Issue 3
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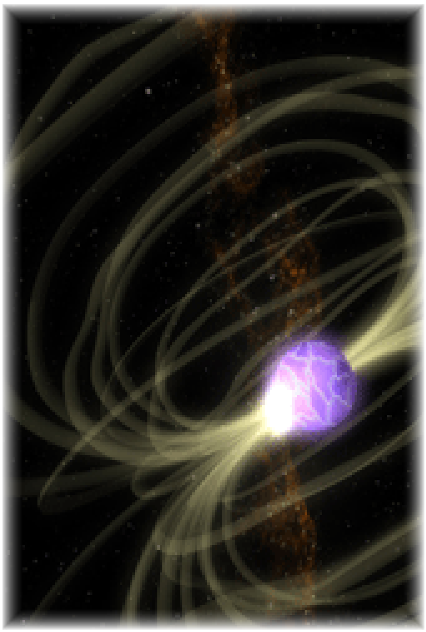
Swift Newsletter

Mission Update

Neil Gehrels, Principal Investigator



An artist's impression of the magnetar SGR 1806-20 during its latest eruption, with plasma streaming along its magnetic field lines.

Welcome to our third newsletter. We have just celebrated the one-year anniversary of the Swift launch and what a great year it has been!

First, of course, we had the beautiful launch followed by activation of the instruments.

Then the science began pouring in! There was the giant flare from SGR 1806-20 in the first month, as well as a deluge of early gamma-ray bursts. Since then, a steady stream of bursts have been ringing our cell phones at all hours of the day – short bursts, high redshift events, crazy afterglows and mysterious dark GRBs. Every month has had a new surprise, and every couple of months a press event (see the article Cosmic Mystery Explained below).

The Swift team is all abuzz right now following the gamma-ray burst conference held Nov. 28 - Dec. 2 in Washington. It was attended by over 280 GRB researchers from all over the world, and highlighted results from Swift as well as findings from HETE-2, INTEGRAL, Konus, IPN, Suzaku and dozens of other observatories. I was amazed how much work is underway by scientists from all affiliations and walks of life. Lots of new findings - for example, Edo Berger and Derek Fox re-analyzed Swift XRT data on the short burst GRB 050813 to obtain a more accurate location on the sky. The previous wisdom was that the burst probably came from one of a couple of galaxies at a distance of 6 billion light years, a little on the far side of the other short bursts at 2.5 billion light years. At the meeting Edo announced that the new XRT position now falls on top of a 3rd galaxy at a surprisingly large distance of 10 billion light years. This throws our fledgling understanding of the energy involved in short bursts on its head; some must be much more powerful than others to explain such a large range in distances.

Other excitement at the conference concerned the high redshift burst GRB 050904, which is described by Giancarlo Cusumano in this newsletter.

During the conference, on November 30, the Italian embassy hosted a banquet in celebration of Swift's first year. It was sponsored by the Italian and UK embassies, the Italian Space Agency, the UK PPARC funding agency and General Dynamics. This was truly a gala evening with a sit-down dinner for 350 people, delicious food, a beautiful atrium, talks, movies, and song.

Here's to a second year with as much fun as the first!

Swift in the News

by Lynn Cominsky, SSU E/PO

10/5/05 - In A Flash NASA Helps Solve 35-Year-Old Cosmic Mystery

Scientists from Swift and HETE have solved the 35-year-old mystery of the origin of powerful, split-second flashes of light known as short gamma-ray bursts. These flashes, brighter than a billion suns, yet lasting only a few milliseconds, have been simply too fast to catch -- until now. This exciting result was presented at a NASA Science Update and included Swift PI Neil Gehrels, HETE PI George Ricker, as well as follow-up scientist Dr. Derek Fox of Penn State.

11/9/05 - Swift Wins "Best of What's New" in Popular Science.

Among all the multitude of nifty gadgets and gizmos that appeared in 2005, NASA's Swift satellite has taken a top honor in the annual "Best of What's New" award from Popular Science magazine. Swift is featured in the December issue as a winner in the aviation and space category for 2005.

11/16/05 - Powerful Magnetar Blast from Another Galaxy

The magnetar blast of 12/27/04 was described in a feature article by Sky and Telescope editor Robert Naeye.

12/14/05 - Cosmic Explosion Could Be Black Hole Swallowing Neutron Star

The short GRB observed by Swift on 7/24/05 was the subject of a series of Nature articles and a press release sent out by NASA/GSFC. GRB072405 was one of the most thoroughly observed short gamma-ray bursts to date. Swift, NASA's Chandra telescope and the Keck Observatory in Hawaii, along with other observatories, captured the burst afterglow in detail. The combined data enabled scientists to speculate on the nature of the merging objects.

Swift Mission Operations Center

By John Nousek, Swift Mission Director

As we cross the New Year for 2006, the Swift Observatory is also crossing many significant milestones. The most recent is the anniversary of the Swift launch on November 20, but just as important were the initial commissioning activities of the three science instruments: the BAT on December 17; the XRT on December 23; and the UVOT on January 12.

Swift continues its fine record of discoveries. The BAT has found 94 new GRBs, and the XRT and UVOT have followed up about 80% of them with record-breaking speed (at least in the pre-Swift record days!). In addition to the BAT discovered GRBs, Swift has also followed up 15 GRBs discovered by the INTEGRAL and HETE-II missions. In total it appears safe that our pre-launch predicted GRB discovery rate and afterglow followup rate will be near 100 GRBs/afterglows per year.

Since the start of normal Swift operations, we have spent about 64% of our time looking at GRB afterglows. We also have spent 7% of our time looking at non-GRB Targets of Opportunity, 8% at calibration targets, 16% at fill-in targets and 5% at non-science targets (mostly cold targets during South Atlantic Anomaly crossings).

Swift has received considerable attention from a wide range of media. Popular Science named Swift one of its "What's Best in What's New for 2005". Discover magazine named the discovery of afterglows from short GRBs (which was led by Swift's discovery of GRB050509b) as one of the top 100 discoveries of 2005. Nature dedicated a cover picture treatment to the short GRB discovery papers. All in all a highly productive year for Swift.

On the technical side, the observatory and instruments are operating nominally. Defined as the time when the BAT can discover bursts, and at least one of XRT or UVOT in followup capable mode, the observatory has been active more than 97% of the total time since April 5 (the start of normal ops). In December the BAT required a re-boot (which cost only 20 hours of observing time). Occasional Attitude Control System issues result in target acquisitions more than 6 arc minutes off-target, requiring a re-setting of the UVOT. Still, with more than 30,000 successful maneuvers the overall observatory performance has been outstanding.

We recently learned that refined orbital lifetime projections have estimated that Swift is likely to survive in orbit to the 2022 timeframe. We have conducted an analysis of the lifetime limits on Swift and we have found no systems which have shown any signs of deterioration that would affect their life. As Swift also has no consumables we are unaware of any reason that Swift should not substantially exceed its lifetime design goal of five years.

So on behalf of the Swift team, we wish our community a happy 2006, which we hope will be followed by many future years of successful Swift operations.

Cosmic Mystery Solved!

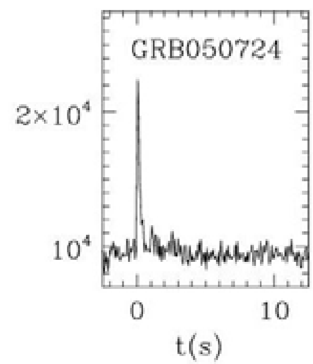
By Phil Plait and Lynn Cominsky, SSU E/PO

For the past 35 years since their initial discovery, one of the biggest mysteries in astrophysics was the source behind short gamma-ray bursts. Unlike their longer cousins (caused by the supernova explosions of young, massive stars) short bursts last for mere milliseconds, and are clearly a different phenomenon. Their extremely brief nature made them very difficult to study. The leading theory was that short bursts were produced when old, dense neutron stars collided, or when a neutron star was "eaten" by a black hole. But the evidence for this was maddeningly elusive.

This past summer, three short bursts were detected that have cracked the mystery wide open. The first of the three bursts (GRB050509b) was observed by Swift on May 9, and lasted only 50 milliseconds. The X-ray afterglow seen after this burst was the first ever detected from a short burst. The GRB appeared to be located near the edge of an elliptical galaxy. Since these galaxies don't contain young stars, this in itself was an important clue to the short burst's origin and supported the neutron star merger theory.

A neutron star ripped apart by a black hole was the cause of GRB 050724, as seen here in this artist's illustration.

On July 9, the HETE-2 satellite detected another short burst, which had extensive follow-up by ground-based telescopes as well as the Chandra Observatory and the Hubble Space Telescope. The more accurate position for this burst ruled out the possibility of a supernova counterpart, and provided even better evidence for an origin due to a neutron star merger.



The light curve (brightness vs. time) of GRB 050724 showing the initial short blast of gamma rays.

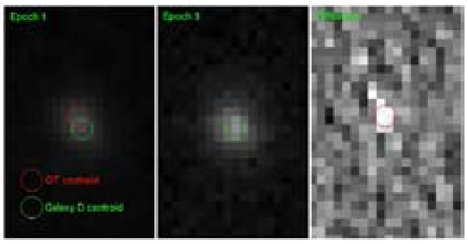
On July 24, 2005, Swift detected the third short gamma-ray burst, GRB 050724, which lasted only 0.25 seconds. Ground-based observations quickly determined that the burst was approximately 3 billion light years away, and associated with an elliptical galaxy, similar to that suggested for GRB050509b.

Another important clue was that, similar to the HETE-2 burst GRB 050709a, X-ray emission for GRB 050724 persisted for some time following the initial short gamma-ray burst - flares of X-rays occurred minutes and even hours later. Most theorists believe that a neutron star merger should create a black hole with only a brief, intense flare, and no lingering emission - so this third burst, and possibly the HETE-2 burst as well, may not have been from that kind of merger.

The secondary blasts of X-radiation may indicate that GRB050724 was caused by an incredibly violent event: the disruption of a neutron star by the enormous gravity of a black hole, the only force in the Universe powerful enough to tear apart a neutron star. The ultradense material then formed a crescent-shaped stream, which, after orbiting for a few minutes, fell into the black hole, causing the later flares.

Although the initial event lasted only a fraction of a second, it put out as much energy as the Sun does in over 100,000,000 years. It took observations by Swift, HETE-2, and the cooperation of an international team of follow-up observatories to understand the causes of these mind-boggling events, and more such discoveries are expected in the months and years to come.

A NASA Science Update press conference on these exciting discoveries was held on October 5 that featured Swift PI Neil Gehrels, HETE PI George Ricker, follow-up lead scientist Derek Fox and 2 other prominent scientists from the astrophysics community. See the Swift in the News article online for the links to the press releases about all three of these bursts.

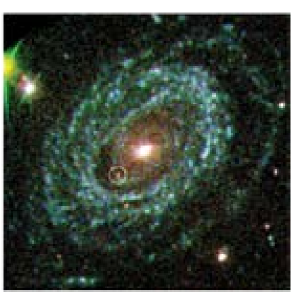


Observations of GRB 050724 showing the burst afterglow and the host galaxy (left), the galaxy after the burst faded (middle), and the processed image showing just the afterglow (right).

Swift's *Other* Burst Observations

By Peter Brown, Penn State

In addition to chasing Gamma Ray Bursts, Swift has also spent some time chasing other kinds of exploding stars – supernovae. The Swift observations are very important because the Ultraviolet/Optical Telescope (UVOT) can measure the brightness of these explosions in the ultraviolet, most of which is blocked by the Earth's atmosphere (thankfully) and cannot be observed by ground-based telescopes. We are also simultaneously able to put limits on the amount of x-rays coming from the explosion with the X-Ray Telescope (XRT). Observations in multiple wavelengths like this give astronomers better insight on the physics and mechanisms of the explosion as well.



Swift ultraviolet image of supernova 2005ke in the spiral galaxy NGC 1371. The supernova is circled.

One type of supernova (designated Ia) is caused when an old, dead star called a white dwarf accumulates matter from a companion star. When enough matter piles up, it can undergo nuclear fusion, the energy source of thermonuclear bombs. The effect is similar for the star, too: the white dwarf can explode. We hope to find out if these types of explosions are always the same brightness. This would help measure distances in the universe, just as you can tell how far away an oncoming car is based on the brightness of the headlights. An example of this is SN2005ke (the letters indicate the order it was discovered in the year 2005). The ultraviolet image shows that its galaxy has lots of new stars forming in its spiral arms.

Other supernovae signal the early deaths of young, massive stars. Some of these might also result in Gamma Ray Bursts, which is why Swift is especially interested in them. One of these is SN2005cs which exploded in the photogenic Whirlpool Galaxy. The pretty images the Hubble Space Telescope took some years ago have been used to identify the kind of star that exploded. The Swift UVOT observations showed the supernova to be extremely hot and bright, fading in the ultraviolet as it cooled very quickly. These supernova observations are among the most exciting of Swift's non-GRB science.

Swift ultraviolet image of supernova 2005cs in the nearby spiral galaxy M51, the Whirlpool Galaxy. The supernova is red, and to the right of the galactic center.

GRB 050904: another milestone set by Swift

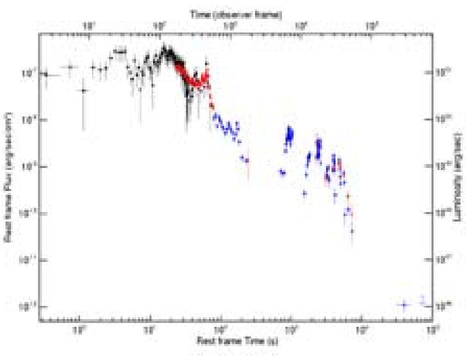
By Giancarlo Cusumano, I.A.S.F

One of the most important discoveries that Swift has made in the last months is the detection of the most distant gamma-ray burst (GRB) ever observed. This burst, known as GRB 050904, triggered the Burst Alert Telescope (BAT) onboard Swift on September 4, 2005; follow-up observations through ground-based optical telescopes determined its redshift to be 6.3 (the redshift is an indication of the distance of a cosmic source – the higher the number, the farther away the object is). This redshift value means that the burst occurred 12.8 billion years ago, only 890 million years after the Big Bang – when the Universe was 6% of its present age. GRB 050904 is by far the most distant cosmic explosion ever observed (the previous record for a GRB was at a redshift of 4.5) and one of the farthest cosmic sources detected (the most distant known quasar is at a redshift of 6.4, and the most distant galaxy at a redshift possibly as high as 7).

Due to the expansion of the Universe in the Big Bang, objects at high redshift appear to be receding from us at very large velocities. This has two main effects: one is to lower the energy emitted by the object (due to the Doppler effect), and the other is to stretch the apparent timescale of the event because of the effects of Einstein's relativity. Due to its large distance, most of GRB 050904's gamma-ray energy emission was therefore shifted into the energy range of Swift's X-Ray Telescope (XRT). The XRT's excellent sensitivity therefore allowed the prompt gamma-ray emission of the burst to be observed with an unprecedented richness of detail. The XRT started observing the burst 161 seconds after Swift's initial detection, but due to relativistic time contraction this translates to only 22 seconds after the actual explosion in the GRB's timeframe.

The GRB's gamma-ray emission was exceptionally high and its evolution over time particularly complex, showing the presence of several secondary explosions at times long after the initial explosion. The burst lasted more than 2 hours and it is among the brightest and longest GRBs ever observed. It represents an exceptional event among the GRBs detected so far, and its unique characteristics could be linked to its distance and to the different star evolution and environment in the early Universe.

Thanks to its sensitivity, Swift is detecting very distant GRBs, opening a new frontier in the study of these explosions. Phenomenological and statistical differences of the very distant GRBs may offer an important tool for studies of the early Universe. A paper about the Swift discovery and observations of GRB 050904 has been accepted for publication in "Nature".



The energy emitted by the GRB versus time.

Swift Exhibition at the UK's National Space Centre

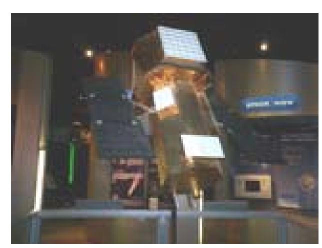
by Jill Richardson, NSC

The National Space Centre is the UK's largest visitor attraction dedicated to the excitement of space. The Centre currently hosts an exhibition about Swift in its Space Now gallery – a live news area maintained by the Space Communications Team.

The NSC exhibit

Swift was an ideal project to include in the gallery, because the near real time detections bring a live element to the exhibition. 'Traffic-lights' are used as a burst alert system for visitors. A red light indicates a burst has just been detected and an amber light indicates a burst was found within the last week. A green light shows no bursts have been detected for a week, but Swift is still watching the sky for the latest flash…and it could happen at any second! A plasma screen is used to display the latest burst's location in the sky. Well-known constellations are included in the image to help visitors recognise the oval as a representation of the sky they see from their backyard. Another screen indicates how far back in time the event that caused the burst occurred.

The Space Communications Team gave visitors tours of the exhibition during the busy October school holidays. These began at the quarter-scale model of Swift. The Centre's Technical Team created a prop to demonstrate the concept of the mask on the BAT. This included a square of transparent plastic sheet with a random arrangement of 'lead tiles' printed on top, suspended above a white 'detector plane'. A torch was used to represent gamma-ray light casting a shadow on the detectors. Young children were encouraged to move the torch to show how bursts from different directions create different shadows. The University of Leicester kindly provided an X-ray mirror to display in the exhibition during the tours, enabling visitors to see what the mirror inside the XRT looks like.



The Swift model on display

Live interviews with Dr Julian Osborne, a member of the University of Leicester's Swift Science Team, took place in front of a public audience in October. The interviews were well received, with a large number of children taking the opportunity to ask Julian questions at the end of each event.

The BAT mask prop

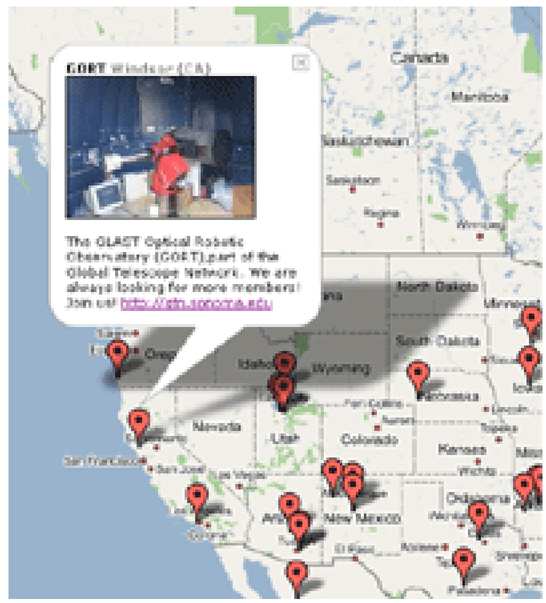
Amateur Corner

by Phil Plait, SSU E/PO

Several members of the Swift Education and Public Outreach (E/PO) team attended the Advanced Imaging Conference held in San Jose, California on November 11 – 13, 2005. This conference is designed as a forum for the dissemination and discussion of information for amateur astronomers who are dedicated to high-quality CCD imaging. The E/PO team attending (Sarah Silva, Phil Plait, Tim Graves, Gordon Spear, and Melissa Crain) went to meet these members of the amateur community, learn more about what they're doing, and to promote the Global Telescope Network (GTN).

As a sponsor of the conference, the team was allotted a five minute slot during the presentations, so Dr. Plait gave an overview of the GTN, inviting the participants to join. The joint Swift/GLAST/XMM-Newton booth was in the exhibit hall, and flyers for the GTN and other projects (including the Swift gliders) were distributed. The response from the participants was enthusiastic, and we expect to see several of them joining the network in the coming weeks.

In a similar vein, Dr. Plait found a website called: http://www.frappr.com, a web-based application which allows a person to add themselves to a map as part of a special-interest group. He found that there was a group of observatories listed, and added the GLAST Optical Robotic Telescope to that group's map, with a link to the GTN website and a plea for others to join. Almost immediately, the group owner joined the GTN! The group has over 100 observatories listed, so again we expect to see the GTN growing as word-of-mouth spreads.



A closeup of the Frappr map showing the entry for GORT

We hope you enjoyed this quarterly publication. The Swift Newsletter was produced by the Swift Education and Public Outreach group at Sonoma State University. You can find all the Swift newsletters online at:
http://swift.sonoma.edu/resources/multimedia/newsletter/index.html

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- ***Swift Mission: http://swift.gsfc.nasa.gov***
- ***Swift Education and Public Outreach: http://swift.sonoma.edu***
- ***Gamma-Ray Burst Real-time Update: http://grb.sonoma.edu***
- ***Global Telescope Network: http://gtn.sonoma.edu***

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