRB hosts and normal star-forming galaxies at z ~ 1-2 suggests that GRB occur in normal environments at the redshift range and can be an unbiased tracer of star forming activity in the universe.

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GAMMA-RAY BURSTS SPATIAL DISTRIBUTION. I. Horvath[1], [1]National University of Public Service, Hungary H-1441 Budapest, PO Box 60. e-mail address: Horvath.Istvan@uni-nke.hu.

Abstract: According to the cosmological principle, the large-scale structure of the Universe is homogeneous and isotropic. The observable Universe, however, shows complex structures on very large scales. The recent discoveries of structures significantly exceeding the transition scale of ~400 Mpc. We report here two structures defined by gamma-ray bursts. One is a ring with a diameter of 1700 Mpc, displayed by 9 gamma-ray bursts (GRBs), exceeding by a factor of 4 the transition scale to the homogeneous and isotropic distribution. The second one is even larger with a diameter of ~3000 Mpc, exceeding the transition scale by factor of at least 7.

R-process Kilonova/Macronova: K. Hotokezaka, Racha Institute of Physics, Hebrew University of Jerusalem, 91904, Jerusalem, Israel.

Introduction: Compact binary mergers (binary neutron star and black-hole neutron star mergers) eject neutron-rich material, where the r-process nucleosynthesis would naturally take place. The r-process material radioactively powers optical/infrared transients, macronovae (also called as kilonovae) [1]. In this talk, I discuss the recent progress and future prospects of the kilonova/macronova studies in the context of both short GRB and LIGO/Virgo gravitational-wave observations.

Light curve and spectrum of macronovae: Recent theoretical studies, e.g., nucleosynthesis calculations in the merger ejecta and radiative transfer simulations of the ejecta, predict that macronovae have the light curve with a time scale of a week and red-infrared spectrum [2-6]. Here the atomic transition of heavy elements plays an important role for deriving the light curves. Furthermore, it is shown that the bolometric light curve has a power-law decline in time, which is also characteristic feature of macronovae.

Observations of macronovae after nearby GRBs: The first candidate was discovered by Hubble space telescope after the short GRB 130603B [7,8]. Based on the detection, the ejecta mass is estimated as at least 0.02Msun. Furthermore, re-analysis of the optical bump in the afterglow of the nearby GRB 050709 and 060614 show that these bumps can be interpreted as macronove [9,10]. This suggests that macronovae may be ubiquitous.

Radio Follow-up observations of the macronova candidates: Because the neutron star merger ejecta have mildly to sub-relativistic velocities, the shock formed between the ejecta and the interstellar medium emit synchrotron radiation in the radio band at late times [11]. Among at the detection of such long-lasting radio remnants, radio follow-up observations have been done for some GRBs [12,13]. The non-detections of the radio follow-up observations of these events constrain the kinetic energy and velocity of the ejecta and can rule out a magnetar model in which significant kinetic energy is injected in the ejecta [12,13].

Prospects to kilonova/macronova searches after LIGO/Virgo merger events: Kilonovae/macronovae and following long-lasting radio remnants are two of the most promising electromagnetic counterparts to LIGO/Virgo gravitational-wave events. Based on the current theoretical and observational understanding, the detectability and optimized strategies for searching the electromagnetic counterparts to gravitational-wave merger events will be discussed [14,15]. In particular, for O2 run, I will show that the targeting galaxy searches will be very powerful for some electromagnetic facilities.

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REPLACE Observation of spectral lags among gamma-ray, X-ray and optical bands in X-ray flares of GRB 140304A.
S. Jeong[1,2,3] and A. J. Castro-Tirado[3], V. Lipunov[4], A. S. Pozanenko[5], I. H. Park[1,2], Z. Lucas Uhm[6], B. Zhang[6] and on behalf of the larger BOOTES, MASTER, Monday, Khureltogot, Nanshan and RATIR collaboration. [1]Department of Physics, Sungkyunkwan University (SKKU), 2066 Seobu-ro, Suwon 440-746, South Korea, [2]Institute of Science and Technology in Space, Sungkyunkwan University (SKKU) (soominjeong@gmail.com), 2066, Seobu-ro, Suwon 440-746, South Korea, [3]Instituto de Astrofisica de Andalucia (IAA-CSIC), Glorieta de la Astronomia s/n, E-18008, Granada, Spain, [4]Sternberg Astronomical Institute, Moscow State University, Moscow, Universitetsky pr.13, Moskow 119992, Russia, [5]Space Research InstituteRussian Academy of Sciences, Russia, Department of Physics and Astronomy, [6]University of Nevada Las Vegas, NV 89154, USA.

Introduction: Using cross-calibrated optical data obtained for GRB140304A, redshift of z=5.282, from MASTER, Khureltogot, Mondy, Nanshan, GTC, BOOTES-4 and RATIR ground telescopes, our observations have shown, for the first time, clearly optical flares accompanying their x-ray counterparts.

We have detected multiple flares ranging from gamma radiation frequencies down into the optical regime.

Here, we present the measurement of spectral lags between the peak times for series of flares in gamma/ X-ray and optical light curves. The power-law indices of the spectral-lag diagrams are investigated.

Next, we extracted the spectral index between X-ray and optical band for these flares, and found them, they are reside within synchrotron emission limit.

Also, we measured the optical linear polarisation of the flares of this GRB, and found an evolution of or change in the polarisation direction and levels across the flare series.

Finally, we add theoretical implication on flare mechanism using GRB140304A detection.

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GRB off-axis afterglows and the emission from the accompanying supernovae. Adithan Kathirgamaraju[1], Rodolfo Barniol Duran[1] and Dimitrios Giannios[1], [1]Department of Physics and Astronomy, Purdue University, 525 Northwestern Avenue, West Lafayette, 47907 IN, USA,

Introduction: Gamma-ray burst (GRB) afterglows are likely produced in the forward shock driven by the GRB jet, e.g. [1]. We focus on afterglows from long GRBs, which are accompanied by broad-line type Ic supernovae (SNe). Using the Afterglow Library [2], we produce synthetic light curves of the afterglow for multiple viewing angles ("off-axis" observers) in the optical and radio frequencies, which could be detected without a gamma-ray trigger ("orphan" afterglows).

We find that only a few percent of optical afterglows viewed off-axis are brighter than the emission from their accompanying optical SNe. In line with previous work, e.g. [3,4], we find that it is best to search for orphan afterglows in the radio band. We also estimate the rates of detecting orphan afterglows in regards to upcoming radio surveys (e.g., VAST).

Recently, the rebrightening of the radio afterglow due to the accompanying supernova remnant has been considered [5]. Long-term follow-up of radio off-axis afterglows could give us insight to the properties of the SN remnant and other mildly relativistic components, if present [6].

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Multi-wavelength analysis of X-ray Flush observed by *Swift*. D.Katsukura[1],T.Sakamoto[1], A.Yoshida[1]
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Abstract: In prompt emission of the Gamma-Ray Bursts (GRBs), extreamly soft events compared with "classical" GRBs (C-GRB) exist. These events are called "X-Ray Flushs (XRFs)". The charactaristics of the prompt emission of XRFs are studied in details in the past by *Ginga*, *Beppo-SAX,* and *HETE-2*.

The E_{peak} which is the peak energy of νF_ν spectrum indicates the property of GRBs. Based on the previos studies, E_{peak} of XRFs are 10^{-1}-10^{-2} times smaller than that of C-GRBs. There are some theoretical models of XRFs. However, the emission mechanism of XRFs is still largely a mystery. To overcome this situation, we conducted a systematic study of XRFs observed by *Swift* not only a prompt emission but also an afterglow property from an optical to X-ray range.

First, we classified the *Swift* GRBs between Desember 2004 and February 2014 as 3 categories, that of XRFs, X-Ray Rich GRBs (XRRs) and C-GRBs, based on T. Sakamoto et al.2008[1]. Second, we analized the spectrum of XRFs, XRRs, and C-GRBs of the prompt emission. We derived E^{obs}_{peak} which is E_{peak} at the observer's frame. We used the *Swift*-BAT data in XRFs and XRRs. For C-GRBs, we combine the *Swift*-BAT data and *Fermi*-GBM data because it is expected that E^{obs}_{peak} of C-GRB is above the energy range of the *Swift*-BAT (15-150 keV). We calculated E^{src}_{peak} whitch is in the rest frame of the GRB for known redshift events. We found that the distribution of E^{src}_{peak} of XRFs is not only less than 100 keV significantly but also continuous from XRFs to C-GRBs.

Next, we analyzed X-ray afterglow data of the *Swift* X-Ray telescope (XRT). We found that the X-ray luminosity (0.3-10 keV) of XFRs tend to be fainter than XRRs and C-GRBs.

Finally, to find out whether the X-ray aftrerglow is consistent with the standard external shock model of GRBs, we used the "boxfit" tool which is the lightcurve and spectrum of afterglow simulation and fitting tool developed by Van Eerten et al.(2012)[2] to calculate the afterglow light curves in X-ray, optical and radio. And then, we compare the calculated light curves to the data.

In my poster, we report the results of systematic analysis from the prompt emissions to afterglows of XRFs.

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iWF-MAXI (iSEEP Wide Field MAXI) soft X-ray transient monitor on ISS

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iSEEP Wide Field MAXI (iWF-MAXI) is a proposed mission on the ISS/JEM to monitor a major fraction of the sky for detecting and localizing soft X-ray transients, starting at the end of 2010‘s. We plan to promptly disseminate the locations of transients to the community to lead follow-up multi-wavelength observations with large observatories in space (e.g. Fermi, Chandra, JWST, ..) and on ground. The main targets of iWF-MAXI are categorized in four classes: (1) X-ray counterparts of gravitational wave (GW) events, (2) Short soft X-ray transients such as stellar flares, nova ignitions, and supernova shock breakouts, (3) Short high-energy transients such as gamma-ray bursts and tidal disruption events, (4) Variable X-ray sources such as black hole binaries, neutron star binaries, and active galactic nuclei (AGN), iWF-MAXI’s main scientific instrument is the Soft X-ray Large Solid Angle Camera (SLC) which consists of a pairs of criss-cross coded aperture detector arrays using CCDs as one-dimensional imagers covering the 0.7-12 keV band with a localization accuracy of 0.1°.

First year observations of GRBs with CALET Gamma ray Burst Monitor.
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Abstract: CALorimetric electron telescope (*CALET*; [1][2]) was launched by H-IIB/HTV-5 on August 19, 2015. *CALET* started the scientific observation on Octorber 6, 2015. *CALET* includes CALorimetor (CAL) and Gamma ray Burst Monitor (CGBM; [3]). CGBM is designed to observe a prompt emission of a Gamma Ray Burst (GRB) in a broad spectral range. CGBM has two kinds of scintillation detectors, Hard X-ray Monitor (HXM;7 keV – 1 MeV) and Soft Gamma ray Monitor (SGM; 40 keV – 20 MeV), to detect GRBs from 7 keV up to 20 MeV energy range. The CAL is sensitive to gamma-rays from 1 GeV to 10 TeV. Therefore, *CALET* has a capability to observe GRBs in a few keV to TeV energy range.

So far, CGBM detected 30 GRBs which include 4 short GRBs since October 2015. The GRB detection rate of CGBM is about 3 GRBs per month. Most of the CGBM GRBs were also detected by other GRB instruments such as *Swift*-BAT, *Fermi*-GBM, *INTEGRAL*-ACS, and *Konus*-WIND. In particular, three GRBs were also detected by Monitor of All Sky Image (*MAXI*) which is located on the same platform of International Space Station as *CALET*. Since energy range of *MAXI* is 2 keV to 20 keV, the *MAXI* data enable to fill out the low-energy part of the spectrum. *MAXI* found the soft emission from GRB 160107A about 45s earlier than the CGBM trigger time. This interesting observation gives us a clue about an onset time of a GRB. Also, CGBM observed the whole episode of GRB 160625B which has a precursor at ~180s before the main emission.

We will report the systematic analysis including a temporal and spectral charactaristics of the CGBM detected GRBs. Furthermore, we will highlight several GRBs, for example *MAXI* – detected GRB160107A and GRB160625B.

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The statistics of BAT-to-XRT flux ratio in GRB: Evidence for a characteristic value and its implications. D. Kazanas[1], J. L. Racusin[1], J. Sultana[2], A. Mastichiadis[3], [1]NASA/GSFC, Greenbelt, MD 20771, [2]Mathematics Department, Faculty of Science, University of Malta, Msida MSD2080 Malta, [3]Department of Physics, University of Athens, Panepistimiopolis, GR 15783, Zografos, Greece.

Abstract: We present the statistics of the ratio, *R*, between the prompt and afterglow ``plateau" fluxes of GRB. This we define as the ratio between the mean prompt energy flux in *Swift* BAT and the *Swift* XRT one, immediately following the steep transition between these two states and the beginning of the afterglow stage referred to as the ``plateau". Like the distribution of many other GRB observables, the histogram of *R* is log-normal with maximum at a value $R_{\rm m} \sim$ 2,000, FWHM of about 2 decades and with the entire distribution spanning about 5 decades in the value of *R*. We note that the peak of the distribution is close to the proton-to-electron mass ratio $R_m \sim m_p/m_e = 1836$, as proposed to be the case in an earlier publication [1], on the basis of a specific model of the GRB dissipation process. It therefore appears that, in addition to the values of the energy of peak luminosity $E_p \sim m_e c^2$, GRB present us with one more quantity with an apparent characteristic value. The fact that the values of both these quantities (E_p and R) are consistent with the same specific model invoked to account for the efficient conversion of their relativistic proton energies to electrons, argues favorably for its underlying assumptions.

References: Use the brief numbered style common in many abstracts, e.g., [1], [2], etc. References should then appear in numerical order in the reference list, and should use the following abbreviated style:

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GRB 130912A and GRB 150424A: two short Gamma Ray Bursts with a plateau phase in the optical afterglow challenge the compact binary merger scenario. F. Knust[1] and J. Greiner[1] and H. J. Van Eerten[1], [1]Max-Planck Institute for Extraterrestrial Physics, Giessenbachstrasse 1m 85748 Garching, Germany (fknust@mpe.mpg.de)

Introduction:

Short GRBs are defined as having a T_{90} <2s and a harder spectrum compared to long GRBs [1]. Their systematically fainter afterglows [2] make follow-up observations challenging. Only about 100 short GRB optical afterglows have been detected.

We present afterglow data of GRB 130912A and GRB 150424A, two rare cases were a shallow decay in the optical light curve, a "plateau phase", was observed. The pure existence of such a plateau challenges the compact binary merger (CBM) scenario.

CBMs are the most favored progenitors for short GRBs [3]. They are expected at high galactic offsets due to the velocity kick they receive when formed, and thus a low circumburst density is expected. Both these poperties are in agreement with observations [4][5][6][7][8][9]. In addition, the compact binary merger rate coincides with the short GRB rate [10]. Moreover, this model is attractive since heavy nuclei produced in neutron star mergers could explain the "missing metals problem". However, a plateau phase in the afterglow can not easily be explained by a CBM progenitor.

An alternative progenitor candidate is an accretion induced collapse of a white dwarf, followed by a magnetar [11]. Unlike the CBM, this progenitor naturally provides a prolonged energy injection, which could explain plateau phases.

Outline: We present two very rare cases of short GRBs with a shallow decay phase in the optical afterglow: GRB 130912A and GRB 150424A. They undoubtedly have the best optical/NIR coverage of the plateau phase of any short GRB.

These data include unique high quality multi-band data from the Gamma Ray Optical and Near-infrared Detector (GROND) [12], and are combined with data from the Swift Ultra-Violet Optical Telescope (UVOT) [13] and the Swift X-Ray Telescope (XRT) [14].

First we characterize the light curves and spectral energy distributions (SEDs) of the two afterglows with the empirical flux description $F \propto t^{-\alpha} \nu^{-\beta}$. We then interpret the light curves and SEDs in the context of the fireball model [15][16].

The pure existence of plateau phases in optical afterglows forces us to reconsider our standard assumptions for short GRBs. Plateau phases cannot be explained by a simple forward shock model. Further complications like a forward-reverse shock system, multiple jet components or energy injection have to be introduced. Those complications put additional constraints on possible progenitor systems and challenge the compact binary merger scenario.

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Fermi-LAT Observations of GRB 160509A. D. Kocevski[1] and F. Longo, [1]NASA Marshall Space Flight Center, [2]Università degli studi di Trieste

Introduction: We present preliminary results of the Fermi Large Area Telescope (LAT) observations of GRB 160509A. The burst was extremely well detected by the LAT at both early and late timescales. The early-time observations exhibited variability above 20 MeV that is highly correlated with the emission observed by the Fermi Gamma-ray Burst Monitor (GBM), whereas the late-time emisison resembles the long-lived afterglow-like emission observed in other LAT detected GRBs The LAT observed emission shows strong evidnece for spectral attention above 40 MeV at early times, before transitioning to a harder spectrum that is consistant with the extension of an electron synchrotron spectrum more commonly seen in afterglow emission. Therefore, GRB 160509A may serve as an exquisite example of a LAT detected burst with a clear transitions from internal shock to external shock dominated emission.

Investigating The Nature of Late-Time GeV Emission in GRBs Through Joint Fermi/Swift Observations

D. Kocevski and J. Racusin[2] on behalf of the Fermi LAT collaboration, [1]NASA Marshall Space Flight Center , [2]NASA Goddard Space Flight Center

Introduction: We present a systematic investigation into the nature of the delayed and long-lived high-energy emission observed from gamma-ray bursts by the Fermi-LAT. The origin of this emission has been much debated within the GRB community, and has led to speculation that bursts detected by the Fermi-LAT may represent a unique population of GRBs, either probing a particular type of environment, the result of a unique set of afterglow conditions, or due to progenitors that produce a rare class of hyper-energetic GRBs. Using afterglow observations by Swift-XRT, we find that the Fermi-LAT detected population exhibit X-ray afterglows that are among the brightest and hardest detected by Swift. Joint spectral fits of simultaneous XRT and LAT observations reveals that a majority of these bright LAT detected bursts require a break in their broadband spectrum between the XRT and LAT energy ranges at very late times. Such a break is expected to persist at high energies in the afterglow spectrum if the GRB blast wave is propagating into a wind-like circumburst medium. This effectively allows the afterglow to remain bright at gamma-ray wavelengths to very late times, enabling their detection by the Fermi-LAT. Therefore, we propose that a majority of GRBs detected at late times by Fermi-LAT are preferentially selecting environments in which their progenitor underwent significant mass loss prior to the core collapse that triggered the GRB.

Gamma-ray emission in the Universe – a possible explanation by the wave modulation

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Modulation by the smallest orbiting frequencies of giant cosmic objects (galaxies and larger) smaller faster orbiting objects leads to very fine oscillations saturating Universe.

The wave planetology [1, 2] successfully applied to explain a number of structural peculiarities of planetary surfaces, lithospheres and atmospheres as well as shapes of planetary bodies states that "orbits make structures". It means that all planetary bodies including asteroids and Sun (aster) moving in non-round (elliptical , parabolic) keplerian orbits are subjected to a warping action of inertia-gravity waves induced in them periodically changing accelerations. These waves having 4 interfering directions in rotating bodies produce tectonic dichotomy, sectors and granules size of which is inversely proportional to orbiting frequencies.

Planets have only one orbit each in the Solar system. But numerous satellites have two orbits: one around their planets and another around Sun. This means that satellites have two populations of tectonic granules ("craters") on their surfaces. Along with two main orbital frequencies and corresponding them granules two side waves and forming them granules appear due to wave modulations. In full accordance with the wave theory the lower frequency modulates the higher one with production of side frequencies at both sides of the latter. Corresponding to them tectonic granules also are formed. This modulation process was repeatedly described and applied to the Moon, satellites of Saturn, the saturnian atmosphere. But the solar system is not entirely isolated. It belongs to Galaxy and moves in it with a certain frequency, say, about 1/200 000 000 years. Orbiting frequencies of all celestial bodies in the Solar system –from 1/8 hours of Phobos to 1/248 years of Pluto – are high comparative to the Solar system orbiting in Galaxy. Dividing all possible orbiting frequencies of the Solar system bodies by the Galactic frequency one comes to a range of side frequencies from microwaves to kilometer waves. This conclusion is a very significant one because it is well known that all bodies of the Solar system are a source of often enigmatic radiowaves. Some calculations are below. A granule size is a half of a wavelength. A scale is the Earth's orbiting frequency 1/1 year and corresponding granule size $\pi R/4$.

Jupiter: (12 y. : 200 000 000 y.)πR = (12 : 200 000 000) 3.14 · 71400 km = 13.4 m tectonic granule or 26.8 m wavelength. Varying orbital frequencies and bodies' radia one comes to the following wavelengths. Jupiter 26.8m, Saturn 56.4m, Uranus 67m, Neptune 124m, Pluto 10.9m, Sun 1.46m, Triton 11.4m (for the circumsolar frequency), 1.84mm (circumneptunian fr.), Amalthea 4.88cm (circumsolar fr.), 0.0028mm (circumjovian fr.), the Moon 5.46 cm (circumsolar fr.), 0.46cm (circumterrestrial fr.) [1. 2].

Any body has its own distinct orbit. There are no two equal orbits, all orbits are different and this means that there are no two equal structures of celestial bodies. All orbits are different because all bodies move complexly in several orbits in their own star systems, in galaxies, in clusters of galaxies, in clusters of galactic clusters in Metagalaxy. Such a complex moving in non-round orbits means oscillations with various frequencies.

High-frequency oscillations are modulated by low-frequency ones with production of side frequencies. The lower side frequencies in bodies terminate by the fundamental wave (wave 1) responsible for ubiquitous tectonic dichotomy (Theorem 1, Kochemasov, 1999 and others). The higher side frequencies correspond to radiowaves for bodies in galaxies (remember radiogalaxies) and have to be else higher frequent due to orbiting in clusters of galaxies and in clusters of galactic clusters. Orbiting velocities gradually increase from smaller systems to larger ones: the Solar (star) system (n x 10 km/s) – galaxy (n x 100 km/s) – cluster of galaxies (n x 1000 km/s) – cluster of galactic clusters (n x 10000 km/s, about c/10, c= the light velocity), where n is about 1 to 5 (on average about 3). Each step means enormous increase of the systems angular momenta as their not only velocities but also masses and radii increase enormously. Such ever increased energies and lower and lower orbiting frequencies provoke (modulate) in bodies higher and higher side frequencies. Thus, if a galactic movement gives radiowaves, orbiting a cluster of galaxies gives gamma-rays, orbiting a cluster of galactic clusters gives the hypothetic ether or isotropic mess of not yet measured very high frequency oscillations (nicknamed "vacuum").

The following discrete scheme may be considered. Modulating frequencies diminish (and cosmic velocities increase) from smaller objects to larger ones: the Solar (star) system (velocities n x 10 km/s) - leads to tectonic granules, sound; galaxy (n x 100 km/s) - radio waves; cluster of galaxies (n x 1000 km/s) – gamma-rays; cluster of galactic clusters (n x 10000 km/s, about c/10, c= the light velocity) – ether,"vacuum",where n is about 1 to 5 (on average about 3). **Reference: [1]** Kochemasov G.G. Universe of oscillations: sound-radiowaves-gamma-rays-ether // Geophysical Research Abstracts, 2003, v. 5, 02159. **[2]** Kochemasov G.G. Wave modulations in the Solar system bodies and their radio emissions // GRA, 2008, v. 10, EGU2008-A-01272.

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Neutrino Transport in Black Hole-Neutron Star Binaries: Dynamical Mass Ejection and Neutrino-Driven Wind. Koutarou Kyutoku[1], Kenta Kiuchi[2], Yuichiro Sekiguchi[3], Masaru Shibata[4], Keisuke Taniguchi[5], [1]Interdisciplinary Theoretical Science Research Group, RIKEN, Wako, Saitama 351-0198, Japan, koutarou.kyutoku@riken.jp , [2]Yukawa Institute for Theoretical Physics, Kyoto University, Kyoto 606-8502, Japan, kiuchi@yukawa.kyoto-u.ac.jp , [3]Department of Physics, Toho University, Funabashi, Chiba 274-8510, Japan, sekig@yukawa.kyoto-u.ac.jp , [4]Yukawa Institute for Theoretical Physics, Kyoto University, Kyoto 606-8502, Japan, mshibata@yukawa.kyoto-u.ac.jp , and [5]Department of Physics, University of the Ryukyus, Nishihara, Okinawa 903-0213, Japan, ktngc@sci.u-ryukyu.ac.jp

Black hole-neutron star binaries, although having been never detected, will become an important player in the near-future astronomy. First, they are primay sourcres of gravitational waves for ground-based laser-interferometric detectors such as Advanced LIGO. Because LIGO has already detected gravitational waves from binary black holes [1], it is quite natural to expect that black hole-neutron star binaries will be detected soon. Second, black hole-neutron star binaries could be a central engine of short-hard gamma-ray bursts (see, e.g., [2,3]). This scenario will be tested by simultatneous detection of gravitational waves and gamma-ray bursts (or its absence). Finally, the ejecta from the merger of black hole-neutron star binaries are promising sites of r-process nucleosynthesis [4]. The ejecta are also important as an agent for driving nearly-isotropic electromagnetic counterpart to gravitational waves and gamma-ray bursts [5,6]. These interesting possibilities motivate us to study the merger of black hole-neutron star binaries theoretically.

Quantitative theoretical study of the merger of black hole-neutron star binaries require numerical-relativity simulations incorporating various important microphysics. In particular, neutrino transport with finite-temperature equations of state for neutron-star matter is essential to accurately determine the properties of the ejecta. Neutrinos may not only expel material from the accretion disk formed after the merger, i.e., neutrino-driven wind, but also affect the neutron richness of the ejecta via the irradiation. It has already been shown that full general relativity and neutrino transport can have a significant impact on the properties of ejecta and resultant abundance pattern of heavy elements in the study of binary neutron stars [7]. Thus, such study is also necessary to understand the outcome of black hole-neutron star binary mergers.

For this purpose, we perform numerical-relativity simulations of black hole-neutron star binaries incorporating approximate neutrino transport via the moment formalism [8,9]. We focus on the case that the neutron star and black hole has 1.35 and 5.4 solar mass, respectively, and also restrict our attention to the black-hole spin that is aligned with the binary's orbital angular momentum with 75% of the extreme Kerr limit. For the equation of state of the neutron-star matter, we adopt three finite-temperature equations of state (specifically, so-called SFHo, DD2, and TM1) to explore the dependence of the outcome on underlying nuclear physics input. These equations of state predicts the neutron-star radius to be in between 11.9km and 14.5km, with which an astrophysically plausible range of the radius may be spanned.

We found that the merger of black hole-neutron star binaries with these binary parameters results in formation of massive accretion disk and dynamical ejection of substantial material with more than 1% of the solar mass. Quantitatively, the mass and velocity of the dynamical ejecta are compatible with previous simulations performed without neutrinos [6]. On top of that, we verified that the neutrino irradiation does not increase the neutrion richness of the dynamical ejecta significantly, so that the dynamical ejecta keep their original chemical composition inherited from the cold, beta-equilibrium neutron-star material. This situation should be contrasted with the dynamical mass ejection from binary neutron stars, in which the neutron richness is raised by shock heating and neutrino irradiation. This finding suggests that the dynamical ejecta from black hole-neutron star binaries will experience substantial fission recycling and forms second- and third-peak r-process elements in a robust manner. At late times, we found that a tiny amount of material is gradually ejected from the accretion disk with modarete neutron richness. Although the amount is not very substantial, future longterm evolution of O(second) will be required to accurately determined the ejected material.

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SVOM OBSERVING STRATEGY. C. Lachaud[1] on behalf of the SVOM consortium, [1]email: cyril.lachaud@in2p3.fr, APC, Univ Paris Diderot, CNRS/IN2P3, CEA/lrfu, Obs de Paris, Sorbonne Paris Cité, France.

Abstract: SVOM, the Space-based multi-band astronomical Variable Objects Monitor, is a future Chinese-French satellite mission starting its space operations in 2021. With its on-board instruments, ranging from optical to gamma-ray frequencies, SVOM is dedicated to the study of the transient universe, focusing on gamma-ray bursts (GRBs). We will present the observing strategy developed to optimize the scientific return of the mission. We will describe the attitude law, which has been optimized to enhance the detection rate and follow-up of GRBs, as well as the communication processes to receive/send data to the satellite. We will then describe the different observation programs: the Core Program (CP) dedicated to the GRBs, the different Target of Opportunity (ToO) modes for observations triggered from the ground and the General Program (GP) for planned observations. Finally, we will discuss, in this context, the multi-messenger observation opportunities with SVOM through the ToO program.

On and Off Axis Orphan Afterglow from Low Lorentz Factor Jets – Candidate Electromagnetic Counterparts to Gravitational Wave Sources

G. P. Lamb & S. Kobayashi

ABSTRACT:

Short gamma-ray bursts (SGRB) are believed to be produced by ultra-relativistic jets from the merger of neutron stars (NSNS) or a neutron star and black hole (NSBH). Observations of such events are currently triggered by gamma-rays from the prompt emission but if the Lorentz factor distribution for such jets is dominated by low Lorentz factors <30 then the prompt gamma-rays would be suppressed. Such low Lorentz factor jets would produce x-ray/optical/radio transients as the jet collides with the ambient medium. For a simple power-law distribution of Lorentz factors of index -1.75, approximately 78% of merger-jets within 300 Mpc (the LIGO detection distance limit for face-on NSNS mergers) would produce failed-GRB transients; such transients are expected to peak in x-ray and optical 0.1-10 days after a merger, with good sky localization they will be detectable by Swift XRT, and brighter than 21st magnitude in 85% of cases. The radio peaks narrowly around 10 days with a peak flux 10-100 mJy at 10 GHz and ~0.1 mJy at 150 MHz. If the jets of SGRB are structured, then such orphan afterglow would also be associated with observations made at angles greater than a narrow core angle; such on axis (within the jet opening angle) failed-GRB afterglows as well as the off axis (after jet break) afterglows should be considered when searching for the electromagnetic counterparts to gravitational wave detections from NSNS(NSBH) mergers.

A Reverse Shock in GRB 160509A.

T. Laskar, K. D. Alexander, E. Berger

The nature of the central engine launching GRB outflows and the mechanism producing the collimated, relativistic jet remain two urgent open questions in GRB physics, with proposed models ranging from jets dominated by baryons or by Poynting flux, and those with nascent black holes or magnetars providing the central engine. Answers to there questions require a direct probe of the GRB jets, which is offered by the reverse shock (RS), and which were predicted to produce optical flashes on hour timescales. However, this signature has only been seen in a few cases in the Swift era, suggesting that RS emission may instead be easier to observe at longer wavelengths.

Here, we present the second multi-frequency radio detection of a reverse shock in a γ-ray burst. By combining extensive radio observations of the Fermi-LAT GRB 160509A at z=1.17 up to 20 days after the burst with Swift X-ray observations and ground-based optical and near-infrared data, we show that the afterglow emission comprises distinct reverse shock and forward shock contributions. Through multi-wavelength modeling, we determine a circumburst density of $n_0 \approx 10^{-3}$ cm^{-3}, supporting previous suggestions that a low-density circumburst environment is conducive to the production of long-lasting reverse shock radiation in the radio band. Consistency arguments connecting the forward and reverse shocks suggest a deceleration time of $t_{\rm dec} \approx 460$ s $\approx T_{90}$, a Lorentz factor of $\Gamma(t_{\rm dec}) \approx 330$, and a reverse shock to forward shock fractional magnetic energy density ratio of $R_{\rm B} \equiv \epsilon_{\rm B,RS}/\epsilon_{\rm B,FS} \approx 8$.

Global numerical simulations of gamma-ray burst jet dynamics and radiation properties. Davide Lazzati[1], [1]Department of Physics, Oregon State University, 301 Weniger Hall, Corvallis, OR 97331. Email: davide.lazzati@oregonstate.edu

Gamma Ray Burst (GRB) jets, their dynamical evolution, and their radiative properties are very complex systems. Arising from a compact engine, they propagate through a dense environment, and eventually radiate away their internal energy. The light we see is therefore a superposition of multiple radiation mechanisms and of emission from a range of zones with different physical conditions. Global numerical simulations of GRB Jets and radiation transfer through them are therefore an invaluable tool to disentangle the burst complexity and to test theories on the burst physical ingredients.

In this talk I will present the results of a set of global hydrodynamic and Monte Carlo radiation transfer simulations of long- and short-duration GRB jets. I will present synthetic light curves and spectra, with and without contribution from non-thermal particles and magnetic field. I will compare the results to individual burst observations as well as to ensemble correlations to tease out what radiation mechanisms and physical conditions explain the observations. I will finally discuss the prospect of using numerical simulations of this kind to predict the multimessenger signal from these events, especially from the case of short bursts, for which gravitational waves are expected and very high energy neutrinos might be detectable in favorable circumstances.

Wide angle emission of short duration gamma-ray bursts and their GW counterparts. Davide Lazzati[1], Alex Diech[1], and Brian J. Morsony[2], [1]Department of Physics, Oregon State University, 301 Weniger Hall, Corvallis, OR 97331. Email: davide.lazzati@oregonstate.edu, [2]Department of Astronomy, University of Maryland, 4296 Stadium Drive, College Park, MD 20742-2421, USA

Short duration gamma-ray bursts (SGRBs) are expected to be associated with the merger of a compact binary system in which at least one of the two components is a neutron star (NS). Binary NS mergers are also candidate sources of gravitational waves, similar to the binary BH mergers recently detected by LIGO. While a SGRB is highly beamed and is easily detected against the gamma-ray background only if its relativistic jet is pointing towards the Earth, gravitational waves are only moderately aspherical and NS binary mergers are expected to be detectable irrespective of their orientation. For a typical short GRB jet opening angle of 16^{o}, the probability of detecting an on-axis burst is only ~4 per cent. Our hope of confirming the supposed association of SGRBs with NS binary mergers is therefore tied to our capability of modeling and detecting the off-axis emission of such events. We present a discussion of the detectability of electromagnetic counterparts of off-axis NS binary mergers detected and localized by LIGO. We show that, while the prompt emission is too dim to be detected, cocoon prompt emission and late afterglow can be detected with current instrumentations. Well localized LIGO detections can therefore not only confirm the association of short burst with binary NS mergers but can be invaluable tools for studying the jet geometry of short GRBs.

The HAWC GRB Programme. D. Lennarz[1] and I. Taboada[1] for the HAWC collaboration, [1]School of Physics and Center for Relativistic Astrophysics, Georgia Institute of Technology, Atlanta, Georgia, USA, dirk.lennarz@gatech.edu

Introduction: HAWC is a very-high-energy gamma-ray extensive air shower detector. It is located in central Mexico at an altitude of 4,100 m above sea level and currently in its second year of operation. The large instantaneous field of view of 2 sr, a duty cycle (up time fraction) of over 95% and the lack of observational delays make HAWC an ideal detector for studying transient sources like gamma-ray bursts (GRBs) at energies as small as 50 GeV. A fast follow-up of GRBs reported by satellites and a real-time, untriggered search of the entire overhead sky are running at the HAWC site. This contribution summarises recent results of the HAWC GRB programme.

Gamma-Ray Bursts from the *Swift* Burst Alert Telescope: Instrumental Sensitivity and Implication on the High-Redshift GRBs

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Introduction:

To date, the Burst Alert Telescope (BAT) onboard *Swift* has detected over 1000 gamma-ray bursts (GRBs), within which about one-third of them have redshift measurements, ranging from z=0.03 to z=9.38. Here, we present summaries of both the temporal and spectral analyses of the BAT GRBs for the past ~ 11 years. In particular, we discuss the instrumental sensitivity and selection effects of the BAT GRB detections, and its implication on the observations of high-redshift bursts for studying the early universe.

Joint Spectral Analysis of Gamma-ray Bursts from *Swift*/BAT and *Suzaku*/WAM

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Introduction:

The prompt emission of gamma-ray bursts produce photons in a very wide energy range, from a few keV to a few GeV. Therefore, broad-band spectral fitting is crucial to constrain E_{peak} and the total energy fluence, E_{iso}, of a burst. In this study, we perform joint spectral analysis of 245 gamma-ray bursts (GRBs) detected by both Swift/BAT and Suzaku/WAM, which is an extension of previous work by [1]. BAT (~15−150 keV) and WAM (~50−5000 keV) together cover most of the main energy range of GRB prompt emission. Moreover, BAT and WAM are the most sensitive instruments in this energy range, which makes them ideal for detail spectral studies. Here, we present our results from both the time-integrated and time-resolved spectral analysis, and discuss the spectral properties, spectral evolution, and the Epeak-Eiso/Liso relation from this sample.

References:

[1] H. Krimm, K. Yamaoka, S. Sugita et al. (2009) ApJ 704, 1405.

A Comprehensive Analysis of Fermi Gamma-Ray Burst Data: IV. On the Spectral Lag and Possible Physical Origin.

Rui-Jing Lu[1], Jing Lv[2], Xiang-Gao Wang[3], En-Wei Liang\altaffilmark[4], Ting-Feng Yi[5], Da-Bin Lin\altaffilmark[6], Hou-Jun Lv[7], Bing Zhang[8], [1]GXU-NAOC Center for Astrophysics and Space Sciences, Department of Physics, Guangxi University, Nanning 530004, China; luruijing@gxu.edu.cn;, [2]GXU-NAOC Center for Astrophysics and Space Sciences, Department of Physics, Guangxi University, Nanning 530004, China; lvjing508@126.com.

Introduction: Spectral lag, defined as the difference in the average arrival time of high- and low-energy photons, is a common feature in gamma-ray bursts (GRBs). But its origins are unclear. The rich collection of GRBs observed by Fermi provides us systematical investigations in a larger sample than ever before. Our statistical analyses of 92 pulses in 84 GRBs show that: (i) Spectral lag could always be identified in the energy band where the spectra evolve and pass through: Hard-to-soft (H2S) evolution produce a positive lag whereas soft-to-hard (S2H) evolution gives a negative lag, thus ending a draw in a pulse will directly yield null lag. (ii) In all H2S pulses (64/92) and most of tracking pulses (21/92), we always identify a positive lag, and the spectral lag has a power law energy-dependent, i.e., spectral lag exhibits a simple growth with energy increasing, and eventually saturate at a high energy end. (iii) The fact shows that H2S spectral evolution is more common feature than S2H evolution in a pulse. (iv) statistically, a wide pulse tends to have a deep slope of the power law dependence, and then deep slope will directly lead to a long spectral lag, but it is not always the true for a tracking pulse. Possible correlations between the spectral lag and other observed properties, such as pulse width, peak luminosity and the peak energy of a spectrum in the spike pulse are also investigated. Our simulations with a simple hypothesis could duplicate the characteristics of the spectral lag, implicating that the spectral lag is nothing but from the time evolution of the spectra across observing energy band.

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LEAP - A LARGE AREA BURST POLARIMETER FOR THE ISS. M. L. McConnell[1,2], on behalf of the LEAP Collaboration. [1]University of New Hampshire, Space Science Center, Durham, NH 03824, [2]Southwest Research Institute, Department of Earth, Oceans, and Space, Durham, NH 03824

Introduction: The process by which some stellar-mass black holes are thought to form (either from the final stages of a highly evolved massive star, also known as a hypernova, or the merger of two compact objects) may result in a release of energy that exceeds anything witnessed in the Universe since the Big Bang. This energy release is believed to result in the formation of two oppositely directed jets, which are observationally manifested as a GRB and its afterglow emission. The initial burst of radiation (dominated by X-rays and γ-rays), referred to as the prompt emission, is believed to come from the innermost region of the jet. The afterglow emission, which originates in the outer part of the jet, has been well studied across the entire electromagnetic spectrum by missions such as Swift and Fermi. These studies have led to a better understanding of the late stages of the jet evolution as it interacts with the surrounding medium. A complete picture of the GRB phenomena also requires an understanding of what takes place in the inner part of the jet, closest to where the black hole is formed. Unfortunately, we have only a limited understanding of the inner jet, as its study depends on the short-lived, high-energy prompt emission, which is far more difficult to measure given the random occurrence (in both space and time) of these sources. Polarization studies of the prompt emission offer a unique opportunity to shed light on both the structure of the inner jet and the mechanisms responsible for the emission. Preliminary evidence of polarized γ-ray emission, at least in some GRBs, has been accumulated in recent years. The limited significance and conflicting nature of these results does not paint a consistent picture of GRB polarization. A more sensitive and systematic study of GRBs, providing definitive measurements for a large sample of events, will address several important questions.

The LargE Area burst Polarimeter (LEAP) is a mission concept for a Compton scatter polarimeter instrument that would be deployed on the international Space Station (ISS). It will be proposed as an astrophysics Mission of Opportunity (MoO) in late-2016. Based on the design of the Gamma Ray Polarimeter Experiment (GRAPE) [1], it employs discrete scintillation detector elements to measure the polarization of the incident flux. The detection principle of the LEAP instrument utilizes both plastic and CsI scintillation detectors to identify Compton scatter events. The azimuthal distribution of Compton scattered photons provides a measure of the source polarization. As a wide-FoV, non-imaging instrument, it is well-suited for measuring the polarization of transient events, such as GRBs and solar flares. Operating in the energy range of 50-500 keV, it will provide coverage of GRB spectra over a range that includes most values of E_p. LEAP will provide a total effective area for polarization (double scatter) events of ~500cm^2. With a total geometric scintillator area of 5000 cm^2, LEAP will not only provide high quality polarization measurements, but it will also provide high quality spectral data as well.

Designed for a lifetime of two years, the LEAP mission will provide polarization results on more than 100 GRBs. These data promise to shed significant light on the nature of GRB jets.

Reference: [1] McConnell M. L. et al. (1997) *Proc. SPIE., 9144,* 91443P.

GRB POLARIMETRY WITH CGRO/COMPTEL. M.L. McConnell[1,2] , Hunter Anderson[1], Werner Collmar[3], and Andreas Zoglauer[4], [1]University of New Hampshire, Space Science Center, Durham, NH 03824, [2]Southwest Research Institute, Department of Earth, Oceans, and Space, Durham, NH 03824, [3]Max Planck Institute for Extraterrestrial Physics, Garching, Germany, [4]University of California, Space Science Laboratory, Berkeley, CA 94720.

Abstract: The COMPTEL instrument on the Compton Gamma Ray Observatory operated on orbit from 1991-2000 [1]. As a Compton telescope, it is intrinsically sensitive to polarization, although the geometry of this design is not optimal for polarization studies. However, the relatively low background (resulting in a high S/B) make COMPTEL a potentially useful tool for transient polarimetry.

We have embarked on a program to analyze CGRO/COMPTEL data in search for evidence of polarization in both transient sources and in brighter steady sources. We are pursuing this work because of the heightened interest in high energy polarimetry, the recognition that some high energy sources may be highly polarized (thus improving our chances of a making useful measurements), and the ready availability of modern computing resources that provide the ability to carry out more comprehensive simulations in support of the analysis. The only significant work done to date with regards to COMPTEL polarimetry was published almost 20 years ago and used a simplified mass model of COMPTEL for simulating the instrument response [2]. Estimates of the minimum detectable polarization (MDP) near 1 MeV included 30% for a two-week observation of the Crab, as low as 10% for bright GRBs, and as low as 10% for bright solar flares. The data analysis performed at the time led to inconclusive results and suggested some unknown systematic error [2]. We contend that a self-consistent analysis will be feasible with high fidelity simulations, simulations that were not easily generated 20 years ago. Our analysis utilizes the latest GEANT4 simulation tools in conjunction with a high-fidelity mass model of the COMPTEL instrument, as available through the MEGAlib simulation package [3]. Given the nine years of COMPTEL data, we expect that this work will likely add to our understanding of the polarization properties of transient sources, such as GRBs and solar flares, as well as perhaps brighter steady sources, such as the Crab and Cyg X-1.

Here we present results from simulations of the COMPTEL polarization response and a summary of the expected Minimum Detectable Polarization (MDP) for all GRBs detected within the COMPTEL FoV. This provides a list of GRBs that will be studied more closely for evidence of polarization. With these data, we summarize the potential for GRB polarization studies.

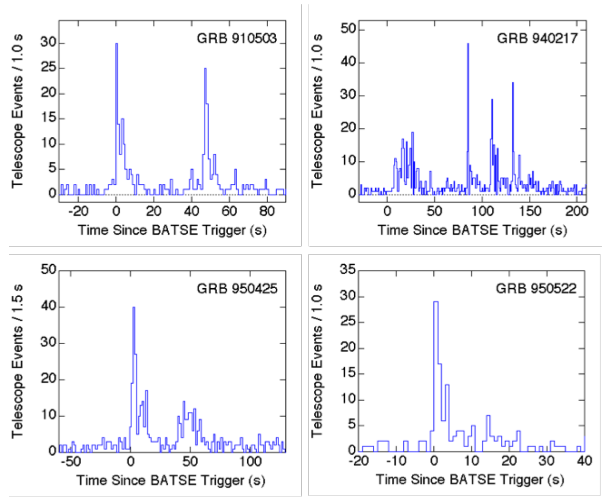

Figure 1. Background-subtracted time histories for some of the GRBs detected by COMPTEL within its FoV.

Figure 2. GEANT4 mass model employed for simulations of the COMPTEL polarization response.

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Compton-pair production gamma-ray telescope (ComPair): a wide field discovery mission for the MeV band.
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The MeV domain is one of the most underexplored windows on the Universe, mainly due to the challenging nature of the measurements. This is an energy range of transition in the Universe. Thermal sources dominate at lower energies, while non-thermal phenomena prevail at higher energies. In addition, observations at both gamma-ray and hard X-ray energies provide compelling evidence of astrophysical objects whose radiative output peaks in the MeV range. Equally crucial is the strong evidence that spectral features such as breaks, turnovers, cutoffs, and temporal behavior, which are critical discriminating factors between competing physical models, occur within this energy band. In this paper we describe a wide-aperture discovery mission concept, Compton-Pair Production Space Telescope (ComPair) and discuss the science that it will address. This mission will investigate the energy range from 200 keV to >500 MeV with good energy and angular resolution and with sensitivity approaching a factor of 10-30 better than previous instruments.

Dissecting high-redshift galaxies with GRBs: three hosts at z~6 observed with HST. J. T. W. McGuire[1], [1]Department of Physics & Astronomy, University of Leicester, University Road, Leicester LE1 7RH, UK; jtwm1@le.ac.uk

Abstract: Long-duration Gamma-Ray Bursts (GRBs) offer unique perspectives on galaxy evolution. Through afterglow spectroscopy, GRBs provide detailed evidence of the internal conditions (abundances, dust content, molecules etc.)[1-3] in high-redshift galaxies, properties that are otherwise very difficult to constrain. GRBs also select star forming hosts independently of their luminosities, enabling the measurement of the proportion of star formation occurring in very faint galaxies beyond the depths of conventional flux-limited galaxy surveys. When hosts are bright enough for follow up, GRB afterglows allow for the comparison of host properties in emission with those in absorption [4], although until now, no hosts have been detected in emission beyond z~5.5 [5]. For this talk, I present the first detection of the host galaxies of GRB 130606A, 050904 and 140515A (Figure 1.) at z~6, showing that they have luminosities and half-light radii consistent with the population of Lyman-break galaxies at that epoch. I also briefly discuss the resulting high-redshift GRB host sample and its implication for the galaxy luminosity function.

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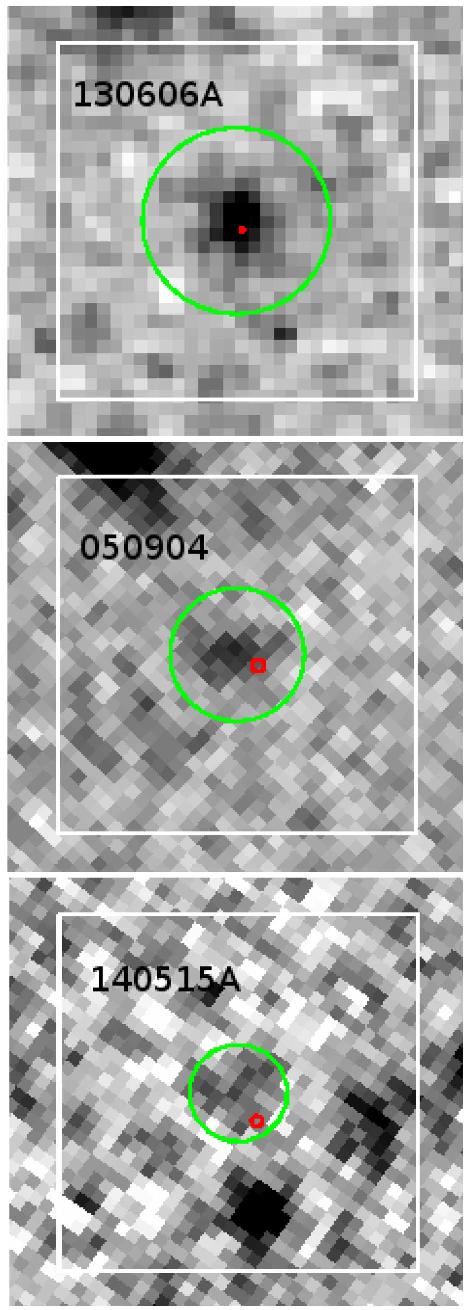

Figure 1: Zoom-ins of the observation fields for each detected galaxy. GRB afterglow positional uncertainty at 1 sigma is shown as red circles, while the detected galaxies are encircled with their customized apertures in green.

PRECURSORS OF SHORT GRBS REGISTERED BY SPI-ACS/INTEGRAL. P. Yu. Minaev[1] and A. S. Pozanenko[1,2], [1]Space Research Institute (IKI), 84/32 Profsoyuznaya Str, Moscow, Russia, 117997; minaevp@mail.ru , [2]National Research Nuclear University MEPhI, 31 Kashirskoe shosse, Moscow, Russia, 115409; apozanen@iki.rssi.ru.

We have searched for precursors in light curves of short gamma-ray bursts registered by SPI-ACS/INTEGRAL in 2002 – 2014.

We assumed that the length of time interval between precursor and main phase of the burst should be greater than 2 sec and precursor properties (e.g. duration, intensity, energy spectrum) should be different from a main phase of the burst.

The total sample consisted of 519 bursts with $T_{90} <$ 2 sec, which was used to search for precursor activity in the individual light curves. We found precursor candidates only for GRB 071030, GRB 100717, GRB 130310. The first one was found to be unreliable, but others two were confirmed by GBM/Fermi and were analysed in details. We also re-analysed precursor candidate for GRB 090510 which was discussed in [1].

Temporal and spectral analysis did not reveal sufficient differences in properties of precursor candidates and main phase of GRB 100717, GRB 130310 and GRB 090510. So the nature of these candidates remains unclear. If we suggest these candidates as “real” precursors, the portion of short bursts with precursor activity will be less than 0.4% from all short bursts registered by SPI-ACS.

We also searched for possible regular precursor in stacked light curve of subsample of 372 brighest short bursts of our initial sample. No statistically significant regular precursor was found on scales from 50 ms to 48 sec (total duration of analysed time interval) in the time interval (-50, -2) sec. A count fluence of the possible regular precursor is weaker than main phase of the burst more than 30 times. This is the most conservative upper limit on the possible regular precursor based on our sample.

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FINDING CRITICAL OBSERVABLES TO CONSTRAIN THE PROMPT MECHANISM IN GRBs.

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The nature of prompt emission mechanism in GRBs remains highly debated with at least three main contenders: (i) subphotospheric dissipation or, above the photosphere, (ii) magnetic reconnection or (iii) internal shocks. These various possibilities differ in terms of dissipation radius, degree of magnetization, presence and role of shocks in the ejecta and radiation processes.

Finding (possibly simple) observables that could help to favor one scenario over the others would therefore be quite useful and, in a second step, could also provide guidelines for constructing new models or improving existing ones.

I will present a few examples of such observables from the early steep decay in X-ray afterglows to GRBs showing a pure thermal spectrum at the start of their prompt emission, which may help to constrain the dissipation radius, or the bumps in the optical light curve of GRB 030329, which could indicate that shocks took place in the ejecta.

SIGNS OF MAGNETIC ACCELERATION AND MULTI-ZONE EMISSION IN GRB080825C

ABSTRACT. E. Moretti[1,2] and M. Axelsson[3,2], on behalf of the Fermi-LAT collaboration [1]Max-Planck-Institut für Physik, Föhringer ring 6, D-80805 München, Germany, moretti@mpp.mpg.de, [2]Oskar Klein Center for CosmoParticle Physics, KTH Royal Institute of Technology, SE-106 91 Stockholm, Sweden, [3]Department of Physics, Tokyo Metropolitan University, Minami-osawa 1-1, Hachioji, Tokyo 192-0397, Japan.

Introduction: The era of the Band function fitting paradigm is ending, due in large part to the high-quality data provided by the Fermi Gamma-ray Space Telescope. Practically all bright GRBs detected by Fermi-LAT and GBM data show deviations from a pure Band function, most often due to extra spectral features being present. Understanding the physics of these components is necessary to reveal the acceleration and emission processes active in the highly relativistic outflows of GRBs. In addition to the sample of bright GRBs we also look for the presence of possible extra components in weaker GRBs. Here we present signs of a new high energy component in GRB080825C, peaking at a few MeV, in addition to the bulk of emission peaking at few hundreds of keV. This component is different from those previously reported, and its high energy and temporal behaviour point to multi-zone emission models where the particle acceleration is due to magnetic reconnection in the jet.

Localizing Gravitational Wave Events with GRB Afterglows B. J. Morsony[1], D. Lazzati[2], and J. C. Workman[3], [1]University of Maryland, [2]Oregon State University, [3]Colorado Mesa University

Abstract: Short GRBs are believed to be produced by NS-NS and/or NS-BH mergers. These mergers also produced gravitational waves which will be detected by LGO/Virgo. However, GW events are will only be accompanied by a GRB directed at Earth in a small fraction of events. In most cases, localizing the GW event and determining the properties of any associated GRB will rely on finding the GRB afterglow. Based on properties of observed short GRB jets, we model short GRB afterglows as a function of observer angle. We then determine the detectability of these afterglows in radio, optical, and X-ray searches. Our goal is to determine the depth and timing of searches most likely to detect GW event counterparts.

MULTI-WAVELENGTH MODELLING OF GRB081007

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Abstract: We carry out extensive multi-wavelength modelling of the afterglow of GRB081007. This burst has a well sampled light-curve in X-ray [1], optical/IR [2,3] and radio frequencies [4]. We use physical modelling where the afterglow evolution is consistently modelled as synchrotron emission from a decelerating ultra-relativistic forward shock and from the corresponding reverse shock. The details of our model is available in Resmi et al., 2012 [5]. To explain the non-standard behaviour of this afterglow, we consider two models: (i) a continuously powered fireball and (ii) time evolving shock microphysics. We implement Markov Chain Monte Carlo parameter estimation based on the *emcee* package [6] to obtain bounds on the model parameters. We discuss the results and limitations of each of the models.

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INVESTIGATING THE PRECURSOR AND PROMPT EMISSION OF SWIFT GAMMA-RAY BURSTS (GRBS). Brittany Myers[1] and Michael Stamatikos[2], [1]The Ohio State University, 1179 University Drive, Newark, OH 43055 (bboyd625@gmail.com), [2]Department of Physics, Department of Astronomy, Center for Cosmology and AstroParticle Physics (CCAPP), The Ohio State University, 1179 University Drive, Newark, OH 43055 (Stamatikos.1@osu.edu), [2]National Aeronautics and Space Administration (NASA), Goddard Space Flight Center (GSFC), Code 661, 8800 Greenbelt Rd, Greenbelt, MD 20771 (Michael.Stamatikos-1@nasa.gov).

Introduction: Gamma-ray bursts (GRBs) are relativistic cosmological events of which bright flashes of transient electromagnetic radiation are produced. Common features of these events include spectral lag, which is the time difference between the arrivals of high and low energy photons, and also prompt gamma-ray emission with an x-ray afterglow, which may include optical detection, lasting much longer than prompt emission. GRBs are currently divided into two loose categories consisting of short and long bursts which are determined by a less than or greater than two second span of the prompt gamma-ray emission. We think the progenitors are for each class of GRB: massive stars for long GRBs and binary compact mergers for short GRBs. Some GRBs such as GRB 061121, observed on November 21st, 2006, have what is known as a precursor emission which occurs before the prompt emission. Using data collected from NASA's Swift mission, we will analyze and compare the spectral lag of the precursor and the prompt emission. Precursor emission triggers Swift's Burst Alert Telescope (BAT) some time before the main event burst, allowing the spacecraft to slew and observe it in its entirety. The astrophysical mechanisms of the central engine activity are still relatively unknown and the spectral lag analysis – especially in the context of precursor emission, might elucidate the situation in that regard. By analyzing the spectral lag of both precursor and prompt emission, we hope to discover if the precursor is an early activation of the progenitor's central engine and possibly a key to understanding its nature.

Multi-Dimensional Full Boltzmann-Neutrino-Radiation Hydrodynamic Simulations and Their Detailed Comparisons with Monte-Carlo Methods in Core Collapse Supernovae. H. Nagakura[1], S. Richers[1] and C. D. Ott[1], W. Iwakami[2,3], S. Furusawa[4], K. Sumiyoshi[5], S. Yamada[3,6], H. Matsufuru[7] and A. Imakura[8]
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Introduction: Neutrinos play a fundamental role for core-collapse supernovae (CCSNe). Indeed, we have been accumulated evidences that the transport of energy, momentum and lepton number via neutrinos give a significant impact on supernova dynamics. The so-called neutrino-heating mechanism aided by multi-dimensional fluid instability is currently the most plausible scenario for the explosion mechanism.

Nontheless, the detail of the scenario is still matter of debate. The arguement is that even the latest results of state-of-the-art simulations by different groups are still at odds with one another. One of the reasons for the discrepancy is that they use different approximate treatmentments for neutrino transport. Intrinsically speaking, the neutrino transport is 7-dimensional problem and it should be determined by solving Boltzmann equation. The approximate neutrino transport methods can not deal with the intermediate state between optically thin and thick region (namely semi-transparet region). The explosion mechanisms could not be validated unless we remove the uncertainties of neutrino transport in the semi-transparent region.

Our Work: To break the status quo, we have developed a 7-dimensional Full Boltzmann-neutrino-radiation-hydrodynamical code with detailed microphysics (up-to-date weak interactions and nuclear equation of state) [1,2]. Furthermore, we succeeded to carry out long-term axisymmetric simulations for two representative supernova progenitors (11.2 and 15 M_sun) (see Fig1). Our analysis primary focuses on the properties of neutrino momentum space, and we reveal that how neutrino angular distributions change as they pass through semi-transparent region (Fig 2).

Above and beyond of the current our code, we also now launch several important projects, which are (1) extending our code in full general relativistic (GR) treatments; (2) cross comparing with a different transfer method to gain more confident on each method. In terms of GR treatments, their formulations have been done [3], and their installations and tests are currently underway (but see [2] for some implementation of GR Boltzmann solver).

For project (2), we compare our results with the other supernova group in Caltech which has developed the Monte-Carlo neutrino transport code [4]. This is the first attempt to compare multi-dimensinal radiation transport in CCSNe context. We disentangle CCSNe problems such as EOS, weak interactions, transport, special or general relativistic treatments. In this conference, I will summarize not only results of our supernova simulations but also recent on-going these projects. If there is enough time, I also discuss how to implement our code to collapsar or mergers of double compact objects.

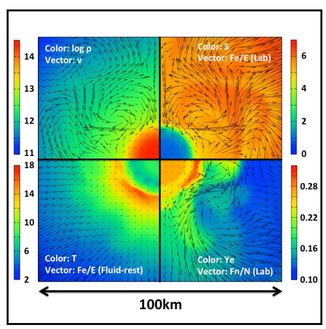

Fig1. 2D Distributions of several hydro quantities in Boltzmann-Hydro simulations.

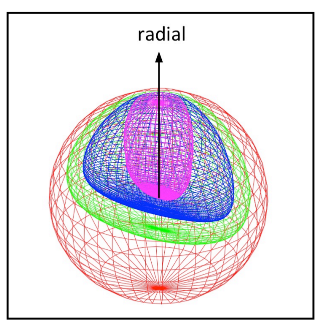

Fig2. Three-dimensional map of neutrino momentum space. Different color represents different spatial location. (Radius is increasing from red to purple)

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THE REDSHIFT SELECTED SAMPLE OF LONG GAMMA-RAY BURST HOST GALAXIES: THE COMPLETE METALLICITY MEASUREMENTS AT $z \leq 0.41$. Y. Niino[1], K. Aoki[2], T. Hashimoto[1], T. Hattori[2], S. Ishikawa[3], N. Kashikawa[1], G. Kosugi[1], M. Onoue[3], J. Toshikawa[1], and K. Yabe[4], [1]National Astronomical Observatory of Japan, 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan, [2]Subaru Telescope, National Astronomical Observatory of Japan, 650 North A'ohoku Place, Hilo, HI 96720, USA., [3]Department of Astronomy, School of Science, SOKENDAI (The Graduate University for Advanced Studies), 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan, [4]Kavli Institute for the Physics and Mathematics of the Universe, The University of Tokyo, Kashiwanoha, Kashiwa 277-8583, Japan

Introduction: Some theoretical studies on the origin of long gamma-ray bursts (GRBs) using stellar evolution models suggest that low-metallicity may be a necessary condition for a long GRB to occur [1, 2, 3]. Metallicity distribution of long GRB host galaxies provides us with an important clue to study the relation between metallicity and a long GRB occurrence. Although metallicity of a long GRB host galaxy is not necessarily identical to that of the progenitor, galaxies with low-metallicity would have higher GRB production efficiency than high-metal galaxies if low-metallicity is a necessary condition for a long GRB to occur [4].

However, despite the dramatic increase of the sample number of spectroscopically studied long GRB host galaxies [5], the relation between metallicity and long GRB occurrence rate is not understood quantitatively. One difficulty is that we can determine redshifts and/or identify host galaxies of only a small fraction of GRBs (~ 30% in recent observations), which is likely biased with respect to the distributions of redshifts and host galaxy properties (the z-determination/host-identification bias). Furthermore, even when the redshift and the host galaxy of a long GRB are known, the host galaxy is not always studied in detail. The targets of the spectroscopic studies have been selected non-uniformly by numerous independent researchers making the effect of the sampling bias unevaluable (the reporting bias). There have been some previous long GRB host observation campaigns invented to overcome the sampling biases (so called unbiased surveys [6, 7, 8]). However, the unbiased surveys face lack of statistics at low-redshifts where reliable spectroscopic metallicity measurements of galaxies are available (< 5 GRBs at $z < 0.5$).

Method: There are advantages of studying GRB host galaxies at low-redshift in some aspects: 1) success rate of redshift determinations and host identifications is high (i.e., the z-determination/host-identification bias is weak), 2) the reporting bias can be eliminated by measuring metallicities of all host galaxies which is difficult to do at higher redshifts, and 3) a wealth of spectroscopic studies of general galaxies to which we can compare long GRB host properties.

In this study, we present the complete list of host metallicities for all long GRBs whose redshifts are spectroscopically determined to be ≤ 0.41 (as of the end of March 2014), including newly obtained spectroscopic datasets of the host galaxies of GRB 060614, 090417B, and 130427A. This is the first fair estimate of the metallicity distribution of GRB host galaxies based on a redshift selected sample in which metallicities of the all host galaxies are measured in the *Swift* era. We compare the metallicity distribution of the low-redshift sample to the model predictions taking account of spatial variation of metallicities among star forming regions within a galaxy [9], and constrain the relation between metallicity and GRB occurrence.

Results & Conclusions: Although the majority of host galaxies in the sample have 12+log(O/H) > 8.4, we find that the models, in which only low-metallicity stars produce GRBs with a sharp cutoff of GRB production efficiency around 12+log(O/H) ~ 8.3, can well reproduce the observed distribution, while the models with moderate (or no) metallicity dependence are not consistent with the observations. This suggests that long GRBs at low-redshifts occur in locally low-metallicity spots in their host galaxies which is not resolved with the current observations, and their progenitor metallicities are significantly lower than the metallicities of the host galaxies or those measured at the explosion sites with ~ kpc scale spatial resolutions. More details can be found in [10].

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Particle-in-cell Simulations of Global Relativistic Jets with Helical Magnetic Fields.

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Introduction: We have studied the interaction of relativistic jets with their environment, using 3-dimensional relativistic particle-in-cell simulations for two jet compositions: (i) electron-proton and (ii) electron-positron plasmas [1, 2]. We have performed simulations of "global" jets containing helical magnetic fields in order to examine how helical magnetic fields affect kinetic instabilities such as the Weibel instability, the kinetic Kelvin-Helmholtz instability (kKHI) and the Mushroom instability (MI) [3, 4].

Simulation Results: Figure 1 shows a comparison between PIC simulations with comparable RMHD simulations showing recollimation shocks and the kink instability. The comparison reveals that PIC simulations can show features similar to RMHD macroscopic processes even within a small simulation system.

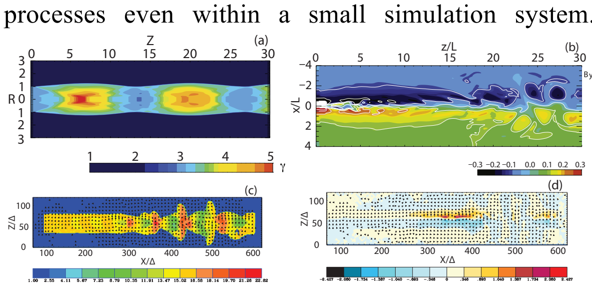

Figure 1. Panel (a) shows a 2D plot of the Lorentz factor for a helically magnetized RMHD jet, adapted from Fig. 10(d) in Mizuno et al. [5]. Panel (b) shows the azimuthal magnetic field component, $\mathbf{B_y}$, throuth the jet center with $|\mathbf{B_y}|$ magnitude contours for a decreasing density helically magnetized jet, adapted from Fig. 4(f) in Singh et al. [6]. The disruption of helical magnetic fields may be caused by the current-driven kink instability. Panel (c) shows a 2D plot of the jet electron Lorentz factor for a PIC $\mathbf{e^-}$ -$\mathbf{p^+}$ jet and panel (d) shows an isocontour plot of the azimuthal magnetic field component, $\mathbf{B_y}$, through the jet center. The disruption of helical magnetic fields is caused by instabilities and reconnection.

Summary: Our global helically magnetized jet simulations show new types of growing instabilities for both electron-proton and electron-postiron plasma jets [4]. Preliminary results indicate that the presence of helical fields suppresses the growth of kinetic instabilities, such as the Weibel instability, kKHI, and MI. Instead, new instabilities appear, associated with recollimation shocks and current-driven kink instability. The $\mathbf{e^-}$ - $\mathbf{p}$+ helically magnetized jet shows recollimation-like shock structures in the current density $\mathbf{Jx}$, similar to the recollimation shocks observed in RMHD simulations containing helical magnetic fields [5]. The observed modulations in the jet electron kinetic energy shown in Fig. 1 (c) appear to correspond to the modulations in the Lorentz factor seen in RMHD studies (see Fig. 1 (a)). Additionally, while not shown here the electron density in the $\mathbf{e^-}$ - $\mathbf{p}$+ jet shows pile-ups which appear to correspond to the recollimation shock structures seen in RMHD simulations. Evidence for growth of a kink-like instability is seen in the azimuthal magnetic field component, $\mathbf{B_y}$ in Fig. 1 (d), and is similar to that seen in Fig. 1 (b) where helical magnetic fields carried by the jet are disrupted by growth of the kink instability. Finally, we see evidence that reconnection is taking place in the jets.

Larger-scale higher-resolution simulations are required to fully resolve the reconnection process and to understand the nature of the new instabilities. Future simulations will be combined with calculations of radiation signatures and polarity along with variations in space and time.

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EXPLORING THE BEHAVIOUR OF LONG GAMMA-RAY BURSTS WITH INTRINSIC AFTERGLOW CORRELATIONS. S. R. Oates[1], J. L. Racusin[2], M. De Pasquale[3], [1]Department of Physics, University of Warwick, Coventry, CV4 7AL, UK, [2]Astrophysics Science Division, NASA Goddard Space Flight Center, 8800 Greenbelt Road, Greenbelt, Maryland 20771, USA, [3]Mullard Space Science Laboratory, University College London, Holmbury St. Mary, Dorking, Surrey, RH5 6NT, UK.

Abstract: We present a correlation observed in both the optical and X-ray afterglows of long duration Swift Gamma-ray Bursts (GRBs), between the initial luminosity (measured at restframe 200s) and average afterglow decay rate. This correlation does not depend on the presence of specific light curve features and is potentially applicable to all long GRB afterglows. We explore how the correlation decay parameters from the optical and X-ray bands relate to each other and to the prompt emission phase. We will also explore the implications and test if the observations are consistent with the expectations of the standard afterglow model.

Features of > 130 Gamma-Ray Bursts at high energy: towards the 2nd Fermi/LAT GRB catalog

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The high-energy emission from Gamma-Ray Bursts is a formidable probe for extreme physics, calling for highly relativistic sources with very large Lorentz factors. Despite the advancements prompted by observations from the Fermi Large Area Telescope and the Fermi Gamma-Ray Burst Monitor, as well as other observatories, many questions remain open, especially on radiative processes and mechanisms. We present here the most extensive search for GRBs at high energies performed so far, featuring a detection efficiency more than 50% better than previous works, and returning more than 130 detections. With this sample size, much larger than the 35 detections presented in the first Fermi/LAT GRB catalog, we are able to assess the characteristics of the population of GRBs at high energy with unprecedented sensitivity. We will review the preliminary results of this work, as well as their interpretation.

MCRaT Simulations of Long Gamma Ray Burst Spectra and Light Curves. T. Parsotan[1] and D. Lazzati[2], [1]Oregon State University (parsotat@oregonstate.edu), [2]Oregon State University (lazzatid@science.oregonstate.edu).

Introduction: We present the results of the Monte Carlo Radiation Transfer, MCRaT, simulations of long gamma ray burst from collapsars. The code was applied to a variety of stellar progenitors and jet properties, including models with variable engines. By injecting photons at an optical depth of at least 100 and following them until they propagate freely from the jet, we show that the matter and radiation components of the jet gradually decouple from one another at a radius smaller than that assumed by the photospheric model. Futhermore, with calculated light curves and simulation spectra fitted to the Band function, we make comparisons to observed data and outline the agreements and strain points between the photospheric model and real bursts.

THE RUGGED LANDSCAPE OF THE CORE-COLLAPSE SUPERNOVA EXPLOSIONS. O. Pejcha[1], T. A. Thompson[2], J.L. Prieto[3], [1]Hubble and Lyman Spitzer Jr. Fellow, Department of Astrophysical Sciences, Princeton University, pejcha@astro.princeton.edu, [2]Department of Astronomy and Center for Cosmology & Astro-Particle Physics, The Ohio State University, [3]Nucleo de Astronomia de la Facultad de Ingenieria, Universidad Diego Portales, Av. Ejercito 441 & Millennium Institute of Astrophysics, Santiago, Chile.

Introduction: The collapse of the core and the associated supernova (SN) explosion mark the end of life of most massive stars, but the mechanism of explosion is poorly understood and perhaps even unknown. Within the framework of critical neutrino luminosity [1-2] we employ spherical quasi-static evolutionary sequences for hundreds of progenitors over a range of metallicities to study how the progenitor structure maps onto observables, such as the fraction of successful explosions, the neutron star (NS) and black hole (BH) mass functions, the explosion energies ($E_{\rm SN}$) and nickel yields ($M_{\rm Ni}$), and their mutual correlations [3].

Results: We find that the successful explosions are intertwined with failures in a complex pattern (Fig. 1) that is not well described by the initial progenitor mass or compactness [4]. We suggest that progenitors with initial masses of 15±1, 19±1, and ~21-26 $M_\odot$ are most likely to form BHs and that the BH formation probability is non-zero at solar-metallicity and increases significantly at low metallicity. The low luminosity, low Ni-yield SNe are produced by progenitors close to success/failure boundaries. We qualitatively reproduce the observed $E_{\rm SN}$-$M_{\rm Ni}$ correlation and we predict correlations between the means and widths of the NS and BH mass distributions. We show that the observed mean NS mass of ~1.33 $M_\odot$ observed in double-NS systems implies that the successful explosion fraction is higher than 0.35.

Comparison to observations: We present a new self-consistent method to derive photospheric radius and temperature evolution of Type II-Plateau supernovae from their spectroscopic expansion velocities and photometric measurements [5]. We apply the method to a sample of 26 nearby supernovae with published light curves ranging from near-UV to near-IR. The light-curve differences among the Type II-Plateau supernovae can be explained by different rates of photospheric radius expansion, which points to variations in the different density profiles of the ejecta as the driver of the observed diversity. Without theoretical supernova atmosphere models, we estimate a set of self-consistent relative distances, reddenings, and nickel masses fully accounting for all internal model uncertainties and covariances.

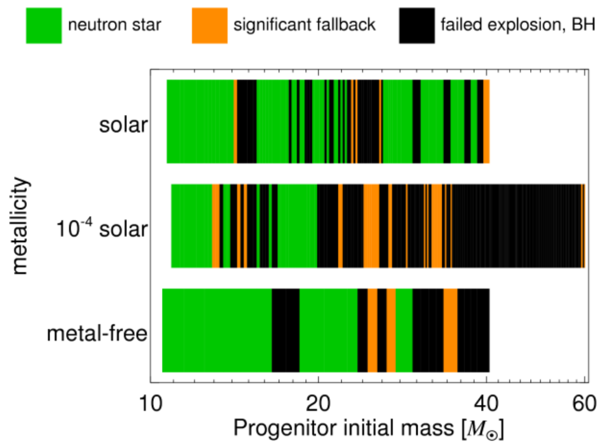

Figure 1. Outcomes of core collapse as a function of initial progenitor mass and metallicity for a set of progenitors [7] and a representative parameterization of the explosion mechanism. We show successful explosions producing neutron stars (green), successful explosions with significant fallback leaving behind either a massive neutron star or a black hole (orange), and failed explosions leading to a black hole (black).

We find that the covariances of $E_{\rm SN}$, $M_{\rm Ni}$, and the bolometric plateau luminosity $L_{\rm pl}$ are so strong that the confidence ellipsoids are highly elongated along the direction of the correlations and reduce their significance. We show that the correlations between $L_{\rm pl}$, $E_{\rm SN}$ and $M_{\rm Ni}$ have an intrinsic width. Our results imply that Type II-Plateau SN explosions are not described by a single physical parameter or a simple one-dimensional trajectory through the parameter space, but instead reflect the diversity of the core and surface properties of their progenitors.

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BURSTCUBE: A CUBESAT FOR GRAVITATIONAL WAVE COUNTERPARTS. J. S. Perkins[1], J. L. Racusin[1], M. S. Briggs[2], G. de Nolfo[1], J. Krizmanic[3], J. E. McEnery[1], P. Shawhan[4], D. Morris[5], and V. Connaughton[6] [1]NASA/GSFC (Greenbelt, MD USA), [2]University of Alabama Huntsville (Huntsville, AL USA), [3]NASA/GSFC/CRESST (Greenbelt, MD USA), [4]University of MD, College Park (College Park, MD USA), [5]University of the Virgin Islands, (St. Croix, USVI USA), [6]USRA (Huntsville, AL USA)

Abstract: We present BurstCube, a novel CubeSat that will detect and localize Gamma-ray Bursts (GRBs). BurstCube will detect both long GRBs attributed to the collapse of massive stars, and short GRBs (sGRBs) that are the result of a binary neutron star mergers, which are also predicted to be the counterparts of gravitational wave (GW) sources soon to be detectable by LIGO/Virgo, as well as other gamma-ray (10-1000 keV) transients. BurstCube contains 4 CsI scintillators coupled with arrays of compact low-power Silicon photomultipliers (SiPMs) on a 6U Dellingr bus, a flagship modular platform that is easily modifiable for a variety of 6U CubeSat architectures. BurstCube will complement existing facilities such as Swift and Fermi in the short term, and provide a means for GRB detection, localization, and characterization in the interim time before the next generation future gamma-ray mission flies, as well as space-qualify SiPMs and test technologies for future use on larger gamma-ray missions. The ultimate configuration of BurstCube is to have a set of ~10 BurstCubes to provide all-sky coverage to GRBs for substantially lower cost than a full-scale mission.

THE HOST GALAXY POPULATION OF LONG-DURATION GAMMA-RAY BURSTS

Dan Perley

We can learn about the progenitors of gamma-ray bursts by observing the types of galaxies that typically produce them. The first such observations almost 20 years ago provided the first evidence that long GRBs were formed from massive stars. Host galaxy research continues today in the hopes of better constraining what type of massive star: in particular, its initial mass, the allowed range of metallicity, and the role of binarity. These studies are now taking huge leaps forward: statistically (hundreds of hosts are now catalogued), systematically (via a better understanding of selection effects, especially host-ISM dust extinction), in redshift (the host population is well-constrained from $z = 0$ to $z = 5$) and in wavelength (legacy-scale samples now exist in the optical, mid-IR, and radio). Long GRBs appear to be almost completely stifled in regions of high metal-content (approximately Solar abundance), but explode readily at moderate metallicity (half Solar). They are exclusively produced by star-forming galaxies, but a high specific star-formation rate is not a required ingredient. Their hosts are more metal-poor than ordinary type Ic supernovae, but probably more metal-rich than superluminous type Ic supernovae, providing a hint towards the connection between the GRB progenitor and that of other energetic explosions.

The SVOM Gamma-Ray Burst Mission. F. Piron[1], on behalf of the SVOM consortium, [1]Laboratoire Univers et Particules de Montpellier, Université de Montpellier, CNRS/IN2P3, Montpellier, France, piron@in2p3.fr.

Abstract: Scheduled for a launch in 2021, SVOM ("Space-based multi-band astronomical Variable Objects Monitor") is a Sino-French space mission dedicated to the study of Gamma-Ray Bursts (GRBs). The satellite payload combines a coded-mask telescope operating in the 4-150 keV energy range for real-time detection and localization of all known types of GRBs, a non-imaging gamma-ray monitor for GRB spectroscopy up to MeV energies, and two narrow-field follow-up telescopes to refine the GRB positions and to study their afterglow emission in the X-ray and visible bands. The pointing strategy of the satellite has been optimized to favor the detection of GRBs located in the night hemisphere, in order to facilitate GRB redshift measurements by the largest telescopes and to enhance ground-based observations in the first minutes. The SVOM ground segment includes a wide-field camera to catch the GRB prompt emission in the visible band and two robotic telescopes to measure the photometric properties of the early afterglow in the NIR/visible band. We will present the scientific objectives of the SVOM mission, the operations, the instruments and their expected performance for GRB studies. We will also outline the prospects for GRB science with SVOM in the context of the multi-wavelength and multi-messenger panorama for the next decade.

SEARCH FOR PECULIAR PROPERTIES OF GAMMA_RAY BURSTS AT HIGH REDSHIFT. G. Pizzichini, INAF/IASF Bologna, Via Gobetti 101, 40129 Bologna, Italy pizzichini@iasfbo.inaf.it

Abstract: I shall report on an ongoing search for peculiar properties of long Gamma-Ray Bursts at high redshift. Up to now only trends probably due to instrumental limitations in detecting the events are found.

GRB AFTERGLOW OBSERVATIONS BY INTERNATIONAL SCIENTIFIC OPTICAL NETWORK (ISON). A. Pozanenko[1], E. Mazaeva[1], A. Volnova[1], L. Elenin[2], R. Inasaridze[3], V. Aivazyan[3], I. Reva[4], A. Kusakin[4], N. Tungalag[5], S. Schmalz[6], E. Chornaya[7], A. Matkin[7], A. Erofeeva[7], E. Litvinenko[8], K. Polyakov[9], V. Nevski[9], A. Ivanov[10], Yu. Krugly[11], G. Paronyan[12], V. Voropaev[2], I. Molotov[2], [1]Space Research Institute of the Russian Academy of Sciences (IKI), 84/32 Profsoyuznaya Str, Moscow, Russia, 117997, [2]Keldysh Institute of Applied Mathematics, Miusskaya sq., 4, Moscow, Russia, 125047 [3]Kharadze Abastumani Astrophysical Observatory, Ilia State University, Kakutsa Cholokashvili Ave 3/5, Tbilisi 0162, Georgia, [4]Fesenkov Astrophysical Institute, Observatory 23, 050020 Almaty, Kazakhstan, [5]Khureltogoot Observatory of Research Center of Astronomy and Geophysics, Ulaanbaatar, Mongolia, [6]Leibniz Institute for Astrophysics Potsdam (AIP), An der Sternwarte 16, 14482 Potsdam, Germany, [7]Ussuriysk Astrophysical Observatory of the Russian Academy of Sciences, Far East Branch, Gornotayojnoye, Ussuriysk region, Primorsky Krai, Russia, 692533, [8]Central Astronomical Observatory of the Russian Academy of Sciences, Pulkovskoye chaussee 65, Saint-Petersburg, Russia, 196140, JSC Astronomical Science Center, Moscow, Russia, [10]Kuban State University, 149 Stavropolskaya Str, Krasnodar, Russia, 350040, [11]Institute of Astronomy of Kharkiv National University, 35 Sumska Str, Kharkiv, 61022, Ukraine, [12]Byurakan Astrophysical Observatory, Byurakan 0213, Aragatzotn province, Armenia

The International Scientific Optical Network (ISON) [1] is devoted to space debris observations, search and follow up comets and asteroids and GRB follow up observations. Currently the ISON consists of 46 worldwide automated and two robotized telescopes of small apertures (0.22 – 1.0 m). Since 2010 we observed more than 140 GRBs (~30 per year) and detected about 40 GRB afterglows.

The fastest observation started 72 seconds [2] (35 seconds after alert receiving) after GRB 150203A trigger onboard Swift observatory. The most interesting GRB optical transient discovered and reported for the first time is GRB 130427A [3]. Also we performed long term monitoring of V404Cygni outburst in 2015 [4].

We provide light curves of most interesting GRB afterglows, analyze statistics of ISON GRB observations and compare an efficiency of short/long GRB observations. We also discuss the efficiency of the ISON follow up of future LIGO sources.

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COMPARISON OF SPI-ACS/INTEGRAL AND GBM/FERMI DATA AROUND A TIME OF DETECTION OF THE LIGO GRAVITATIONAL WAVE EVENTS. A. Pozanenko[1], P. Minaev[1], M. Barkov[2], and M. Toropov[3], [1]Space Research Institute (IKI), 84/32 Profsoyuznaya Str, Moscow, Russia, [2]Astrophysical Big Bang Laboratory, RIKEN, 2-1 Hirosawa, Wako, 351-0198, Saitama, Japan, [3]JSC ANT-service, Moscow, Russia.

We investigate the data obtained with SPI-ACS/INTEGRAL detector around a time of detection of the LIGO gravitational wave events GW150914, GW151226 and candidate LVT151012.

We compare sensitivity of SPI-ACS and GBM/Fermi for short GRBs using *Log*(N)-*Log*(S) distributions and confirm that GBM transient event at 0.4 s after GW150914 [1] should be detected by SPI-ACS [2]. If the GBM event is a real event, then it could be occulted by the Earth for SPI-ACS. If so, coordinates of the GBM event can be estimated with accuracy of about 2.5 grad. (radius) and the coordinates not coincide with localization area of GW150914.

Using wavelet technique we have searched for possible periodic-like signal around a time of detection of GW150914. We found a packet of 8.3 s pulsed emission consisting of a few periodic-like pulses starting about 2 s after GW150914. To estimate a chance probability we analyzed SPI-ACS data before and after GW150914 (about 1 Ms in total) with the same technique. Using different methods (including two-parametric coincidence estimation [3]) we estimated a chance probability of the packet of periodic pulses to be coincident with GW150914 as 0.02 – 0.2%. We have not found any significant pulsed emission in GBM/Fermi data around the time of detection of GW150914. Also we have not found any periodic-like signal around GW151226 and LVT151012 in SPI-ACS/INTEGRAL data. We discuss possible nature of periodic-like pulses after GW150914.

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AN IMPULSIVE MODEL FOR GRB SPECTRAL AND TEMPORAL EVOLUTION. R. D. Preece[1] and J. Hakkila[2], [1]Department of Space Science, University of Alabama in Huntsville, Huntsville, AL 35899 (Rob.Preece@nasa.gov), [2]University of Charleston, SC, at the College of Charleston (Graduate School, 66 George St., Charleston, SC 29466, hakkilaj@cofc.edu) and Department of Physics and Astronomy, College of Charleston, SC.

Introduction: Several bursts have been bright enough that their spectral and temporal evolution could be examined in detail. Observations of spectral lag, pulse width broadening and spectral evolution, have suggested a consistent impulsive model of pulse energization [1]. The first 2.5 s of GRB 130427A consisted of an initial impulsive event at very high energies nearly coincident with the GBM trigger time, with E_{peak} cooling as a t^{-1} power law throughout the emission episode [2]. The pulse first brightened and then decayed in the GBM passband, generating spectral lag and pulse temporal width broadening. The abundance of LAT data, both LLE and transient, solidly reinforced this behavior. In general, the post-peak spectral evolution is definitively not consistent with an impulsive shell model, favoring instead a magnetic mini-jet scenario [3]. Combinations of such pulses can account for observed GRB light curves and allows for the emergence of both hard-to-soft and hardness-intensity-tracking spectral evolution behavior. We present a detailed analysis of the recent bright burst GRB 160625B.

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TRANSIENT ASTROPHYSICS OBSERVATORY (TAO). J. L. Racusin[1] on behalf of the TAO team, [1]NASA Goddard Space Flight Center, Cod 661, 8800 Greenbelt Rd. Greenbelt, MD, 20771, USA; judith.racusin@nasa.gov

Abstract: The Transient Astrophysics Observatory (TAO) is a NASA MidEx mission concept (formerly known as Lobster) designed to provide simultaneous wide-field gamma-ray, X-ray, and near-infrared observations of the sky. TAO will locate and characterize the electromagnetic counterparts to gravitational wave sources, probe the epoch of reionization and cosmic chemical evolution through high-redshift GRBs, and discover4 and monitor an array of other transient sources. In addition to TAO's ability to initiate observations of new sources autonomously, the observatory will be able to rapidly respond to uplinked targets from LIGO/Virgo and other ground- and space-based alerts. TAO will quickly begin X-ray and near-IR observations, including prompt redshift measurements, with rapid dissemination of data products to the community. When not chasing transients, TAO will survey the sky with the Gamma-ray Transient Monitor (GTM), the Wide Field Imager (WFI), and the (near-) InfraRed Telescope (IRT).

COSMOLOGICAL EVOLUTION OF PRIMORDIAL BLACK HOLES

Authors: Jared Rice and Bing Zhang (UNLV)

Abstract: The cosmological evolution of primordial black holes (PBHs) is considered. A comprehensive view of the accretion and evaporation histories of PBHs across the entire cosmic history is presented, with focus on the critical mass holes. The critical mass of a PBH for current era evaporation is M_{cr}~5.1×10^{14} g. Across cosmic time such a black hole will not accrete radiation or matter in sufficient quantity to hasten the inevitable evaporation, if the black hole remains within an average volume of the universe. The accretion rate onto near-critical mass holes is most sensitive to the mass of the hole, the sound speed in the cosmological fluid, and the energy density of the accreted components. It is easy for a PBH to accrete to 30 M_{sun} by z~0.1 even outside any overdense region of the universe, so two merging PBHs are a plausible source for the gravitational wave event GW150914. However it is difficult for isolated PBHs to grow to supermassive black holes (SMBHs) at high redshift with masses large enough to fit observational constraints.

Manifestation of the jet photosphere in GRB spetra.

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Introduction:

We will discuss recent progress in our understanding of the emission mechanisms underlying the prompt phase in GRBs. In particular, we will discuss varying apperearences expected from the jet photosphere and compare these with observations. We will show that subphotospheric dissipation is a strong candidate for explaining the observed spectral shapes and evolutions.

CALET Upper Limits on X-ray and Gamma-ray Counterparts of GW 151226

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We present upper limits in the hard X-ray and gamma-ray bands at the time of the LIGO gravitational- wave event GW 151226 derived from the CALorimetric Electron Telescope (CALET) observation. The CALET gamma-ray burst monitor (CGBM) covered 32.5% and 49.1% of the GW 151226 sky localization probability in the 7 keV - 1 MeV and 40 keV - 20 MeV bands respectively. The main instrument of CALET, CALorimeter (CAL), placed a 90% upper limit of 2×10^{-7} erg cm^{-2} s^{-1} in the 1 - 100 GeV band where CAL reaches 15% of the integrated LIGO probability (~1.1 sr). The CGBM 7 σ upper limits are 1.0×10^{-6} erg cm^{-2} s^{-1} (7-500 keV) and 1.8×10^{-6} erg cm^{-2} s^{-1} (50-1000 keV) for one second exposure. We show the analysis result of an electromagnetic counter part search of GW 151226 event and also discuss about a future prospect of CALET in upcoming LIGO-Virgo O2 run.

THE GAMMA-RAY BURST TRIGGER SYSTEM ONBOARD SVOM/ECLAIRS, DESIGN AND SIMULATIONS

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Brief Abstract Summary: We present the design and simulations of the real-time Scientific Trigger Unit of the gamma-ray coded-mask imager ECLAIRs onboard the future mission SVOM, which will localize GRBs and allow their follow-up observations by X-ray and visible telescopes.

Abstract: SVOM, the Space-based multi-band astronomical Variable Objects Monitor, is a future Chinese-French satellite mission for studies of Gamma-Ray Bursts (GRBs). The Phase B has been concluded in July 2016 and the launch is foreseen in 2021. With its set of 4 on-board instruments as well as dedicated ground instruments, SVOM will study GBRs in great details, including their temporal and spectral properties in visible, X-rays and gamma-rays. The coded-mask telescope ECLAIRs on-board SVOM continuously observes a large portion of the sky in the 4-150 keV energy range. The ECLAIRs onboard Scientific Trigger Unit analyzes in near-real time the detector data stream in oder to detect and localize GRBs. It requests the spacecraft slew to allow GRB follow-up observations by the onboard narrow field-of-view telescopes (MXT in X-rays and VT in the visible), and alerts the community of observers via a dedicated ground network. This paper presents the design of the ECLAIRs Scientific Trigger Unit and recent simulation results.

The untriggered GRBs from Fermi-GBM in coincidence with LIGO. K. Siellez[1] , G. Carullo[1], S. Forsyth[1], L. Cadonati[1], M. Briggs[2,3] and V. Connaughton[4], [1]Center for Relativistic Astrophysics and School of Physics, Georgia Institute of Technology, Atlanta, GA 30332, USA, karelle.siellez@ligo.org, [2]Department of Space Science, University of Alabama in Huntsville, 320 Sparkman Drive, Huntsville, AL 35805, USA, [3]CSPAR, University of Alabama in Huntsville, 320 Sparkman Drive, Huntsville, AL 35805, USA, [4]Universities Space Research Association, 320 Sparkman Drive, Huntsville, AL 35806, USA.

Introduction: This year we celebrated the 100th anniversary of the Theory of the General Relativity of Einstein [1] and the first direct observation of Gravitational Waves [2]. LIGO [3] opened the new area of gravitational wave astrophysics with the detection of the coalescence of two black holes [4]. Neutron star mergers (either double neutron star or neutron star - black hole systems) [5] and collapsing massive stars [6] are the next candidate for the detection of Gravitational Waves. They are though to be also the progenitor of respectively short and long Gamma-Ray Bursts. A detection in coincidence of both the Gravitational Waves and the electromagnetic emission would open a new window in astrophysics: the multimessager area.

In order to detect this coincidence, the LIGO team uses a low-latency analysis that search for coincidences of GW triggers within some time window of a GRB in nearly real time thanks to the GCN sent by the satellite. Using a known position or a known time help to simplify the coherent analysis and reduce the background, thus, at medium and long latency, the GRB team of LIGO proceed to a triggered deep search using two most sensitive pipelines. But those analysis are realized on triggered GRB only.

The GBM team has developed a code that looks for untriggered GRBs that the Fermi GBM satellite have missed. Thanks to this code, we have extracted a list of GRBs candidate and analysed their spectral and temporal properties. The all-sky analysis, using the time of those events have been made with the X pipeline of LIGO for the first run of the detector.

The focus of this work is to describe the different searches developed for the gravitational waves detection triggered on GRB detection. We will show the motivations and analysis made for the untriggered searches. We will discuss about the developpement of the GBM code and its integration in the second run of LIGO that will start in September 2016 as well as the implication of those untriggered GRB on the expected rate of coincident event, the classification of long and short GRBs, and the possible new kind of progenitor for short GRBs at low redshift.

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The Hurst Exponent of Gamma-Ray Bursts. E. Sonbas[1,2], K. S. Dhuga[2], G.A. MacLachlan[2], and J. Landay[2], [1]University of Adiyaman, Department of Physics, 02040 Adiyaman, Turkey, edasonbas@yahoo.com, [2]Department of Physics, The George Washington University, Washington, DC 20052, USA

Introduction: Using a wavelet decomposition technique, we have extracted the Hurst exponent for a sample of long and short Gamma-Ray Bursts (GRBs) detected by the Burst Alert Telescope (BAT) aboard the Swift satellite. The Hurst exponent is a scaling parameter that can be used to gauge the long-range behavior in a time series. The mean Hurst exponent for the short GRB sample is significantly smaller than that for the long GRB sample, suggesting that this index may serve as an unbiased criterion for distinguishing short and long GRBs. In addition, a K-S test for the two samples suggest that the null hypothesis can be rejected.

KONUS-WIND OBSERVATIONS OF SHORT GAMM-RAY BURSTS. D. Svinkin[1], D. Frederiks[1], R. Aptekar[1], S. Golenetskii[1], M. Ulanov[1], T. Cline[2], and K. Hurley[3], [1]Ioffe Institute, Politekhnicheskaya 26, St. Petersburg, 194021, Russia, [2]NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA; Emeritus, [3]University of California, Berkeley, Space Sciences Laboratory, 7 Gauss Way, Berkeley, CA 4 94720-7450, USA

Introduction: Gamma-ray bursts (GRBs) can be divided into two distinct morphological classes based on the properties of the observed gamma-ray emission: short/hard GRBs, with a duration of less than 2 s and a negligible spectral lag (these GRBs are thought to be the results of mergers of binary compact objects; so-called Type I GRBs), and long/soft GRBs which last typically longer than 2 s, have softer spectra and non-negligible spectral lag (which probably originate from the core collapse of massive stars; Type II GRBs) [see e.g. 1].

The Konus-Wind GRB spectrometer (hereafter KW, [2]) has observed ~3000 GRBs, both short and long, in the period from launch in 1994 to 2015.

The KW short GRB sample: The KW short GRB sample was selected using the boundary between short and long GRBs of T_{50}=0.5 s. Containing ~400 GRBs, this sample is one of the largest to date in the broad energy band 10 keV-10 MeV. For these short bursts, the 'physical' Types were derived using the burst hardness-duration distribution by a method similar to that described in [3] and are as follows (the fractions of KW short GRBs of each type are given in parentheses): I (merger origin, ~70%), II (collapsar-origin, ~8%), I/II (the type is uncertain, ~12%). The sample includes 30 GRBs which can be classified as short GRBs with extended emission (EE) based on the short duration of an initial pulse and the presence of subsequent emission exhibiting no prominent spectral evolution.

Results: We present the results of spectral and temporal analysis of about 400 short GRBs detected by KW. We found that most of the time-integrated spectra are best-fitted by a cutoff power law (CPL) model, with typical photon index $\alpha \sim -0.5$ and $E_p \sim 500$ keV. An additional power-law component is needed to describe the spectra of three short GRBs.

Among 30 short GRBs with EE, 21 GRBs have intense enough EE to perform spectral analysis. For four of them the EE spectrum requires a "curved" CPL model with a rather high E_p of 160 keV-2.2 MeV.

Finally, we consider the results obtained in the context of the Type I (merger-origin) / Type II (collapsar origin) classification. Type I and Type II bursts occupy virtually non-overlapping regions in the E_p–total energy fluence (S) plane. The Type I GRBs form an elongated distribution that generally follows an $Ep \sim S^{0.5}$ relation. The Type II bursts from our sample do not share this correlation; they form a small, soft spectrum population which represents a tiny fragment of the long-soft KW GRB distribution. To a lesser extent, the same is true of the Type I and Type II population behavior in the E_p-peak energy flux (F_{peak}) plane. The candidate for a magnetar giant flare in the Andromeda galaxy (GRB 070201) is an apparent outlier in the E_p–F_{peak} distribution, supporting the non-GRB nature of this event.

The KW sensitivity to Type I GRBs is crucial for a search for electromagnetic counterparts of LIGO/Virgo events. For typical Type I GRB spectral parameters the sensitivity is $\sim 2\times10^{-7}$ erg cm^{-2}.

References: [1] Zhang (2009) *ApJ 703*, 1696. [2] Aptekar et al. (1995) *SSRv 71*, 265. [3] Horváth et al. (2010) *ApJ 713*, 552

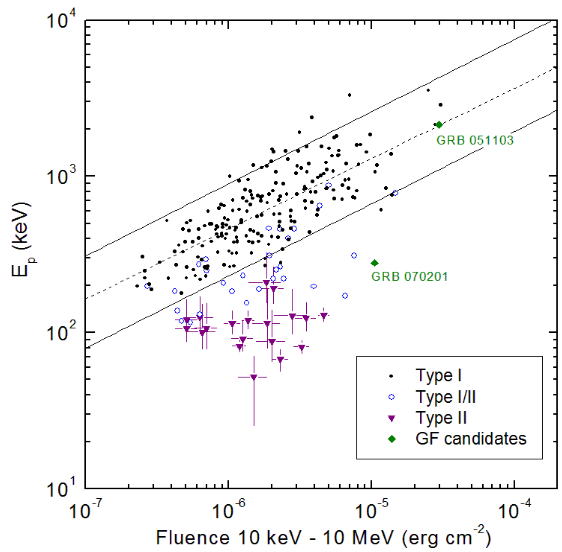


Figure 1. The E_p vs. the total energy fluence distribution for Type I (black circles); the bursts with uncertain type I/II (empty circles); and the Type II bursts (triangles). The extragalactic soft gamma-repeater giant flare candidates are shown with diamonds. The dashed lines denote the best powerlaw fit for the Ep–S (with an index of 0.46 ± 0.16) relation of the Type I GRBs. The solid lines denote the 90% prediction bands.

ADVANCED LIGO SEARCHES FOR GRAVITATIONAL WAVES ASSOCIATED WITH GAMMA-RAY BURSTS. Dipongkar Talukder[1] for the LIGO Scientific Collaboration and Virgo Collaboration, [1]University of Oregon (talukder@uoregon.edu).

Gamma-ray bursts (GRBs) are the most energetic astrophysical events that we observe in our universe, in the electromagnetic spectrum. According to the existing models, the long-soft GRBs are related to the core collapse of rapidly rotating massive stars. The progenitors of short-hard GRBs are widely thought to be coalescing binary neutron star or neutron-star-black-hole binary systems. Both types of GRB events are expected to emit gravitational waves that are detectable by Advanced LIGO when the source is within its range. Here we present efforts to localize gravitational-wave signal candidates on the sky and to identify coincidences in time with GRBs from the Swift and Fermi satellites on a very low-latency timescale. We discuss the strategies developed to promptly launch deep searches for gravitational waves associated with GRBs. We also present the status of these searches during Advanced LIGO's first observing run.

GEOMETRY-BASED PHYSICAL MODELLING OF THE FERMI GBM BACKGROUND.

K. Toelge[1] and J. Greiner[1], [1]Max Planck Institute for Extraterrestrial Physics, 85748 Garching, Germany.

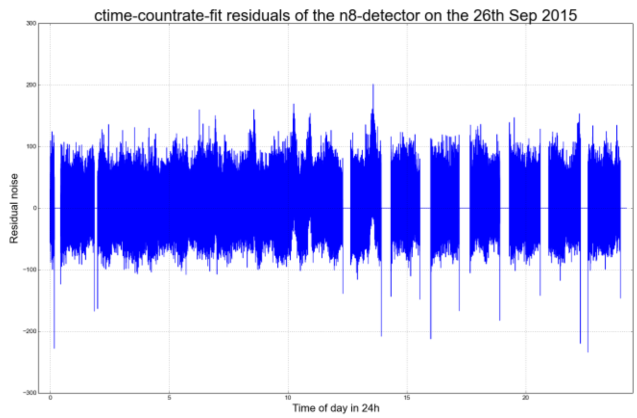
Introduction: We use the detector orientation and satellite position to model the background of the *Fermi* Gamma-ray Burst Monitor (GBM). The current use of polynomial fitting works only over short time-scales, and while suitable for GRB triggers, it is problematic for longer-duration or slowly rising transients. It does also not account for sudden changes in the orientation due to e. g. an autonomous repoint request (ARR).

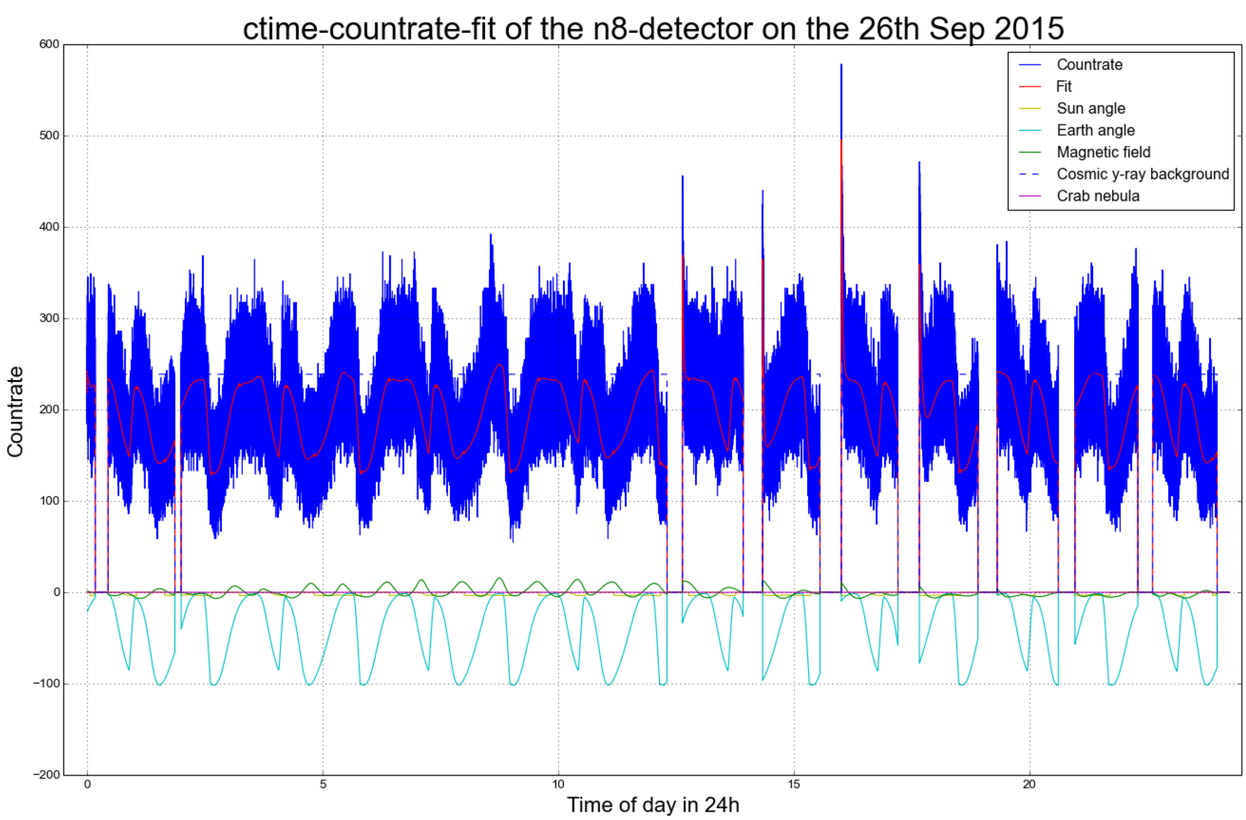
Our method uses five main background components, and for each of these computes the energy-dependent imprint on each GBM detector, using the spacecraft/detector geometry and position. This allows us to fit the background of an entire daily data-file and describe a large fraction of the regular and seemingly irregular variations in the orbital background. (large figure)

Subtracting this well motivated physical background model we are left with a relatively flat residual noise of the data. (small figure)

Singular events, of course, cannot be accounted for in the model, such as gamma-ray bursts (GRBs), soft gamma-ray repeaters (SGRs), solar flares, terrestrial gamma flashes (TGFs), or local and distant particle events. Cross-correlating different detectors and energy channels then helps to classify and filter the scientifically relevant events.

Once fully tested, this gives us the possibility to handle the GBM background in a nearly automatic fashion, thus allowing us to search for untriggered events.





The Rate of Short Duration GRBs from Swift observations

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[3]Center for Research and Exploration in Space Science and Technology (CRESST) and NASA Goddard Space Flight Center, Greenbelt, MD 20771 USA (amy.y.lien@nasa.gov);
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Introduction:

The rate of short GRBs and its evolution over cosmic times add a fundamental constraint to the age of their progenitor systems. This is a critical input to understand the formation and evolution of their progenitors, likely compact binary mergers, and whether there exists more than one channel producing short GRBs. The short GRBs rate also provides an independent measurement of the rate of compact binary mergers in the local Universe. This is a vital piece of information to quantify their role in the galactic chemical evolution, and to estimate their detection rate with advanced LIGO/Virgo, as well as the probability of a joint GRB-LIGO detection.

We used *Swift* observations of short GRBs to estimate their jet opening angles, luminosity function, and intrinsic rate of events. Monte Carlo simulations were used to model the complex selection effects affecting the observed sample. We present our preliminary results and discuss their implications for future gravitational wave detections.

Evidence of Bulk Acceleration in GRB Prompt Emission and X-ray Flares Z. Lucas Uhm[1], [1]Department of Physics and Astronomy, University of Nevada, Las Vegas, USA; uhm@physics.unlv.edu

Abstract: One of the most outstanding questions in GRB field concerns about the composition of relativistic jets that are responsible for producing bright prompt gamma-rays and X-ray flares. Among the two possibilities (i.e., a matter-dominated or a Poynting-flux-dominated outflow), it is possible to expect a signature of bulk acceleration of emitting region only in the case of a Poynting-flux-dominated jet. Here, I will present the recent discovery on two independent observational evidence of bulk acceleration in GRB prompt emission and X-ray flares.

CENTRAL ENGINES AND RADIATION MECHANISMS OF GAMMA-RAY BURSTS. P. Veres, CSPAR, University of Alabama in Huntsville, peter.veres@uah.edu

Gamma-ray burst research is strongly impacted by two major recent astrophysical developments: the direct detection of gravitational waves (GW) from binary black holes by Advanced LIGO and the detection of extragalactic neutrinos with IceCube. These discoveries could shed light on both the compact binary merger scenario and the collapsar model, the two leading central engine candidates for GRB central engines. The Gamma-ray Burst Monitor (GBM) on Fermi routinely follows up both GW and neutrino alerts. GBM detected a short gamma-ray burst 0.4 s after the first gravitational wave event and it is unclear if they are associated. Significant radiation from black hole binaries is unexpected and quite intriguing. One of the most important questions for future GW events is the confirmation or refutation of GRBs associated with binary black holes. Assuming the gravitational wave event GW150914 and GW150914-GBM (the gamma-ray signal detected 0.4 seconds later) are related, I will discuss the implications on the current GRB radiation models. I will also talk about prospects of determining the composition of the jets of gamma-ray bursts. Soon the >100 GeV energy range will be accessible for GRBs either with existing (HAWC, VERITAS, MAGIC or HESS) or with the future ground based telescopes (CTA). We will get closer to the origin of late arriving, high energy photons that violate the synchrotron limit of an otherwise seemingly synchrotron spectrum. I will discuss another pressing question which is the identification of the synchrotron self-Compton component in the GRB spectrum or finding an explanation for its absence.

Gravitational wave observations can constrain gamma-ray burst models: the case of GW 150914 - GBM

P. Veres, R. D. Preece, A. Goldstein, P. Mészáros, E. Burns, V. Connaughton

The possible short gamma-ray burst observed by Fermi/GBM in coincidence with the first gravitational wave (GW) detection, offers new ways to test GRB prompt emission models. Gravitational wave observations provide previously inaccessible physical parameters for the black hole central engine such as its horizon radius and rotation parameter. Using a minimum jet launching radius from the Advanced LIGO measurement of GW 150914, we calculate photospheric and internal shock models and find that they are marginally inconsistent with the GBM data, but cannot be definitely ruled out. Dissipative photosphere models, however have no problem explaining the observations. Based on the peak energy and the observed flux, we find that the external shock model gives a natural explanation, suggesting a low interstellar density ($\sim 10^{-3}$ cm^{-3}) and a high Lorentz factor (~2000). We only speculate on the exact nature of the system producing the gamma-rays, and study the parameter space of a generic Blandford-Znajek model. If future joint observations confirm the GW-short GRB association we provide similar but more detailed tests for prompt emission models. (ApJL - accepted, arXiv:1607.02616)

THE FOURTH FERMI GBM GAMMA-RAY BURST CATALOG: THE FIRST EIGHT YEARS. A. von Kienlin[1], C. A. Meegan[2] and W. S. Paciesas[3], [1]Max-Planck-Institut für extraterrestrische Physik, Giessenbachstrasse, D-85748 Garching, Germany, azk@mpe.mpg.de, [2]The Center for Space Plasma and Aeronomic Research (CSPAR), University of Alabama in Huntsville, 320 Sparkman Drive, Huntsville, AL 35805, USA, chip.meegan@nasa.gov [3]Universities Space Research Association, 320 Sparkman Drive, Huntsville, AL 35805, USA, bill.paciesas@nasa.gov

Abstract: The fourth Fermi GBM Gamma-Ray Burst Catalog, currently under preparation, will extend the six-year-catalog [1] by two more years. The intention of the GBM GRB catalogs is to provide information to the community on the most important observables of the GBM detected GRBs. For each GRB the location and main characteristics of the prompt emission, the duration, peak flux and fluence are derived. Furthermore, information is given on the settings and modifications of the triggering criteria and exceptional operational conditions.The poster will introduce the catalog and present distributions of these derived quantities.

The fourth catalog is an official product of the Fermi GBM science team, and the data files containing the complete results are available from the High-Energy Astrophysics Science Archive Research Center (HEASARC).

References:

[1] Bath P. N. et al. (2016) *ApJS, 223,* 28.

Probing the properties of high-redshift Universe using GRBs. F. Y. Wang[1] and Z. G. Dai[2], [1]School of Astronomy and Space Science, Nanjing University, China (fayinwang@nju.edu.cn), [2] School of Astronomy and Space Science, Nanjing University, China (dzg@nju.edu.cn).

Introduction: Gamma-ray bursts (GRBs) are among the most intriguing phenomena in the Universe [1,2]. According to the duration time, GRBs are usually classified into two classes: long GRBs and short GRBs. Long GRBs are thought to arise when a massive star undergoes core collapse, but the progenitors of short GRBs are mergers of double neutron stars or neutron star-black hole binary. In view that the history of the Universe during the so-called ``dark age'' is still poorly known, GRBs, as bright beacons in the deep Universe, would be the unique tool to illuminate the dark Universe and allow us to unveil the reionization history[3,4]. GRBs provide ideal probes of the formation rate and environmental impact of stars in the high-redshift universe[5,6], including the metal enrichment of the intergalactic medium (IGM)[7,8]. In this talk, I will present progress on GRB Cosmology, such as probing star formation rate [6,9], gravitational wave [10] and metal enrichment history using GRBs[7].

GRB X-ray flares, which may have important clues to the central engine, are common phenomena in the GRB afterglows[11,12]. I discuss statistical results of X-ray flares, i.e., energy, duration time and waiting time distributions, and compare the results with solar flares[13]. The similarity between the two kinds of flares are found, which may indicates that the physical mechanism of GRB X-ray flares is magnetic reconnection[13,14].

References: Use the brief numbered style common in many abstracts, e.g., [1], [2], etc. References should then appear in numerical order in the reference list, and should use the following abbreviated style:

[1] Gehrels, N., Ramirez-Ruiz, E., Fox, D. B., 2009, ARA&A, 47, 567.

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[10] Tan, W. W., Wang, F. Y., 2016, submitted to MNRAS

[11] Burrows, D. N. et al., 2005, Science, 309, 1833.

[12] Barthelmy, S. D. et al., 2006, Nature 438, 994.

[13] Wang, F. Y., Dai, Z. G., 2013, Nature Physics, 9, 465.

[14] Dai, Z. G., et al., 2006, Science, 311, 1127.

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GAMMA-RAY BURST JETS REVISITED. Xiang-Gao Wang[1], Bing Zhang[2], En-wei Liang[1] and Rui-Jing Lu[1], [1]GXU-NAOC Center for Astrophysics and Space Sciences Guangxi University, Nanning 530004, China, wangxg@gxu.edu.cn, [2]Department of Physics and Astronomy, University of Nevada Las Vegas, NV 89154, USA; zhang@physics.unlv.edu

Introduction: Gamma-ray bursts (GRBs) are believed collimated, and are proposed as a standard energy reservoir and potential candles to trace the Hubble diagram of the universe in the high redshift range. In this paper, we using a large optical afterglow sample from February 1997 up to 2015 to investigate the jet break phenomenons in GRBs. 44 GRBs is found that their temporal/spectral behaviors are consistent with the the jet break predictions of the forward shock models, including 41 long/soft (Type II) and 3 short/hard (Type I) GRBs. None of jet break with energy injection is found. 22 GRBs have a lower limit for jet break. We perform the statistical analysis and get electron spectral index p=2.27±0.42, jet break time $\rm log(t_b/s)=5.25\pm0.59$, jet opening angle $\theta_j=(3.3 \pm 1.5)^\circ$, and various energy, isotropic γ-ray energy $E_{\gamma,iso}$, isotropic kinetic energy $E_{K,iso}$, geometrically corrected E_γ and jet corrected kinetic energy E_K. We use the jet break candidates to test the typical experimental luminosity correlations, e.g., Amati, Frail, Ghirlanda, Liang-Zhang Relation. 5 GRBs are graded as two-component jet GRBs.

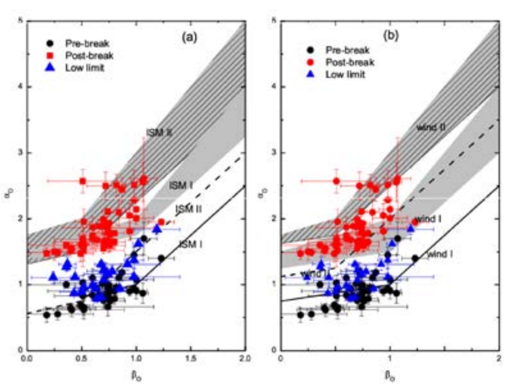


Figure 1:The measured afterglow α and β values compared against the closure relations in the jet break model. (a) and (b) for the ISM and wind models, respectively; and solid anddashed lines are for the spectral regimes I ($\nu>\nu_c$) and II ($\nu_m<\nu<\nu_c$), respectively.

NONLINEAR COSMIC RAY ACCELERATION DURING GAMMA-RAY BURST AFTERGLOWS.

D. C. Warren[1], D. C. Ellison[2], M. V. Barkov[1,3,4], and S. Nagataki[1]. [1]Astrophyiscal Big Bang Laboratory, RIKEN, (Rm 219, Main Research Building, 2-1 Hirosawa, Wako, Saitama 351-0198, Japan; donald.warren@riken.jp), [2]Physics Department, North Carolina State University, [3]Institute for Physics and Astronomy, University of Postdam, [4]DESY.

The standard synchrotron model for gamma-ray burst (GRB) afterglows [e.g. 1,2] has been applied with great success since its introduction. However, every paper based on this model (with extremely rare exception, e.g. [3]) makes the same two assumptions: (1) that the electrons responsible for the afterglow form a simple power law, and (2) that particle acceleration takes place in the test-particle regime.

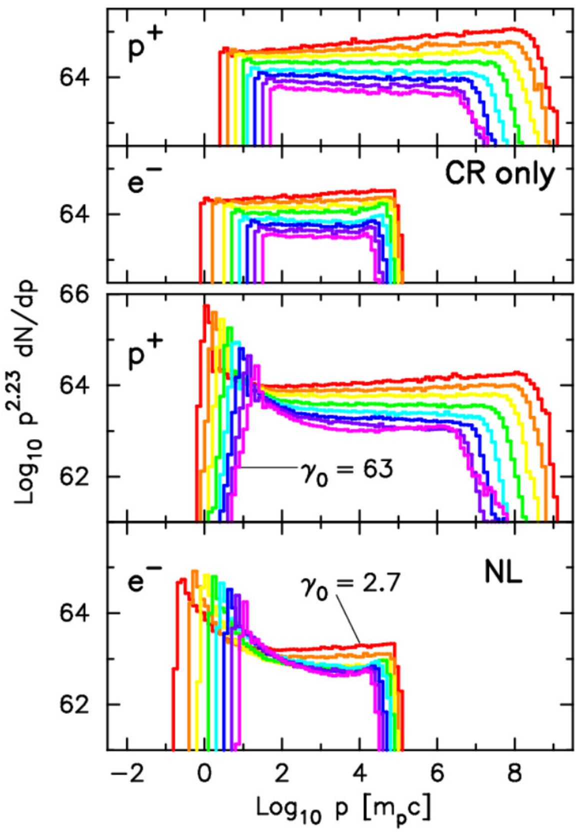
Particle-in-cell (PIC) simulations [e.g. 4,5] challenge both of these assumptions. There is a clear thermal peak in addition to a (possible) nonthermal power-law tail, and as much as 10% of the bulk flow energy is placed in the nonthermal tail. At present, PIC simulations are limited in dynamical range and cannot sample the time, space, and energy scales required to model a full GRB afterglow.

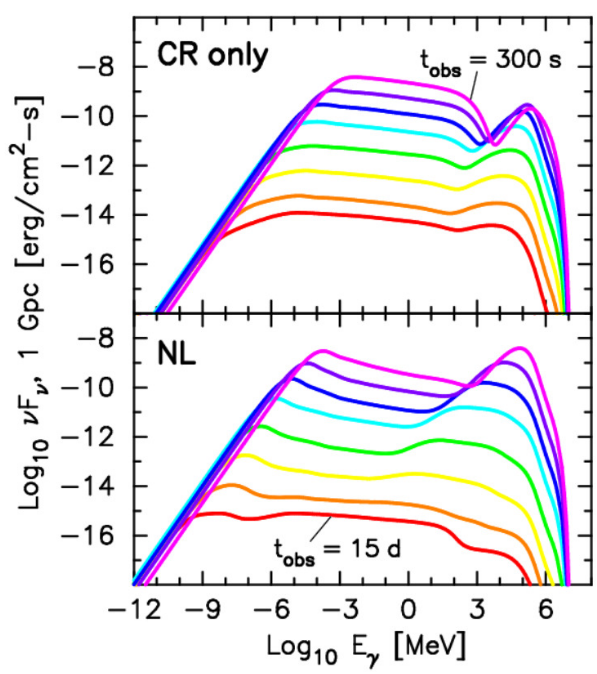
We present here a Monte Carlo treatment of particle acceleration in GRB afterglows, which allows us to model the acceleration of all particles, from pre-accelerated electrons to the highest-energy protons, in a self-consistent manner. We include thermal particles and calculate the nonlinear interaction between the shock structure and the particles being accelerated. As well, we follow our particles long after they cross the shock, testing the one-zone model commonly used in the literature.

Our results show a clear deviation from the traditionally assumed power law (top figure), with a both an obvious thermal peak and a pronounced evolution in the particle spectra shapes.

These changes lead to observable differences in the photon spectra (bottom figure), including a significant enhancement in GeV flux due to the synchrotron self-Compton process. Our model predicts spectral evolution in the X-ray as the thermal peak crosses that band, in accordance with [3]. We also show that the one-zone model is satisfactory for X-ray afterglows, but may be inadequate in optical and at GeV energies.

References: [1] Sari R., Piran T., & Narayan R. 1998, *ApJL*, 497, L17. [2] Gao H., Lei W.-H., Zou Y.-C., Wu X.-F., & Zhang B. 2013, *New Astronomy Reviews*, 57, 141. [3] Giannios D. & Spitkovsky A. 2009, *MNRAS*, 400, 330. [4] Spitkovsky A. 2008, *ApJL*, 682, L5. [5] Sironi L., Spitkovsky A., & Arons J. 2013, *ApJ*, 771, 54.





Binary Neutron Star Mergers Throughout the Evolving Universe. B. K. Wiggins[1,2], C. L. Fryer[1], J. M. Smidt[1] and D. H. Hartmann[3], [1]Center for Theoretical Astrophysics, Los Alamos National Laboratory (wiggins@lanl.gov), [2]Southern Utah University, [3]Clemson University (hdieter@g.clemson.edu).

With the advent of aLIGO, gravitational wave emission from binary neutron star mergers may soon be detected with high cadence, and their hypothesized link to short GRBs might be confirmed with space-based gamma ray observatories.

While long-duration gamma ray bursts originate from massive stars and thus are located near their stellar nurseries, binary neutron stars may merge on much longer timescales, and thus may have had time to migrate appreciably. The strength and character of the electromagnetic afterglow emission of binary neutron star mergers is a sensitive function of the circum-merger environment. Though the explosion sites of short GRBs have been explored in the literature, the question has yet to be fully addressed in its cosmological context. We present simulations of the evolution of a large co-moving volume with star formation and combined with stellar population synthesis models to self-consistently track the locations and environmental gas densities of merger sites throughout the cosmic web. We present probability distributions for densities as a function of redshift and discuss model sensitivity to population synthesis model assumptions.

Prospects for Ground-Based Detection of Very High Energy Emission from GRBs. J. Wood, University of Wisconsin - Madison, Madison WI

Abstract: We present the prospects for detection of very high energy (VHE) emission around 100 GeV from Gamma-Ray Bursts (GRBs) with the newest generation of ground-based gamma-ray telescopes. This includes the now operating High-Altitude Water Cherenkov (HAWC) Observatory and the soon to be constructed Cherenkov Telescope Array (CTA). Detections of GRBs in this energy range are important as observations of the highest energy photons probe the environment of the emission region, particle acceleration mechanisms, and intergalactic space itself.

Energy response function of CALET Gamma ray Burst Monitor. Y. Yamada[1], T. Sakamoto[1], A. Yoshida[1] for the CALET collaboration.
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Abstract: CALorimetric Electron Telescope (CALET; [1][2]) was attached to the Japanese exposed facility Kibo of the International Space Station (ISS) on August, 2015. CALET started it's regular operation on Octorber 2015. CALET has two scientific instruments: CALorimetor (CAL) and Gamma ray Burst Monitor (CGBM; [3]). CGBM has two types of scintillation detectors. The Hard X-ray Monitor (HXM) which utilizes $LaBr_3$(Ce) crystal has the energy range of 7 keV – 1 MeV. The soft Gamma-ray Monitor (SGM) uses BGO crystal and covers 50 keV – 20 MeV.

In this paper, we present the current status of the energy response function of the CGBM using the ground and the flight data. We will explain the development of the CGBM energy response function. We will also show the spectral analysis results of CGBM using our developed energy response function for simultaneously detected bright GRBs by other GRB detectors.

References: [1] Asaoka, Y., the CALET Collaboration, PoS (ICRC2015) 603 [2]Torii, S., the CALET Collaboration, PoS (ICRC2015) 581 [3] Yamaoka K., Yoshida, A., Sakamoto, T. et al. 2013, 7th Huntsville Gamma-Ray Burst Symposium, GRB 2013: paper 41 in eConf Proceedings C1304143

IN-ORBIT PERFORMANCE OF THE CALET GAMMA-RAY BURST MONITOR

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CALorimetric Electron Telescope (CALET [1][2]) is a cosmic-ray mission to observe high energy electrons and gamma-rays in the GeV-TeV range. The main scietific motivation is to clarify an origin of TeV electrons propagated in our Galaxy and search for signatures from dark matter. CALET has been developed and operated under international collaborations among Japan, U.S. and Italy.

CALET consists of two scientific instruments: primary instrument, Calorimeter (CAL) sensitive to 1 GeV-10 TeV gamma-rays and secondary instrument, Gamma-ray Burst Monitor (CGBM [3]) sensitive to X- and soft gamma-rays in the 7 keV-20 MeV range. CGBM was designed and attached to complement CAL observations of Gamma-ray Bursts (GRBs) in the GeV range. To cover a wide energy coverage for GRBs, CGBM further consists of two types of detectors: two Hard X-ray Monitors (HXMs) in the 7 keV-1 MeV range and one Soft Gamma-ray Monitor (SGM) in the 50 keV-20 MeV range. The HXM utilizes LaBr3(Ce) scintillator with 3inch diameter and 0.5inch thickness, while SGM is BGO crystal with 4inch diameter and 3inch thickness. Both are read out by Hamamatsu Photomulitiplier Tubes (PMT).

CALET was successfully launched by H-IIB/HTV from JAXA Tanegashima Space Center in summer 2015, and attached to the Exposed Facillity (EF) of Japanese Experimental Module (JEM) “Kibo” on the Interntional Space Station (ISS). CGBM was turned on Octorber 6, 2015. Since then, all the CGBM detectors have been working well for about one year. 30 GRBs have triggered CGBM in the on-board trigger system till July 2016 as expected from previous estimation.

In this paper, we will present in-orbit operation and performance of CGBM such as operation history, background rate and spectra in the ISS orbit with 400 km altitude and inclination angle, gain variation, on-board trigger rate, and timing and spectral performance for GRBs in addition to details of CGBM system.

References:

[1] Asaoka, Y., the CALET Collaboration, PoS (ICRC2015) 603
[2] Torii, S., the CALET Collaboration, PoS (ICRC2015) 581
[3] Yamaoka K., Yoshida, A., Sakamoto, T. et al. 2013, 7th Huntsville Gamma-Ray Burst Symposium, GRB 2013: paper 41 in eConf Proceedings C1304143

Time evolution of the spectral break in the high-energy extra component of GRB 090926A. M. Yassine[1], F. Piron[1], R. Mochkovitch[2] and F. Daigne[2], [1]Laboratoire Univers et Particules de Montpellier, Université de Montpellier, CNRS/IN2P3, Montpellier, France (e-mail: manal.yassine@lupm.in2p3.fr, piron@in2p3.fr), [2]UPMC-CNRS, UMR7095, Institut d'Astrophysique de Paris, 75014 Paris, France (e-mail: mochko@iap.fr, daigne@iap.fr).

Introduction: The gamma-ray light curve of the long GRB 090926A shows a short pulse at 10 seconds post-trigger in both Fermi GBM and LAT instruments. This bright spike coincides with the emergence of a power-law component at energies greater than 10 MeV, which exhibits a spectral attenuation at a few hundreds of MeV. We combine the LAT Pass 8 data with the GBM data in joint spectral fits to reanalyze the broad-band spectrum of GRB 090926A during its prompt phase. Our analysis not only confirms and better constrains the high-energy spectral break during the bright spike, but also reveals that the spectral attenuation persists at later times, with an increase of the break energy up to the GeV domain until the end of the prompt phase. Assuming that the spectral break comes from photon annihilation and requiring that all emissions are produced above the photosphere of GRB 090926A, we derive values of the jet Lorentz factors Γ between 100 and 250, with a weak dependency on the temporal evolution of the spectral break. Lower limits on Γ with larger values are also obtained, assuming instead that the spectral break reflects the natural curvature of the inverse Compton spectrum. Combined with the extreme temporal variability of GRB 090926A, these Lorentz factors lead to emission radii $R \geq 10^{14}$ cm which are consistent with an internal origin of both the keV-MeV and GeV prompt emissions.

Calorimetric Electron Telescope (CALET) : Mission and Overview

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The Calorimetric Electron Telescope (CALET) was successfully launched and attached to the International Space Station (ISS) at the end of August 2015. After the initial checkout, the scientific operations began in October 2015. Currently observations by the main instrument CALorimetor (CAL) covers 99% of the ISS orbit time with sensitivity to gamma-rays above 1 GeV or 8 GeV depending on operational mode; mostly 1 GeV during the time when the CALET Gamma-ray Burst Monitor (CGBM) is available, while CGBM covers about 50% of the orbit with roughly from 10 keV to 20 MeV. We will present the operational status of the CALET and scientific results during the first year of its successful operation.

TIME-RESOLVED SPECTRAL SHAPES OF GAMMA-RAY BURSTS. H.-F. Yu[1], [1]Max Planck Institute for Extraterrestrial Physics (Giessenbachstr. 1, 85748 Garching, Germany, sptfung@mpe.mpg.de).

Introduction: Thanks to the high temporal and spectral resolutions of the *Fermi* Gamma-ray Burst Monitor (GBM), the time-resolved spectral shapes of gamma-ray bursts (GRBs) can be studied in great detail in the keV to MeV range. I will review the recent research advancements about the physical mechanism of GRB prompt emission, made possible via data obtained by the GBM, focusing on the constraints placed on conventional theories by the recent study of the sharpness angle of GBM GRB time-resolved spectra.

AN EXPLORATION OF ISSUES WITH GBM GRB SPECTROSCOPY. H.-F. Yu[1], J. M. Burgess[2,3], and J. Greiner[1], [1]Max Planck Institute for Extraterrestrial Physics (Giessenbachstr. 1, 85748 Garching, Germany, sptfung@mpe.mpg.de), [2]The Oskar Klein Center for Cosmoparticle Physics (SE-106 91 Stockholm, Sweden, jamesb@kth.se), [3]Department of Physics, KTH Royal Institute of Technology (AlbaNova, SE-106 91 Stockholm, Sweden).

Introduction: The GRB prompt emission mechanism has been puzzling for years. Recently, it has discovered that the spectral shapes of the observed GRB spectra, mainly obtained by the Fermi Gamma-ray Burst Monitor (GBM), are too sharp to be consistent with the synchrotron interpretation[1]. Through conventional GBM spectral analysis technique, we found an unexpectedly large discrepancy in the observed photon flux between different pairs of GBM detectors. The effect on the spectral parameters and the physical interpretation of GRB emission mechanism is unknown. We investigate these issues, and using the newly developed tool, the BAyesian Location Reconstruction of GRBs (BALROG) we re-analyse the spectral properties of GBM GRBs. By fitting the GRB location and spectrum simultaneously, BALROG can appropriately marginalize the spectral parameters over the location parameters and has the ability to marginalize effective area corrections in the spectral distributions as well. Such analysis approach can help in the search for a consistent and physical model of GRB prompt emission mechanism.

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THE POLAR AND THE EINSTEIN PROBE MISSIONS

Weimin Yuan (NAOC/CAS), Jianchao Sun (IHEP/CAS), Cheng Zhang (NAOC/CAS), Shuang-Nan Zhang (IHEP/CAS), presented by Bing Zhang (UNLV)

Two China-led future missions will be presented, POLAR and Einstein Probe. POLAR is a GRB polarimeter to measure the polarization of prompt emission of GRBs in 50–500 keV with a large effective area and a wide field of view. Scheduled for a launch in late 2016, POLAR will be onboard the Chinese space laboratory "Tiangong-2 (TG-2)". As a candidate mission of priority in CAS's space science program, the Einstein Probe is designed to carry out surveys of high-energy transients including GRBs in the soft X-ray band, complementary with the capability of prompt X-ray follow-up observations. Its wide-field imaging capability is achieved by using established technology of micro-pore lobster-eye optics, thereby offering unprecedentedly high sensitivity and large Grasp.

ELECTROMAGNETIC COUNTERPARTS OF GRAVITATIONAL WAVE SOURCES.
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I will discuss possible electromagnetic (EM) counterparts of ~kHz gravitational wave (GW) sources including NS-BH, NS-NS, and BH-BH mergers. The possible EM signals include short-duration GRBs and afterglows, kilo-nova (merger-nova) and afterglows, as well as a more speculative possible connection with fast radio bursts. I will discuss how detections/non-detections of these counterparts for current and future LIGO/Virgo GW sources may advance our understanding of physics of compact star mergers, especially NS equation-of-state and possible charges of BHs and NSs.

GRB 160625B: A Burst of Three B.-B. Zhang[1] et al., [1]Instituto de Astrofisica de Andalucia (IAA-CSIC), P.O. Box 03004, E-18080 Granada, Spain, zhang.grb@gmail.com

GRB 160625B is a peculiar Gamma-Ray Burst which consists three dramatically different isolated sub-bursts. These three sub-bursts are separated by long quiescent background. Their durations are quite different, ranging from 0.8 s to 212 s. Interestingly, each of these sub-bursts has different spectral properties, which allow us for the first time to observe the transition between thermal and non-thermal radiation in a single GRB. Such transition is a clear indication of radiation mechanism change as well as a possible energy dissipative radius change. By presenting the multi-wavelength observations of this GRB, we discuss several possible physical pictures that can form this particular burst and its implication of the origins of other GRBs.

Radiation Mechanism and Jet Composition of Gamma-ray Bursts and GeV–TeV-Selected Radio-Loud Active Galactic Nuclei.

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Introduction: Gamma-ray bursts (GRBs) and GeV–TeV-selected radio-loud active galactic nuclei (AGNs) are compared based on our systematic modeling of the observed spectral energy distributions of a sample of AGNs with a single-zone leptonic model. We show that the correlation between the jet power ($P_{\rm jet}$) and the prompt gamma-ray luminosity ($L_{\rm jet}$) of GRBs is consistent, within the uncertainties, with the correlation between jet power and the synchrotron peak luminosity ($L_{\rm s,jet}$) of flat spectrum radio quasars (FSRQs). Their radiation efficiencies (ε) are also comparable (>10% for most sources), which increase with the bolometric jet luminosity ($L_{\rm bol,jet}$) for FSRQs and with the $L_{\rm jet}$ for GRBs with similar power-law indices. BL Lac objects (BL Lacs) do not follow the $P_{\rm jet}$–$L_{\rm s,jet}$ relation of FSRQs. They have lower ε and $L_{\rm bol,jet}$ values than FSRQs, and a tentative $L_{\rm bol,jet}$–ε relation is also found, with a power-law index different from that of the FSRQs. The magnetization parameters (σ) of FSRQs are on average larger than that of BL Lacs. They are anti-correlated with ε for the FSRQs, but positively correlated with ε for the BL Lacs. GeV narrow-line Seyfert 1 galaxies potentially share similar properties with FSRQs. Based on the analogy between GRBs and FSRQs, we suggest that the prompt gamma-ray emission of GRBs is likely produced by the synchrotron process in a magnetized jet with high radiation efficiency, similar to FSRQs. The jets of BL Lacs, on the other hand, are less efficient and are likely more matter-dominated.

References:

[1] Jin Zhang, Enwei Liang et al. (2013) ApJL, *774,* L5. [2] Nemmen et al. (2012) 2012, *Sci, 338,* 1445

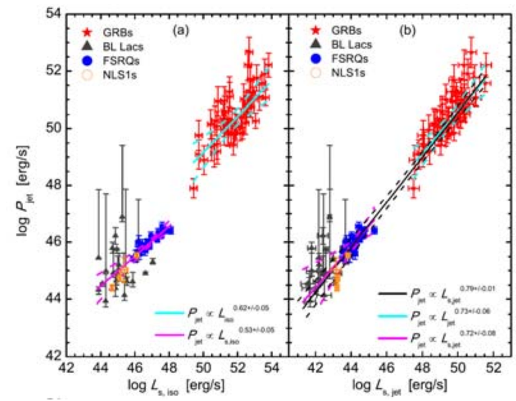

Fig 1. Jet power as a function of (a) isotropic synchrotron radiation peak luminosity of AGNs and isotropic gamma-ray luminosity of GRBs, (b) geometrically corrected synchrotron radiation peak luminosity of AGNs and GRB jet luminosity. The solid and dashed lines are the best linear fits and their 3σ confidence bands for the GRBs (cyan) and FSRQs (magenta). In panel (b), the best fit and its 3σ confidence band (black lines) to the combined GRB and FSRQ sample are also shown. The data of GRBs are from Nemmen et al. 2012.

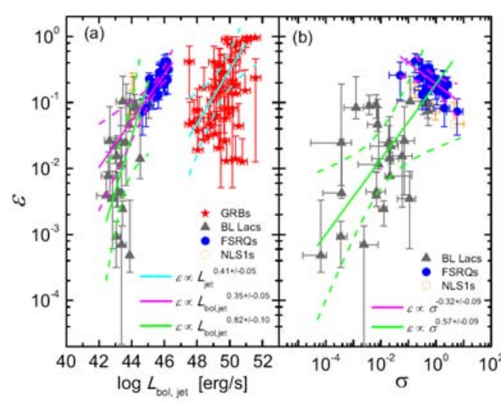

Fig 2. Jet radiation efficiency (ε) as a function of the jet luminosity (geometrically corrected bolometric luminosity of AGNs and prompt gamma-ray luminosity of GRBs) and the magnetization parameter (σ) of AGNs in our sample. The colored lines are the best linear fits along with 3σ confidence bands to the data of the GRBs (cyan), FSRQs (magenta), and BL Lacs (green). The data of GRBs are from Nemmen et al. 2012.

ENERGY AND SPECTRA OF GAMMA RAY BURSTS FROM MERGERS OF BINARY BLACK HOLES.

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Introduction: LIGO has recently confirmed the existence of black holes and their binary merger through the recent first ever detection of gravitational waves (GWs) from the merger of binary black holes with 36 and 29 solar masses, repectivelly, denoted as the event of GW150914) [1]. The Fermi Gamma-ray Burst Monitor detected a short gamma ray burst (GRB) from the same binary black hole merger about 0.4 seconds after the GW arrived [2]. The calculated odds of that being a coincidence between the GRB and GW phenomena are only 0.0022%, so that they were be highly correlated. GRBs are the most energetic events occurred in the universe. According to their durations being greater than two seconds or not, astrophysicists usually categorizes GRBs into long and short ones [3]. It is generally believed that long GRBs are produced by the collapse of massive stars to form compact objects such as neutron stars or stellar black holes while hort GRBs are caused by the merger of binary neutron stars or a neutron star with a black hole [4]. It still remains unknown on how the merger of binary black holes that generates GWs, because of lack of large amount of matter around, to produce a GRB

Recently, Zhang [5] has proposed a new mechanism for gamma ray bursts as emissions of dynamic black holes according to his newly developed black hole model of the universe [6-7]. A black hole, when it accretes its star or merges with another black hole, becomes dynamic. A dynamic black hole has a broken event horizon and thus cannot hold the inside hot (thus high-frequency) blackbody radiation, which flows or leaks out and produces a GRB. A star when it collapses into its core black hole produces a long GRB and releases the gravitational potential energy of the star as gamma rays. A black hole that merges with another black hole produces a short GRB and releases a part of their blackbody radiation as gamma rays. This study bases on this new mechanism to quantitatively investigate the energy and spectra of the short GRB emitted from the merger of binary black holes that produced the LIGO detected GWs.

GRB Energy and Spectra: The energy and energy spectrum of a short GRB that is produced by the merger of binary black holes that produced the GWs first ever detected by the LIGO detectors are plotted in Figure 1. Here T_s is the temperature of a reference black hole with mass M_s of about three solar masses. For $T_s = 1.5\times10^{11}$ K, the energy emitted is about 10^{49} ergs and the flux received is about 0.1 counts/cm^2/s/keV with energy at 1 MeV. The results obtained are consistent with the measurements in order of magnitude [2]. In addition, since the GRB occured during the merger of the binary black holes while the GWs were generated during the rotatation of the binary black holes, we can understand why the GRB arrived 0.4 seconds later than the GW did.

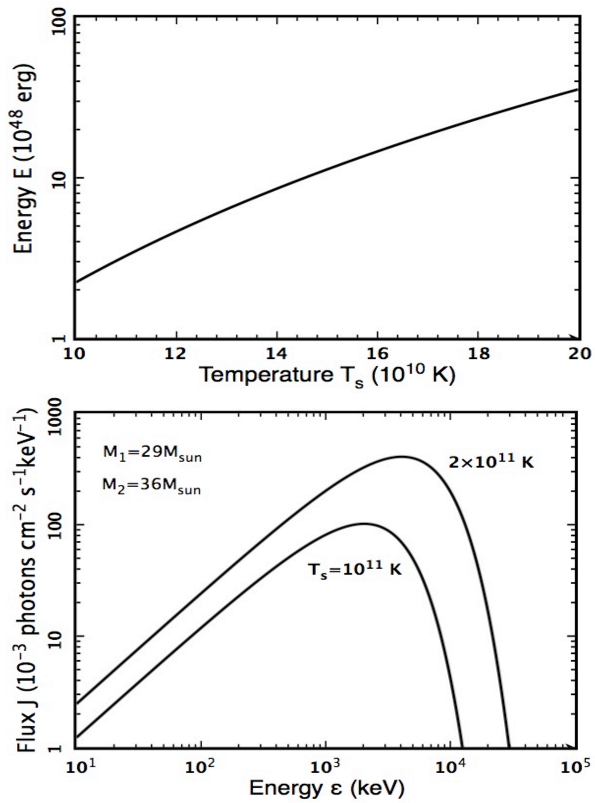

Fig. 1: Energy (top panel) and spectra (bottom panel) of the short GRB emitted from the merger of binary black holes that produced the GWs detected by the LIGO detectors.

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