National Aeronautics and Space Administration

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Swift Newsletter

Welcome Message from PI Neil Gehrels

The last six months of Swift gamma-ray burst science have been what I would call a swirl of complexity. In conference talks and hallway conversations, the discussion inevitably turned to new questions raised by Swift observations. Quite a few seem to be coming to a head at this time.

- What is the distance to short gamma-ray bursts? The first distance measurements in 2005 pointed toward low distances - much less than long bursts. Now it appears that there is a wide range from low to high.
- How can long and short bursts be distinguished from each other? It sounds easy - use the duration of the event to decide. However, we are finding that a good fraction of short bursts have long-lasting tails that can easily be confused with long bursts.
- Do long gamma-ray bursts all have accompanying supernovae? Models predict that when the core of a massive star collapses to a black hole and produces a gamma-ray burst, there is enough energy deposited in the star to explode it. Also, there is observational evidence of four nearby bursts with coincident supernovae. However, this summer Swift detected two nearby bursts that appear to be in the long category but have no supernovae detected to stringent limits.
- Are the gamma rays in a burst beamed in narrow jets toward us? Prior to Swift there seemed to be strong evidence for beaming in the fading optical light after bursts. We still believe there must be collimation, but the Swift X-ray and optical afterglow data are complex and are resisting simple interpretations.

Is this a cause for alarm? No, it is precisely the way progress is made. The data are guiding us down the crooked path toward correct answers and ultimate understanding. Also, what could be more fun than having new mysteries to unravel!

One of the venues for discussing the above topics was the gamma-ray burst meeting in London this September. It was a Royal Society Discussion meeting and was expertly organized by Alan Wells, Keith Mason, and Martin Rees. It was a fabulous conference with scientists of many different areas of interest and expertise discussing the new findings from Swift and other observatories.

Image 1. Swift caught the elliptical galaxy NGC 1316 with two supernovae at the same time, a rare circumstance. Most galaxies only have 1-3 per century. See news article on p. 2.

The Swift E/PO group is pleased to announce a new series of audio interviews with Swift scientists available through the Swift website. The first interview is with Dr. Gehrels, who talks about very distant gamma-ray bursts. The interviews are online at: ***http://swift.sonoma.edu/resources/multimedia/audio***

Swift in the News

by Lynn Cominsky, SSU E/PO

8/30/06 - Caught in the Act, Scientists Watch Supernova Explode

Scientists using NASA's Swift satellite and a combination of orbiting and ground-based observatories have for the first time caught a supernova in the act of exploding. The event became visible on February 18, 2006, and was studied by many different groups using Swift instruments and ground-based telescopes. The results were summarized in four Nature papers that appeared in the August 31 issue, and in several different press releases, including this one from NASA HQ: *http://swift.gsfc.nasa.gov/docs/swift/news/2006/06-72.html*

HEAD Meeting News

10/4/06 - Mug Shots of Supernovae Reveal Two Key Findings

Scientists using NASA's Swift satellite have observed two dozen recent star explosions, called supernovae, quickly after the events and have discovered never-before-seen properties, some of which run counter to prevailing theories. Read the GSFC release about the HEAD Press conference featuring Dr. Stefan Immler: *http://swift.gsfc.nasa.gov/docs/swift/news/2006/06-84.html*

10/5/06 - NASA Performs Headcount of Local Black Holes

NASA scientists using the Swift satellite have conducted the first complete census of galaxies with active, central black holes, a project that scanned the entire sky several times over a nine-month period. The hard X-ray survey results were presented in a HEAD press conference by Drs. Richard Mushotzky, Jack Tueller and Craig Markwardt and are summarized in this GSFC release: *http://swift.gsfc.nasa.gov/docs/swift/news/2006/06-87.html*

10/5/06 - Scientists Determine The Nature of Black Hole Jets

NASA and Italian scientists using Swift have provided the most compelling evidence to date that black hole jets are made of protons. Led by Dr. Rita Sambruna, who presented the results in a HEAD press conference, the international team studied the spectra of two blazars in order to reach their conclusions which are described in a GSFC press release: *http://swift.gsfc.nasa.gov/docs/swift/news/2006/06-86.html*

11/6/06 - Monster Stellar Flare Dwarfs All Others

Swift detected a flare with one hundred million times the energy of a typical solar flare from a star in the binary system II Pegasi. The flare from this system – which is 135 light years from Earth -- was detected in December 2005. The results were reported by Dr. Rachel Osten at the Cool Stars conference, and were described in a release from GSFC: *http://swift.gsfc.nasa.gov/docs/swift/news/2006/06-93.html*

11/21/06 -Twin Star Explosions Fascinate Astronomers

A galaxy that has produced four supernovae since 1980 lit up with two at once, in an amusing image taken by the Swift UVOT and featured in a Penn State release: *http://www.science.psu.edu/alert/Swift11-2006.htm*

12/21/06 - Swift Finds New Kind of Black Hole Explosion

Studies of two bursts that appear to be a new kind of explosion resulted in four papers in the December 21, 2006 issue of Nature. The explosion is called a "hybrid" gamma-ray burst as it seems to have some of the properties of both "long" and "short" bursts, previously distinguished by both duration and spectral properties, and attributed to different formation mechanisms. Read the NASA HQ release: *http://www.nasa.gov/mission_pages/swift/bursts/hybrid_grb.html*

Burst of Controversy May Signal New Class of GRBs

By: Derek Fox, Penn State University

A gamma-ray burst detected by Swift on June 14, 2006, has been stirring up controversy within the GRB research community. The burst lasted for 100 seconds, which should easily qualify it for membership in the class of "long bursts" that have been subject to detailed study for more than nine years. At the same time, though, it exhibits some properties of the "short bursts" that were first identified and studied in detail last year. The unique combination of characteristics has theorists and observers scratching their heads, and has caused them to dub this burst, GRB 060614, the possible first example of a new class of "hybrid gamma-ray bursts."

Observations from Swift raised the first questions about this event. Neil Gehrels, Swift PI, was the lead author in a paper to the magazine Nature (see p.2), in which the satellite team describes one paradoxical aspect of the burst. If we think of a gamma-ray burst as a short piece of music, then the more energetic gamma-rays in the burst correspond to higher notes, and the less energetic gamma-rays correspond to lower notes. For a typical long burst, the lower notes lag the higher notes by a fraction of a second – a slight asynchrony. The 100 second-long piece that was GRB 060614, however, was played in strictest unison across the whole gamma-ray keyboard. Bursts from the short class – those lasting less than two seconds – typically exhibit this sort of synchrony, but it had never before been seen from such a long burst.

Subsequent observations by ground-based telescopes and the Hubble Space Telescope added further wrinkles. First, the burst was found to lie within a bright, relatively nearby galaxy, 1.6 billion light-years away in the constellation Indus. GRBs at such a close distance are rare, and whenever one can be identified, astronomers like to study it closely. In every previous case where a long burst was subjected to such study, it rewarded astronomers by blossoming, two weeks after the event, into a brilliant and long-lived supernova. Not so GRB 060614 – it was seen instead to disappear without a trace. This too, although a novel behavior for long bursts, has been the typical pattern for short ones – a point made by the authors of three additional papers in Nature, led by Massimo Della Valle, Johan Fynbo, and Avishay Gal-Yam.

The difference between long and short bursts is a deep one. Because of their habit of turning into supernovae, the long bursts are considered to result from the collapse and explosion of a short-lived massive star, ten or so times the mass of the Sun. Meanwhile, the occurrence of some short bursts in old, red galaxies has demonstrated that they cannot be produced by such massive stars – rather, they are thought to be due to the inspiral and merger of two old, dead stellar remnants, either neutron stars or black holes.

So: was GRB 060614 produced by a single massive star, by two merging stellar remnants, or by something else entirely? It's an important question, and without a clear answer at this time. All that can be said is that this event is the best candidate in a long time for something totally new, a "hybrid burst" that might just represent the most exotic class of them all.

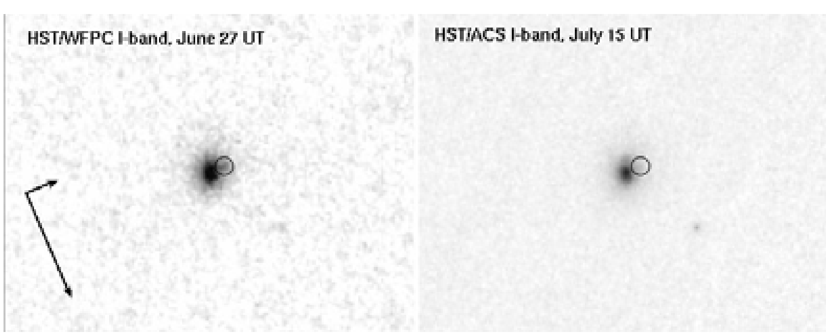


Image 2. The GRB060614 optical afterglow is visible in the June 27 image from Hubble Space Telescope (left) but had faded by July 15 (right). These images show that the GRB did not produce the expected supernova.

Obervatory Update

By: John Nousek, Penn State University

Swift continues operating smoothly and efficiently. We have gained better understanding of the observatory and the instruments, so we have been able to make upgrades to their performances.

By the time you read this, we will have crossed the milestones of discovering more than 200 new GRBs (with prompt observations of more than 75%). We will have conducted more than 60,000 slews of the observatory (a slew is when we move from one target to the next). Approximately 98% of the usable observing time (i.e. when we are outside the South Atlantic Anomaly) has been spent collecting BAT data for the detection of new GRBs and for the BAT hard X-ray all-sky survey.

Our Italian colleagues have continued their excellent support by providing more than 9000 ground passes from their Malindi tracking station in Africa at better than 98% success rate. Our Penn State mission operations center has successfully captured more than 99% of the total data generated by Swift. Our Goddard Space Flight Center Swift Science Center and Swift Data Center have continuously processed data and supported user requests for all the Swift data. The United Kingdom continues with its active support of the UVOT and XRT teams and the UK Data Center. Italy also provides a Data Center and support for the XRT team. Goddard has supported the BAT team and the all-sky BAT survey data analysis.

In addition to GRBs, Swift has conducted a vigorous Target of Opportunity program with more than 200 approved targets. These targets range from observations of comets with the XRT and UVOT, to nearby supernova, to distant AGNs, and previously unknown sources of gamma rays and ultra-high energy (TeV) photons discovered by INTEGRAL, HESS and VERITAS.

Approximately one out of every three days the Flight Operations Team responds outside normal working hours to command Swift to chase new science targets (usually new GRBs), to capture data missed by the routine downloads, or to respond to instrument or spacecraft anomalies. We have reduced the incidence of anomalies by operational

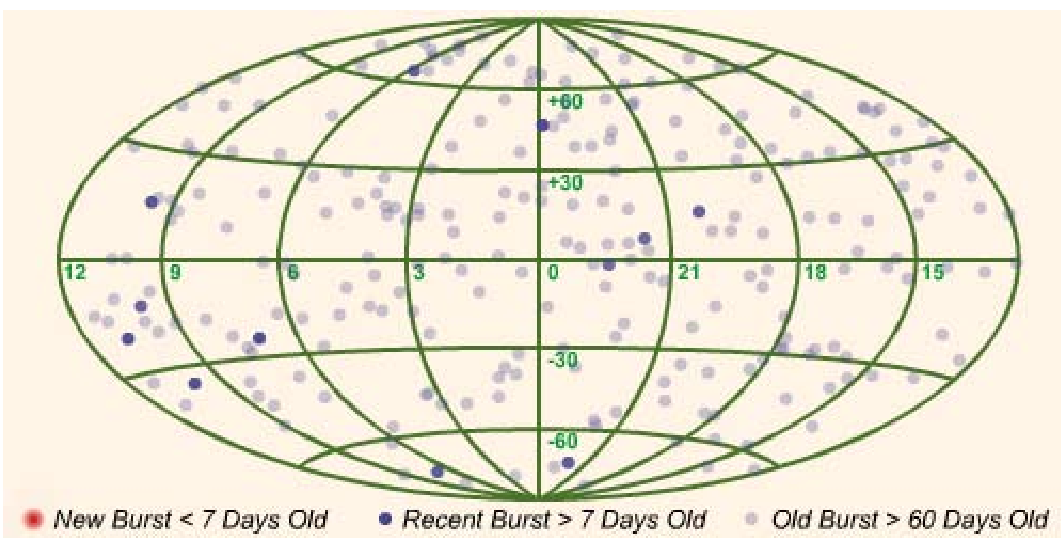


Image 3. An all sky map showing the location of all the bursts detected by Swift and other satellites from Aug. 25, 2004 to January 2, 2006.

procedures and software patches. The BAT operated more than 300 days on a continuous basis, and the UVOT for 92 days. The XRT, however, has never had a software crash. Overall the Swift science uptime is about 97%.

We have just completed the second full year of Swift operations (which satisfied the Swift minimum success criteria), and we are very pleased by the recommendation of the NASA Senior Review that Swift plan for four more years of operations.

The observatory and instruments are all operating at full science capability. Minor performance glitches (very rare instances of loss of star tracker lock, loss of three columns in the XRT CCD, passive temperature control due to loss of the XRT TEC, and BAT noisy detectors) are all controlled by operational procedures and/or software improvements. There are no consumables on Swift and the orbit will last well beyond this four year period. At this point we see no reason not to expect Swift to continue on its mission through at least 2010.

I want to announce that we plan to hold a workshop at Penn State on May 1-2, 2007, to consider the top level strategy for Swift science. Is the current emphasis on GRBs and afterglows the right priority for the future of Swift, or should we consider increasing the time available for TOOs or other science programs? More details on the workshop will be available early in 2007.

Amateur Corner

by: Logan Hill, SSU E/PO

Once again members of the Swift Education and Public Outreach (E/PO) team were present at the Astronomical Imaging Conference (AIC) in San Jose via the Global Telescope Network (GTN). Held in November, the AIC is a formal gathering of amateur astronomers whose instruments and observations are nothing but professional. Accompanying the astronomers at the conference were vendors of high-quality CCD cameras, telescopes, and astronomy software.

From the joint Swift, GLAST, and XMM-Newton booth, the E/PO team distributed GTN flyers, Swift stickers, and other E/PO materials. Interest in active galaxies and other gamma-ray producing objects was generated within the astronomer community as the team explained how the GTN operated; specifically its robotically automated interface and its connection to the gamma rays detected by Swift. As was the case last year after attending the AIC, the GTN membership grew, signaling the importance of direct contact with the amateur astronomy community.

As a sponsor, the GTN sent Dr. Phil Plait, Tim Graves and Logan Hill to the conference this year. They were excited to find the community interested in robotic telescopes used for both science and education; notably Russ Croman and Rick Gilbert's Remote Imaging talks. Thanks to Steve Mandel, the conference coordinator, the AIC once again brought together leading amateur astronomers and cutting edge technology for three days of talks, lectures and discussions. The GTN and Swift E/PO are honored to have been involved with the AIC.

For more information about the GTN, go to:
http://gtn.sonoma.edu

and the AIC 2006 web page can be found at
http://www.galaxyimages.com/AIC2006.html

E/PO Update

By: Phil Plait, SSU E/PO

When making educational products for the classroom (what educators call “formal” materials), the Swift E/PO group keeps an eye on the National Science Education Standards, a set of basic grade level specific concepts that was put together by a large group of educators, and funded by such groups as the NSF, NASA, and the U.S. Department of Education.

In the middle school standards, Newton’s Laws figure prominently, as they should – you can base the rest of high school physics on them! So years ago the E/PO group put together a series of three posters, each one expounding upon one of Newton’s Laws. These posters were a hit with teachers, but over the years we found they needed serious updating. So we carefully examined the concepts and the posters, and almost totally reworked them.

Each poster features beautiful and topic-appropriate artwork by artist Aurore Simonnet, illustrating concrete examples of each Law. Furthermore, the posters were designed in such a way that if they are mounted next to each other, the artwork flows organically from each poster to the next.

On the back side of each poster is an explanation of the given Law, a description of the illustrations on the front of the poster, an example of the Law using the Swift spacecraft itself as an example, and an activity that will give students hands-on experience with the Law.

For the First Law, the students roll a toy car down a ramp and observe the results (we even worked in a safety message about seat belts!). For the Second Law, students examine drawings of a moving car and a girl throwing a ball, and match these drawings to a series of simple plots showing position, velocity, and acceleration. The Third Law activity has them making simple balloon rockets which they can race.

To the original set of three, we have added a fourth poster for the Universal Law of Gravitation. In the activity, they drop various objects to see if they fall at the same rate or if heavier ones fall faster. They also calculate the gravitational acceleration of the various planets, and can use that to find what they would weigh on Mercury and Pluto!

To download these activities:
http://swift.sonoma.edu/education

Image 4. When the four Newton’s Laws posters are displayed together, they form a seamless integrated image of the basic laws of classical physics.

SWIFT SUPERNOVAE OBSERVATIONS

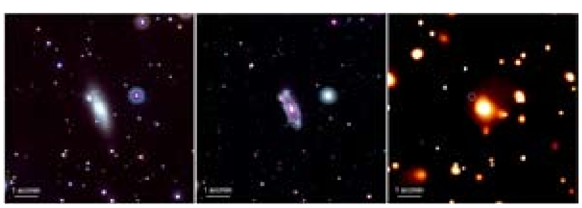
Visible | Ultraviolet | X-ray

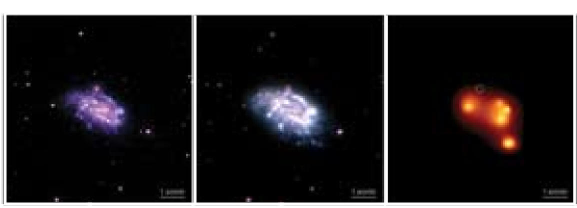

M81


M83


M101

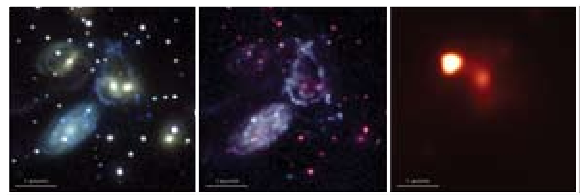

M51 - SN 2005cs

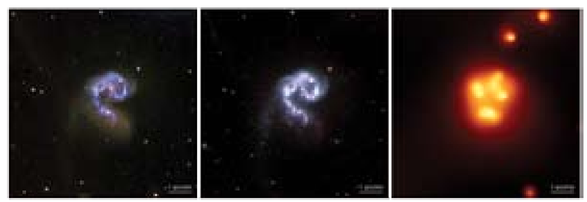

NGC 2811 - SN 2005am


NGC 1559 - SN 2005df

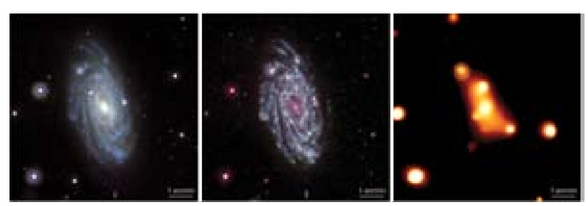
Visible | Ultraviolet | X-ray


NGC 6946


Stefan's Quintet - Arp 319


Antennae - NGC 4038

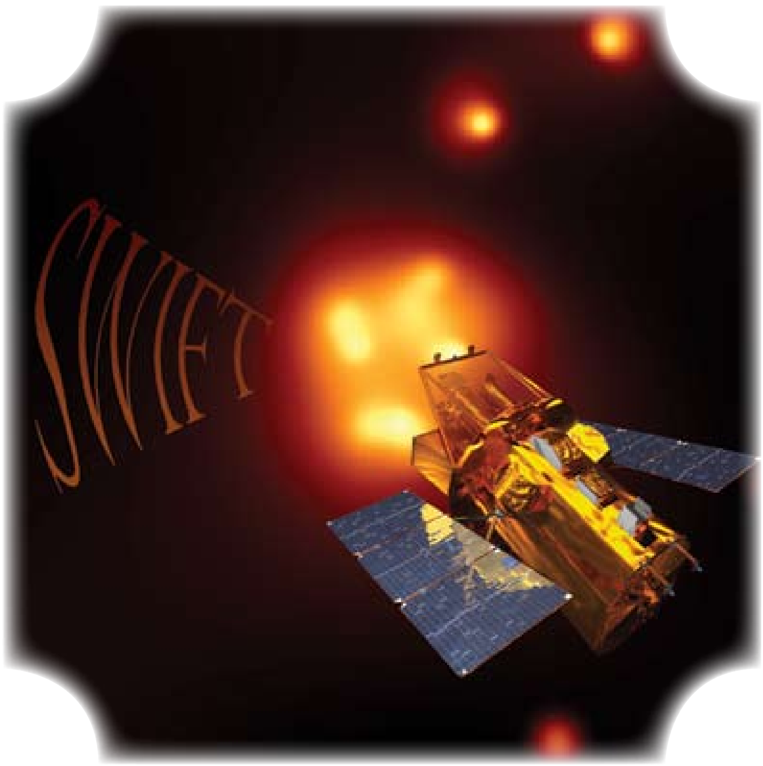

NGC 1371- SN 2005ke


NGC 3953 - SN 2006bp


M100 - SN 2006X - SN 1979C

One of Swift's secondary science mission goals is to observe supernovae, providing astronomers with optical, ultraviolet, and X-ray data of these exploding stars. This gallery shows some of these observations-- making it clear that not only is Swift supporting excellent science, it is also creating images that are pleasing to the eye. Credit: Stefan Immler, GSFC.

http://swift.sonoma.edu/resources/multimedia/images/



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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http://swift.sonoma.edu/resources/multimedia/newsletter/signup.html

For more information, please visit these Swift websites:

- ☞ ***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*

http://www.nasa.gov/swift

18 February 2005