National Aeronautics and Space Administration

Swift Newsletter

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Swift Year in Review - PI Neil Gehrels

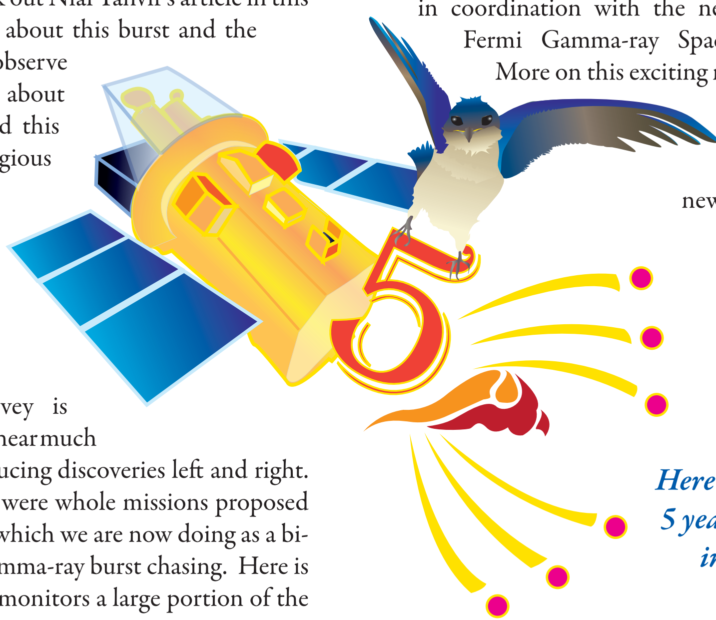
Hello, friends of Swift. Our mission has now been in orbit for 5 years, with the anniversary on 20 November 2009. It sometimes boggles to mind to think of the satellite orbiting above us, reorienting from target to target every few minutes day-in, day-out. We will celebrate the 5-year milestone with a science workshop at Penn State.

For this anniversary newsletter, I would like to tell you about a couple of neat scientific findings from the mission, both of which have taken 5 years to happen. The first is a “blast-from-the-past” very distant gamma-ray burst and the second is a survey of the gamma-ray sky being performed by the BAT instrument on Swift.

The world astronomical community is still abuzz about the Swift detection of the most distant object in the universe last April. It was gamma-ray burst GRB 090423. Check out Nial Tanvir’s article in this newsletter for more about this burst and the exciting chase to observe it. Scientific articles about it have just appeared this month in the prestigious Nature journal. We have been waiting for years for such a distant burst and were finally rewarded.

The BAT sky survey is something you don’t hear much about, but it is producing discoveries left and right. Prior to Swift, there were whole missions proposed to do such a survey, which we are now doing as a bi-product of Swift’s gamma-ray burst chasing. Here is how it works. BAT monitors a large portion of the sky (about 1/6) all the time to look for GRBs. They occur about twice per week and last only a few tens of seconds each. BAT’s detection of GRBs is what makes Swift tick, but it only takes 0.01% of the instrument’s time. The rest of the time, BAT is surveying the gamma-ray sky at a sensitivity level never before achieved. (BAT operates in the low energy portion of the gamma-ray band, between X-rays and gamma-rays, so it is sometimes called a “hard X-ray” survey.) To date, BAT has detected nearly a thousand sources. Most of them are massive black holes at the centers of galaxies, many of which are surrounded by thick clouds of gas and dust. Gamma rays are the most penetrating radiation and zip right through the clouds. BAT is giving the first complete census of massive black holes in our local universe. This is the opposite kind of science from GRBs. Instead of a flash and bang, it is a slow process of adding data over months and years. Now, five years into the mission the results are starting to flow from the BAT survey.

There is another new development for Swift. We are now performing many observations in coordination with the newly-launched Fermi Gamma-ray Space Telescope. More on this exciting new pairing of gamma ray missions in the next newsletter.



Here’s a toast to 5 years of Swift in orbit!

Swift in the News

By Logan Z. Hill (SSU NASA E/PO)

2/10/09 – NASA's Swift, Fermi Probe Fireworks from a Flaring Gamma-ray Star

The soft-gamma-ray repeater, SGR J1550-5418 has been producing unpredictable X-ray and gamma-ray flares that Swift and Fermi have observed. Sometimes producing more than a hundred flares within twenty minutes, this neutron star has long been known for its radio and X-ray emissions, but with eruptions on October 3, 2008 and January 22, 2009, viewed by Swift and Fermi, it has been reclassified as a soft-gamma-ray repeater, one of only six known.
Read more:

http://www.nasa.gov/mission_pages/swift/bursts/gammaray_fireworks.html

2/20/09 – NASA's Swift Spies Comet Lulin

Using Swift's Ultraviolet/Optical Telescope (UVOT) and X-Ray Telescope (XRT), on the 28th of January, Comet Lulin was observed to have a hydroxyl cloud over 200,000 miles long. The data Swift gained from observing the comet have helped to add further details to its make-up and structure, especially the tail where solar radiation separates the hydroxyl ion into oxygen and hydrogen creating a region of X-ray emission. Read more:

http://www.nasa.gov/mission_pages/swift/bursts/lulin.html

4/3/09 – Swift's Comet Tally Highlighted in Observatory Webcast

Brady Haran has made a film *Day in the Life*. As part of the 100 Hours of Astronomy project, the European Southern Observatory's webcast included a montage of Swift's comet observations. Comet images used included 73P/Schwassmann-Wachmann 3, Lulin (see above), and 8P/Tuttle. Read more:

http://www.nasa.gov/mission_pages/swift/bursts/observatory_webcast.html

Mission Director Report

By John Nousek, Swift Mission Director (Penn State)

Here at the Mission Operations Center (MOC), we are eagerly awaiting the Fifth Anniversary milestone of the Swift launch on November 20, 2009. Swift was designed to have a minimum mission life of two years with a design goal of five years. I'm happy to report that the observatory and all its instruments continue to operate smoothly, really as well or better than they operated at launch.

This excellent behavior is a combination of the sound original design and improvements made in ground operations and on-board flight software.

At the observatory level Swift is carrying out observations approximately 98% of the useable time (i.e. time when the satellite is outside the South Atlantic Anomaly). We have had only two episodes where Swift was off-line due to anomalies. One, resulting from a small instability in one of the gyro units, has been corrected by a software approach which combines data from all three gyros, resulting in accuracy in pointing which is higher now than the original design. The other, resulting most likely from a cosmic ray hit in the electronics of the solid state recorder, was repaired by a software reset of the recorder.

We have made improvements to the ground operations which allow us to be much more responsive to Target of Opportunity (ToO) requests, resulting in a great increase in Swift science beyond GRBs. We now typically receive about 2 ToO requests per day with 2-3 observations per request.

We also continue to improve our ground software which checks the planned science target list, catching the very rare situations in which Swift would be inaccurate in pointing, or forced to violate the pointing constraints. This improved software reduces the few times (out of about 150,000 maneuvers) when the on-board software produces undesirable results.

Each of the instruments has also made significant improvements in performance. The BAT now captures data during the times of slewing, and via ground-processing is able to detect GRBs during the slews (albeit delayed slightly by the relay and processing time). The BAT also causes GRB triggers for events slightly below the normal threshold, followed by short snap shots by the XRT. If the XRT detects an afterglow the information is reported to the GCN, but for the false positives we do not continue observations. The XRT uses the UVOT image to improve knowledge of the XRT positions from 4.5 arcseconds to 2.2 arcseconds. Software and voltage settings now allow the XRT to operate about 5 degrees warmer than the original values. New modes also help XRT offset the effects of the micrometeorite damage to the XRT CCD.

The UVOT has developed and changed software and modes to allow more frequent use of the grism on GRB response, and the white-light filter, thus giving a more sensitive detection limit to the GRBs, and if the GRB afterglow is sufficiently bright, a low resolution spectrum. The UVOT also developed new data products (called the GeNIE image) which allows the UVOT team to rapidly set more sensitive limits on afterglow brightness when no bright object is near the XRT position.

As we move to the future more improvements lie ahead. We are conducting a study to increase the automation of science planning. The effect of this will be to reduce the time required for creating new schedules. We are working on software to incorporate the effect of radiation on the CCD in the XRT. We are working to add the capability of using ground stations at Santiago, Chile; MILA, Florida; and Wallops Island, Virginia. With added stations we will be able to more fully exploit the BAT's ability to sense GRBs during slews and do single photon data analysis. We will also implement spacecraft software changes to avoid the occasional (~6 times per year) events when a software bug in the star tracker gives an erroneous position.

4/28/09 – New Gamma-ray Burst Smashes Cosmic Distance Record

On April 23 2009, at 3:55 am EDT (7:55 GMT), Swift observed a gamma-ray burst which lasted ten seconds and had only an X-ray afterglow. The burst was determined to have originated 13.035 billion light-years away, at a redshift of 8.2, making it the most distant burst ever recorded. See Nial Tanvir's article, "A light from the end of the dark age: GRB 090423." Read more:

http://www.nasa.gov/mission_pages/swift/bursts/cosmic_record.html

5/15/09 - Swift Mission team wins the Maria and Eric Muhlmann Award for 2009

The Board of Directors of the Astronomical Society of the Pacific has awarded the Swift Mission team with the Maria and Eric Muhlmann Award. The award is given for "recent significant observational results made possible by innovative advances in astronomical instrumentation, software or observational infrastructure." Swift was recognized for "the innovative way in which the satellite's trio of instrumentation works in concert to discover gamma-ray bursts and their afterglow, combining gamma-ray, X-ray, ultraviolet and optical data." The award was received by Swift team member Dr. Edward Fenimore of Los Alamos National Laboratory.

6/8/09 – Keck Study Sheds New Light on 'Dark' Gamma-ray Bursts

Using the 10-meter Keck I telescope, Joshua Bloom's international team found that for eleven of fourteen dark bursts observed by Swift, there was a distant faint quiescent galaxy which suggests that there is dust obscuring the visible light of the bursts even though the galaxies do not appear to be dusty themselves. Read more:

http://www.nasa.gov/topics/universe/features/keck_burst.html

Credit: NASA/Sonoma State University/Aurore Simonnet

9/16/09 – Swift Makes Best-ever Ultraviolet Portrait of Andromeda Galaxy

While waiting for gamma-ray bursts to observe, Swift used its UVOT to take over 300 images of M31, the Andromeda Galaxy, with three ultraviolet filters. The brilliant portrait took a total of 24 hours of exposure time and images amounting to 85 GB of storage. Read more: *http://www.nasa.gov/mission_pages/swift/bursts/uv_andromeda.html*

Credit: NASA/Swift/Stefan Immler (GSFC) and Erin Grand (UMCP)

Listen to Blueshift podcast: *http://astrophysics.gsfc.nasa.gov/outreach/podcast/wordpress/index.php/2009/09/16/swift-sees-andromeda-in-a-new-light/*

A light from the end of the dark age:

By Nial Tanvir (University of Leicester)

Many of us who are involved in making followup observations of Swift GRBs (not to mention their partners and families!) have learned to live with frequent mobile phone alerts at all hours of the day and night.

One of the main reasons we do it is in the hope that occasionally something rather special will come along. On 23 April this year we were rewarded with a very special burst indeed.

The trick to finding high redshift GRBs is to search for afterglows which appear bright and blue in the infrared, but invisible in the visible, as it were. This is the unmistakable signature of the Lyman-alpha break wiping out the flux throughout the optical region.

As ever, though, ground observers have to contend with the vagaries of the weather, and on occasions technical difficulties. In the case of GRB 090423, high winds at Mauna Kea made observations difficult, with UKIRT being forced to close immediately after taking the first image in which we identified an infrared afterglow of the burst. Thankfully, the coordinated efforts of telescopes around the world, in particular Gemini, VLT and the TNG, ensured that in this case further high-quality infrared photometry and spectroscopy of the afterglow were obtained, showing the burst to have originated at a record-breaking z=8.2. This translates to a light travel time of 13.0 billion years compared to the 13.7 billion year age of the universe – the gamma rays were traveling to us since near the beginning of time!

It has long been recognised that GRBs have the potential to be detected at very high redshifts, at distances where other objects are too faint and too rare to be seen, or if seen, too hard to obtain redshifts for. The problem is, GRBs are rare – in four and a half years of searching, the highest redshift GRB found by Swift was 080913 at z=6.7. At the time, this was the second highest spectroscopic redshift known for any object, which illustrated the promise, but also the difficulty of searching for early GRBs.


GRB 090423. The image is a composite of data from Swift's UV/Optical and X-Ray telescopes. Credit: NASA/Swift/Stefan Immler.

The great attraction of gamma-ray bursts is not only that we can see them at great distances, but also that when we do, they can be used to study the earliest generations of stars, and their effect on the Universe. Their existence tells us that massive stars were forming at that time, and pinpoints the location of their host galaxies. Their afterglow spectra allow us to study the progress of reionization and chemical enrichment enrichment, giving clues to the properties of even earlier stars.

So, what have we learned from GRB 090423? Perhaps the most important lesson is that GRBs really were being produced 700 million years after the Big Bang, giving considerable confidence that we will be able to use them as beacons in the era of reionization. This is tremendously important since galaxies are expected to be very faint at these distances, and even JWST and the new generation of extremely large ground-based telescopes will struggle to study them in any detail.

Regretably, on this occasion, the afterglow fell well short of the staggering intrinsic brightness we have seen in GRBs such as 080319B. Furthermore, the first spectroscopic observations were not possible for many hours, which limited the information which could be obtained. However, deep searches may yet reveal the host galaxy of GRB 090423, and in coming years the discovery and followup of further extremely high redshift GRBs may make them the most important tools we have for investigating the earliest collapsed structures in the Universe.

From Earth To The Universe (FETTU)

By Logan Z. Hill (SSU NASA E/PO)

For the International Year of Astronomy (IYA), Swift E/PO teamed up with other San Francisco Bay Area E/PO groups in order to put on the FETTU traveling exhibit. Fourteen six-foot by three-foot banners on seven stands have made their way around the SF/Oakland area sparking excitement and wonder among all ages.

The spectacular objects included in the exhibit are Antares, Andromeda Galaxy, and Milky Way. Each image includes descriptive text and its distance from Earth (where applicable) in both English and Spanish.

Venues have included Sonoma State's Seawolf Day, Oakland Aviation Museum, San Ramon Art & Wind Festival, and the Annual Meeting of the Astronomical Society of the Pacific. The next scheduled event is the Exploration Station at the American Geophysical Union, San Francisco on December 12 – 13, 2009.

This exhibit is a smaller version of the original FETTU exhibit sponsored by the IAU which is being displayed all over the world for the IYA. In addition, the Bay Area missions also sponsored a larger exhibit at the California Academy of Sciences which is now currently at the San Jose Tech Museum. You can visit the FETTU home page here:

http://www.fromearthtotheuniverse.org/index.php