National Aeronautics and Space Administration

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# Swift Newsletter

## Welcome Message from PI Neil Gehrels

Welcome to our fourth newsletter.

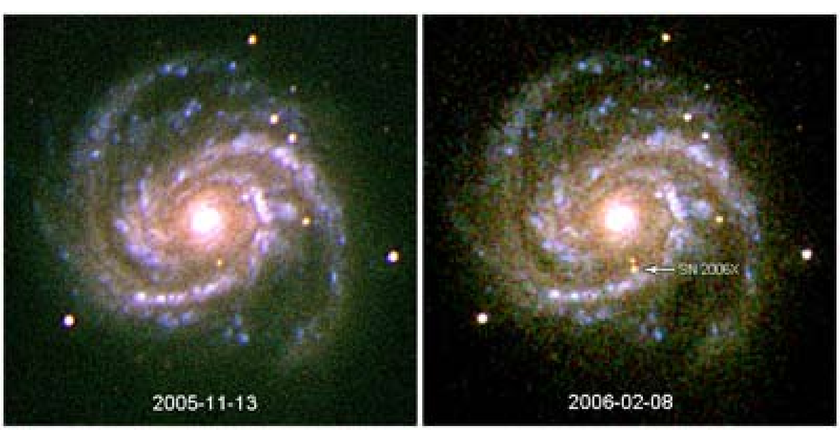
It has been an eventful few months since our last newsletter. One big scientific event was GRB 060218 (see article by Stefan Immler below). We caught a gamma-ray burst and supernova happening at the same time. Thanks to the burst, we repointed our X-ray and optical telescopes at the position of the burst and have been making exquisite observations of this rare Type Ib/c supernova from the beginning.

Swift is up for Senior Review this year, which means that our science and future plans will be peer-reviewed to determine budget levels for the next 4 years. We just turned in a written proposal on March 20 and will make a presentation to the review committee on April 27.

With this review as motivation, we have thought carefully about future science opportunities and directions for the mission. The Swift discoveries have been great during the first year of the mission, but we have only scratched the surface of the mission potential. GRBs will continue to be the focus for the next 4 years. Particular objectives include: 1) detecting enough short-duration bursts to study them in detail and determine if the tantalizing hint of a merging star origin is correct; 2) using GRBs to probe the distant Universe, extending our reach to the time of the earliest stars; 3) catch several more of the rare nearby events to find out if all GRBs have accompanying supernovae or only special ones do; and 4) learn how jets of particles and/or light emerge from the central explosion in bursts.

Even while chasing GRBs at every opportunity, Swift will have observing time left over to pursue other kinds of science in the future, much as we have done up until now. In the Senior Review, we are proposing to expand the Swift Guest Investigator program to allow scientist to propose for non-GRB observations (see article by Padi Boyd, below). Swift is a premier tool for observations of supernovae, novae, flaring stars, black holes, active galaxies... The list is long and we look forward to working with the community on these other neat topics, as well as GRBs.

Results from the Senior Review will be announced this summer.




*Swift UVOT Images of Supernova 2006X*

## Swift in the News

*by Lynn Cominsky, SSU E/PO*

**2/3/06 - The Black Hole Road Show Kicks Off in Denver**

The Swift launch and animations of Swift locating a GRB are featured in the new planetarium show produced by Tom Lucas, that premiered to the press at the Denver Museum of Nature and Science on January 31, 2006. See the education article below and also the NASA web feature.

**2/24/06 - Scientists Detect New Kind of Cosmic Explosion.**

Scientists using NASA's Swift satellite have detected a new kind of cosmic explosion. The event appears to be a precursor to a supernova, and occurred on February 18, 2006. Scores of satellites and ground-based telescopes were trained on the sight, watching and waiting as the event climbed to maximum brightness within the week, making this the best observed supernova-GRB connection to date. Read the GSFC press release, the NASA release, and the Penn State release.

**3/8/06 - Scientists Piece Together the Most Distant Cosmic Explosion**

In the March 9 issue of Nature, Swift scientists (Cusamano et al.) discuss how this explosion, detected on 4 September 2005, was the result of a massive star collapsing into a black hole. Read the Penn State release.

For links to all of these press releases and images, see:

*http://swift.gsfc.nasa.gov/docs/swift/news/*

## Swift Mission Operations Center

*By John Nousek, Swift Mission Director*

The Swift Mission Operations Center continues to support the mission with an extremely high level of efficiency. Swift has now carried out approximately 6000 ground passes over the Malindi tracking station (provided by ASI, the Italian Space Agency) with more than 99% of the data successfully reaching the ground. Swift is also reporting data to and being commanded by the Tracking Data Relay Satellite System (TDRSS), as well as using the DAS (Demand Access System) as needed.

This high level of performance has meant that Swift has discovered GRBs at a rate of about 100 per year, and the discovery information is available nearly immediately to the community for scientific follow-up. More than three-quarters of the new GRBs found by the BAT have sensitive X-ray and optical afterglow searches initiated by the XRT and UVOT instruments aboard Swift, starting within a few minutes (or less) of the BAT discovery.

Ever growing, however, is the non-GRB science potential of Swift. The high efficiency and simplicity of Swift scheduling means that every working day, the Swift Science Operations Team (SOT) convenes a planning meeting which replans Swift's daily observation schedule (and when required by events can replan in just a few hours). The health and safety of the observatory are guarded by the Flight Operations Team (FOT), which creates the daily commanding loads, and monitors observatory performance and safety.

Both the SOT and FOT respond on a 24/7 basis to any Swift issues requiring immediate attention. The SOT and FOT each respond about 2-3 times per week to out-of-hours activities. The SOT responds to each new burst and high priority Targets of Opportunity, while the FOT responds to instrument safing issues (problems that might result in Swift shutting itself down to protect itself) and uploads new Automated Targets to supersede those previously planned, whenever the PI determines the new target is sufficiently important.

During the early part of the mission, instrument safing and observatory pointing constraints caused most of the out-of-hour responses, but as we have gotten to know Swift better, these situations have become less common. For example, the UVOT was protecting itself too aggressively from viewing bright stars, leading to the need for resets on a weekly basis. Now, new code modifications and better parameters settings have led to continuous UVOT operation for the last 60 days. As a result, over the past six months after regular working hours, activities have increasingly been caused by scientific opportunities which couldn't wait for the next day.

An example of the science flexibility of Swift is shown by the on-going RS Oph campaign. RS Oph is a recurrent nova which has been undergoing a dramatic outburst. Swift originally planned occasional monitoring of this system, which was showing a smooth, slow decay in visible light. When XRT observations showed that a new soft-X-ray component had become visible, we added daily observations, which unveiled a rich phenomenology of X-ray, UV and optical variability and spectral changes, opening new insights to the nature of the system and the surroundings of the X-ray emission source.

As the Swift mission matures we can expect that highly variable sources will provide exciting new scientific opportunities to utilize the capabilities of the Swift satellite, and the Mission Operations Center.

## Swift Science Center Update

*By: Padi Boyd, GSFC*

Since the launch of Swift, a healthy NASA Guest Investigator (GI) Program has funded US observers to carry out new scientific investigations using Swift data, perform ground-based follow-up observations, and embark on theoretical projects on gamma ray bursts. The first two cycles of the GI program focused only on GRB studies. But for Cycle 3, the Swift project is expanding the GI Program to allow scientists to propose "target of opportunity" (TOO) observations for non-GRB sources as well. Targets of opportunity arise when a known astronomical source such as a neutron-star- or black-hole binary switches into an interesting and unusual state, or when an exciting new object such as a new supernova is discovered. For these events, Swift's combination of instruments and quick and flexible telescope scheduling will result in unprecedented multiwavelength observations that should allow scientists to learn more about these objects and test the limits of some astronomical theories.

Just as is the case with GRB observations, the TOO data will become immediately public via Swift's Quicklook Data Website. Scientists worldwide will be able to immediately analyze and interpret the data coming from these interesting targets.

Scientists interested in observing a TOO will write a proposal to the Swift GI program. Proposals are due July 28, 2006. Proposals will also still be accepted for the existing GRB topics already mentioned. The TOO targets will be chosen by a panel of scientists during a "peer review" organized by NASA Headquarters in the fall of 2006. Then scientists with accepted TOO proposals will be responsible for alerting the Swift team when their target has met the "trigger criteria".

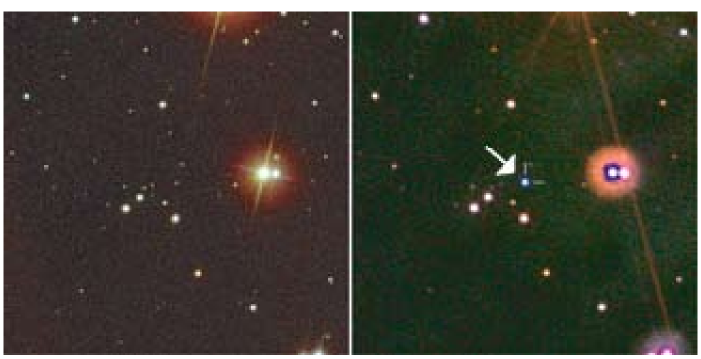
We expect that expanding the GI program to include non-GRB targets of opportunity will increase Swift's impact on a broad range of astrophysics topics. Information about the Cycle 3 GI program can be found at NASA's Research Opportunities in Space and Earth Scientists 2006 website at: http://nspires.nasaprs.com. In the coming months, the Swift website (http://swift.gsfc.nasa.gov) will be updated with detailed instructions for proposers for Cycle 3.

## GRB 060218 - SN 2006aj

*By: Stefan Immler, GSFC*

A remarkable gamma-ray burst, designated GRB060218, was detected with the Burst Alert Telescope (or BAT) onboard Swift on February 18, 2006. The burst lasted for nearly half an hour, significantly longer than most bursts seen before, which typically last from a few milliseconds to tens of seconds, and was surprisingly dim in gamma-rays. Swift was able to observe the explosion from the beginning with all three of its instruments: the BAT, which discovered the burst, the X-ray Telescope, and the Ultraviolet/Optical Telescope, which provided high-resolution images and spectra across a broad range of wavelengths.

The most exciting aspect of this burst was the association with a supernova explosion, called SN 2006aj. At a redshift of z=0.033, corresponding to a distance of about 440 million light-years, it is one of the closest supernova explosions ever observed to give rise to a gamma-ray burst, and shows characteristics never seen before. In combination with observations from more than 20 observatories around the world, Swift observed the afterglow of this burst to grow brighter in optical light for a few days. This brightening, along with other telltale spectral characteristics in the light, showed how the supernova was evolving. The coordinated space- and ground-based observations started at the prompt phase of the gamma-ray burst—in other words, while the burst was still going on, instead of much later as is usually the case. This gave an unprecedented view of a supernova from start to finish across many wavelengths, ranging from radio, optical, UV, through X- and gamma rays. Radio telescopes in fact have seen this burst from the day it was detected, another first.



*Left: "Before" image, from the Sloan Digital Sk Survey. Right:" After" image, from NASA/Swift UVOT. The arrow indicates the newly brightened supernova, which outshines the host galaxy in the "before" image. Credit: SDSS (left), NASA/Swift/UVOT (right)*

Already, GRB060218/SN2006aj is the best studied gamma-ray burst/supernova association. Among the early results are measurements of the amounts of elements in the supernova, as well as studies of the velocity and symmetry of the outgoing shock wave which triggered the event. These may lead to a more complete understanding of why this SN had an accompanying gamma-ray burst.

## Black Holes Fascinate the Public

*By: Phil Plait and Lynn Cominsky, SSU E/PO*

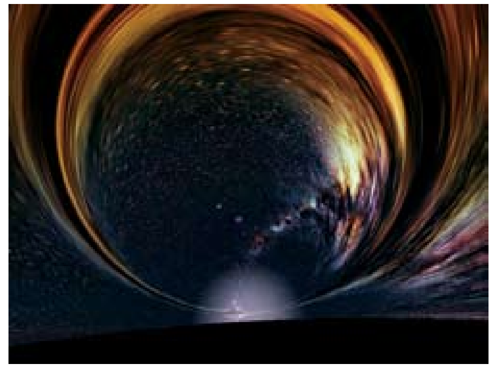
And why shouldn't they? Terrifying, dark, mysterious, mind-bending, black holes pluck at the strings of our consciousness. We're drawn to them, like it or not, as inexorably as matter on the brink of the event horizon. Movies and TV shows have been made about them, thousands of newspaper and magazine articles have been written. Scientifically, entire observatories have been built with the main purpose of observing them, not the least of which is Swift.

Clearly, tapping into this phenomenon is an excellent way to educate the public about astronomy and the Swift mission. Tom Lucas (www.tlproductions.com), the director and producer of the acclaimed PBS Nova documentaries "Runaway Universe" and "Voyage to the Milky Way," has done just that. With the Denver Museum of Nature and Science (DMNS; www.dmns.org), he has created "Black Holes: The Other Side of Infinity", a full-dome digital planetarium show that immerses the viewer into the universe of black holes. The Swift mission is featured prominently in the presentation, showing the launch of the observatory (with many Swift scientists cheering) and featuring an excellent animation sequence showing how Swift observes gamma-ray bursts, the birth cries of black holes.

One aspect that makes this presentation unique in that it uses not just artist's animations but actual numerical simulations, solutions to mathematical equations, to represent the first stars forming, supernovae exploding, and galaxies colliding. Donna Cox and her team at the National Center for Supercomputer Applications (http://www.ncsa.uiuc.edu/) created many of the simulations, including a virtual fly-through of the Milky Way that is simply awesome to behold.

The crown jewel of the show lies at the end of the Milky Way tour: a virtual trip into the supermassive black hole that lies in the heart of our home Galaxy. Dr. Andrew Hamilton, a professor at the University of Colorado, Boulder, has created what he calls the "black hole flight simulator" – software which solves Einstein's equations of Relativity on the fly to create an impressive visual sight-seeing simulation of this one-way voyage. Viewers will see matter and energy drawn inexorably into the event horizon, and watch as they too make this final plunge into the maw of the hole.

Once inside, space itself rushes down to the center of the black hole where a singularity lies, a mathematical paradox where volume becomes zero and density rises to infinity. According to everything we know about physics, nothing could survive such a descent, not even space itself. But since this trip is a virtual one, Dr. Hamilton's software can ensure we pass safely into the black hole, through a "wormhole" in space, and then out once again in a distant locale in our Universe, or perhaps having even passed into another Universe altogether.



*The Milky Way's light distorted at the event horizon of a black hole.*
*Credit: Denver Museum of Nature and Science*

"Black Holes: The Other Side of Infinity" was primarily funded by a grant from the National Science Foundation, but was started using seed money from the GLAST E/PO program. SSU Prof. Lynn Cominsky served as one of two science directors, and Dr. Phil Plait was a science consultant to the show. It is currently playing at the DMNS and will soon be shown across the world. For each museum that leases the show from Spitz, Inc. (www.spitzinc.com), the SSU E/PO group has offered to train the museum professionals to give teacher workshops about black holes that tie-in with the presentation, using educational materials specifically designed to go with the show. Lucas is currently finishing the production of a PBS NOVA television documentary called "Monster of the Milky Way" which will expand on several aspects of the planetarium show and will reutilize many of the spectacular simulation sequences, including the trip into the black hole at the center of the Milky Way. The NOVA program is expected to premier in September, 2006.