National Aeronautics and Space Administration

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Swift Newsletter

Swift Year in Review - PI Neil Gehrels

Welcome to the spring 2008 issue of the Swift newsletter. We just received the great news that Swift was ranked number 1 in the NASA Senior Review. The Senior Review is an assessment that NASA does every two years to determine the budgets for its operating missions. Swift was compared on the basis of science return per dollar to the 9 other NASA astrophysics missions (excluding the Hubble Space Telescope). The highest ranking will mean that we receive the full budget request for the next 2 years plus we will have our request for the following 2 years penciled in as a baseline for the next review. This follows excellent recent budget news on Swift in the UK and Italy which promises continued full funding for the Swift teams in those countries as well.

As we sometimes say in the gamma-ray burst business, the heavens were kind to Swift during the past few months. You will find in this newsletter news about two recent discoveries that were unexpected surprises. One was the observation of a distant gamma-ray burst with afterglow of visible light that was so bright it could have been seen with the naked eye. It was not actually captured by any human eyeballs that we know of, but was recorded by robotic telescopes on the ground. It was a factor of 100 brighter than the previous record holder and 100,000 times brighter than the typical visible afterglow of GRBs.

The other discovery was of an X-ray outburst observed by Swift's XRT instrument while observing a supernova in a nearby galaxy. During the measurement, another supernova occurred in the same galaxy. The chance of capturing such an event in the narrow field of view of our X-ray telescope was exceedingly small and had never previously happened in all the years of X-ray astronomy. You can read about the remarkable result of that chance observation in the article below by discoverer Alicia Soderberg.

This brings to mind the fun fact that all gamma-ray bursts or other kinds of flashes that Swift will ever detect are already on their way to us. That is the nature of our vast universe. It takes billions of years for light to reach us from distant galaxies. All astronomical observations are like time machines looking back in time, but it is even more interesting in the case of gamma-ray bursts since they are pulses of radiation. You can think of them as ever-expanding thin disks of radiation flying through space for eons before being captured in our Swift telescopes.

Swift is #1 with us!

Swift in the News

By Chip McAuley, SSU E/PO

12/18/07 - "Shot in the Dark" Explosion Stuns Astronomers

Astronomers detected a gamma-ray burst (GRB) seemingly from the middle of nowhere. This startling discovery surprised scientists because long-duration GRBs are assumed to be related to the collapse of a massive star. Learn more about this surprising discovery by reading the Official GSFC Press Release:

http://www.nasa.gov/centers/goddard/news/topstory/2007/intergalactic_shot.html

2/26/08 - Swift Satellite Catches a Galaxy Ablaze with Starbirth

NASA Astronomers have created the most detailed ultraviolet mosaic image of an entire galaxy in history. Taken over 11 hours and combining 39 frames, the "Triangulum Galaxy" — located about 2.9 million light-years from earth — became the first to receive this ultraviolet distinction, which combines images taken by the Swift satellite. For more information visit the Official GSFC Press Release:

http://www.nasa.gov/mission_pages/swift/bursts/m33.html

3/20/08 - Satellite Detects Naked-Eye Explosion Halfway Across Universe

Swift scientists detected an unusually powerful Gamma-ray burst on March 19 — over 7.5 billion light-years away. The cosmic explosion now holds the record as the most distant stellar phenomenon that would have been able to be seen with the naked eye. At the time the burst took place, earth did not exist and the universe was half its age. Learn more about this naked-eye phenomenon by reading the Official GSFC Press Release.:

http://www.nasa.gov/centers/goddard/news/topstory/2008/brightest_grb.html

5/2/08 - Gehrels Elected Fellow of American Academy of Arts & Sciences

Neil Gehrels, principal investigator for the Swift mission, became a Fellow of the American Academy of Arts & Sciences for his accomplishments as an astrophysicist. "I am delighted to be elected to the American Academy. The discoveries from Swift played a key role and I am extremely grateful to the superb science team for making the mission a success.," said Gehrels according to reports. For more information on Gehrels' accomplishment, visit the Official GSFC Press Release:

http://swift.gsfc.nasa.gov/docs/swift/news/2008/neil_aaas.html

5/19/08 – The Mouse That Roared: Pipsqueak Star Unleashes Monster Flare

A monster flare came from a common red-dwarf star — the brightest of any star seen other than the sun. The type of burst from this stellar neighbor, at a relatively close distance of 16 light-years, would "deplete the atmospheres of life-bearing planets, sterilizing their surfaces," according to Rachel Osten, a Hubble Fellow at the University of Maryland, College Park and NASA's Goddard Space Flight Center. To learn more about this flare visit the Official GSFC Press Release.

http://www.nasa.gov/centers/goddard/news/topstory/2008/pipsqueak_star.html

5/21/08 – NASA's Swift Satellite Catches First Supernova in the Act of Exploding

Astronomers made history when they caught a star in process of exploding. The first time such a discovery has been made it will have far-reaching impacts. "For years we have dreamed of seeing a star just as it was exploding, but actually finding one is a once in a lifetime event," said Alicia Soderberg. "This newly born supernova is going to be the Rosetta stone of supernova studies for years to come." See the Princeton Website for more information and a link to the Media Telecon:

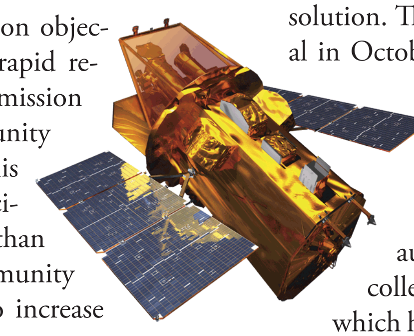
https://www.princeton.edu/presskits/astro/

Mission Director Report

By John Nousek, Penn State, Swift Mission Director

The Swift Observatory continues humming along successfully after three and a half years of operation. We have conducted more than 105,000 separate maneuvers to targets and amassed a stunning total of more than 265 GRB detections. At the current time Swift has discovered about 75% of all GRBs with known redshifts and 87% of all GRBs with detected afterglows.

In addition to the GRB prime mission objective, the great Swift versatility and rapid response has made Swift the 'go-to' mission for a huge range of Target of Opportunity science. We have been conducting this short notice opportunity- based science at a rate of 400 per year (more than once per day on average), and community demand will likely cause this rate to increase still further.



We are implementing the results of the recent Guest Investigator program selection which has allowed, for the first time, the ability of non-team members to propose targets for Swift pointed observations. We are ahead of schedule in carrying out these observations, and we expect each year to broaden the opportunities.

We continue to improve the observatory by tuning flight software and making changes to our ground operations. We have just started a new response to Targets of Opportunity (which include GRBs discovered by other missions and Swift GRBs discovered in ground processing). This change will allow for faster response (important in the new era when GLAST discovered GRBs require rapid and accurate confirmation and positioning), and reduce the demands on the Swift Flight Operations Team.

On August 11, 2007, Swift had a significant hardware problem with one of its gyro units, which provide a key part in the ability to point Swift accurately at targets. We rapidly realized that this unit had developed a small 'wiggle' in its pointing stability measurement ability, so we switched in the flight backup unit. Unfortunately the backup was slightly misaligned in a way that could not easily be handled by the observatory flight software.

After a period of intense analysis and testing by the General Dynamics team and the Penn State MOC and Goddard BAT team, we developed a system of using all three gyro units in tandem.

Great appreciation goes to Craig Markwardt of the BAT team who conceived of the three gyro solution. The new gyro system became operational in October, and the pointing behavior is now the best we have ever had in the life of Swift.

All three instruments have improved their capabilities and simplified and automated their operations. The BAT is collecting data during our slew maneuvers, which has lead to several new GRB detections. We are also developing a flight software patch for the BAT to enable lowering the GRB detection thresholds and having "low threshold" and "normal threshold" classes of events.

For the low threshold class, the confirmation of an XRT detection will allow us to find GRBs which are too faint for the original BAT settings. The XRT has changed voltages to decrease backgrounds (especially while observing close to the Earth limb), and has developed a cross-calibration with the UVOT which allows the XRT to measure the location of a GRB afterglow approximately twice as accurately as previously. The UVOT has completed a calibration and software analysis tool package to allow use of the grisms in a more substantial way.

We have been extremely pleased with the operation of Swift and are planning on continuing operations for at least the next four years. We continue to improve Swift's performance and we look forward to new and exciting scientific programs in both GRB and other areas in astrophysics.

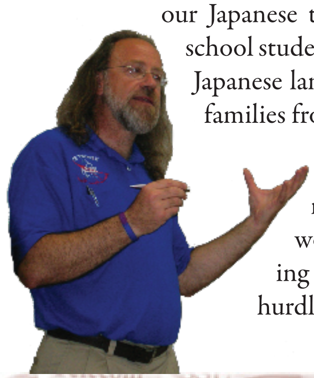
International Cooperation: Life as an Educator Ambassador

By David Beier

As a NASA Swift Educator Ambassador the past 4 years, I have had the luxury and joy of presenting an assortment of different workshops to teachers and students in a number of different forums – from NSTA Conventions across the country to AAPT National Meetings, from state science conferences to regional science teacher meetings. I have facilitated workshops with 'The Invisible Universe', '7 Ways a Black Hole Can Kill You', 'The Electromagnetic Spectrum', 'The Life Cycle of Stars' and, most often of late, 'Newton's Laws of Motion'.

But, last summer, I was given the opportunity to share our NASA science with many students and teachers halfway across the globe. I spent most of the month of June 2007 in Japan, teaching physics and delivering lectures and workshops to fascinated, and fascinating, people very interested in the same things that capture MY imagination – Black Holes.

This opportunity was afforded me by my Headmaster, Mr. Art Atkison. I teach at The Barstow School, a small independent school in Kansas City, Missouri. The Barstow School has a sister school, Amaki High School, in Kurashiki City, Okayama Prefecture, Japan. The Amaki School is designated by the Japanese Education Department as a Super Science School. The previous school year, 25 Japanese students and 3 teachers had spent 3 weeks attending our school, in home-stays with some of our families. The main goals of our school partnership are to share culturally and to also provide an exchange of science ideas. I was chosen to go to Japan for a 3-week summer stay with our Japanese teacher and some of our high school students who have been studying the Japanese language, each of us staying with families from our host school.



The trip was an incredibly rich cultural experience and a wonderfully challenging teaching experience. There was one little hurdle I needed to overcome.

I was greeted at the Amaki School with open arms and spent the first couple of days just observing classes and trying to get the lay of the land. I gave an hour-long presentation to the student body of nearly 700 on Black Holes – '7 Ways a Black Hold Can Kill You'. In an attempt to appear like I had some grasp of the Japanese language, I introduced myself, trying to say 'My name is David Beier and I am a teacher.' Unfortunately, the word for 'teacher' in Japanese is amazingly close to the word for '1000 years old'. They all laughed as told them all my name and that I was 1000 years old. Good accidental ice breaker. The powerpoint presentation with the graphics was very helpful, and I learned to pace myself so my translators could keep up. It was rather disconcerting to say something clever, and then having to wait a minute before there would be laughter from the students and staff. Killer wait time. They were fascinated with the information, as far as I could tell. For all I know, the Amaki teacher who was translating my words was simply telling the students, "Act like you are interested. He is our guest."

I was pleased to be able to glean that the following week in physics they would begin the study of waves. I was set to teach. I had shipped forward some materials from my presentations on the GEMS NASA Invisible Universe book.

My new Japanese students were going to study properties of waves as they played with slinkies and springs and a variety of light sources. I was surprised to learn that the format for teaching was strictly instructor lecture and students taking notes, no questions asked. I began teaching my first class and performed a quick demonstration with a spring, drew a wave on the board, and asked a simple question about wavelength. The physics teacher wrote some Japanese characters next to the wave I had drawn on the board. My words were translated to the class and I was met with silent stares from the students. I asked another question, listened to the translation into Japanese, and again, silence.

I turned to my English teacher translator and asked if they did not understand my questions. "Mr. Beier, did you want them to answer your questions?" In the Japanese school culture, it was explained to me, questions from the instructor are strictly rhetorical questions. Yikes! For the rest of my stay, I told her to explain, I expected them to raise their hands and actually ANSWER questions that I posed to the class. They laughed, and slowly learned to answer me and engage in conversation in class. It all worked out well for the remainder of my stay. I am certain the Physics instructor cringed when he heard the translation of what I was saying, and knew he was going to need to re-train his students his students after I was back in the USA. We spent the week working through the activities in the Invisible Universe book, laughed and learned by DOING Physics.

The next week I gave a lecture on the Suzaku Mission and did several activities with the science faculty and physics students from the NASA education publication on this mission. Jim Lochner had shipped a number of Suzaku activity books to me directly to Japan. This is the joint Japanese Aerospace Exploration Agency (JAX/NASA) X-ray observatory. The entire school was very enthusiastic to hear of this joint mission and to play the role of the Japanese scientist in these activities.

My visit to the Amaki High School in Japan was followed with a return visit to Kansas City in October by a dozen students and two teachers who spent nearly two weeks in our community living with host families, going to classes and conducting research science projects. The partnerships between our schools, with much credit to NASA for helping us overcome our language and cultural differences through science education, enables international cooperation. The Barstow School and Amaki High School continue moving forward as I prepare to head back to Japan with another group of students, and as we prepare for another visit from them in the coming months.

Science and NASA bring us together.

X-rays Mark the Spot: The Birth of a Supernova in Real Time

By Alicia Soderberg, Princeton University

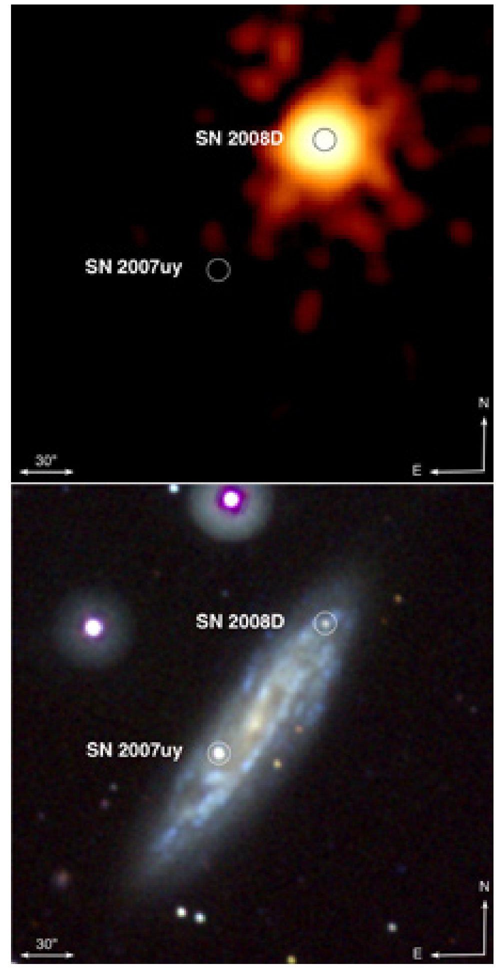
In the four years since its launch, the Swift satellite has discovered hundreds of long-duration gamma-ray bursts (L-GRBs): a rare class of massive star explosion intimately related to supernovae but 1000 times less common and orders of magnitude more powerful. The rapid follow-up of L-GRBs enabled by Swift's co-aligned UVOT and XRT, has revolutionized our understanding of these extraordinary explosions.

Lacking the prompt gamma-ray pulse of L-GRBs, ordinary supernovae are invariably discovered by their optical emission, which only reaches peak brightness several weeks after the explosion. In fact, by the time most supernovae are discovered, most of the fireworks are already over. We, therefore, lack an un derstanding of the first minutes, hours, and days in the evolution of supernovae.

All of this changed on January 9 of this year. During a brief observation with Swift/XRT of a supernova in the nearby galaxy, NGC 2770 (d=27 Mpc), another star in the same galaxy exploded. The explosion was marked by an extremely luminous X-ray outburst, $L_x \approx 10^{44}$ erg s^{-1}, lasting just a few minutes. Rapid follow-up with Swift's UVOT, XRT, in addition to ground-based facilities quickly revealed that the X-ray outburst marked the birth of a supernova, SN 2008D.

Such an outburst has long been predicted to signal the very moment when a supernova shockwave breaks through and blows apart the star, the so-called "break out" emission. However, since the short-lived signal is incredibly hard to detect, this X-ray signature had never yet been seen.

As reported in a recent paper to Nature (Soderberg et al., 2008, Nature, 453, 469), every aspect of SN 2008D was fully in line with expectations for an ordinary core-collapse explosion. The X-ray outburst is well described by the long-predicted, but never yet seen, shock break-out emission. Therefore, while some supernovae produce L-GRBs, SN 2008D is not one of them.



NASA/Swift Science Team/Stefan Immler

This leads to the exciting conclusion that we can expect all ordinary supernovae to produce a similarly spectacular X-ray outburst at the time of explosion which may be used as an early warning beacon to enable follow-up from ground based facilities. Looking forward, the field of supernova discovery and study is on the brink of a paradigm shift -- with more powerful X-ray satellites being designed now (e.g. EXIST), we predict that hundreds of supernovae will be discovered each year in the act of exploding, thanks to their powerful X-ray outbursts.

NASA Satellite Detects Naked-Eye Explosion Halfway Across Universe

Robert Naeye, NASA's GSFC

A powerful stellar explosion detected March 19 by NASA's Swift satellite has shattered the record for the most distant object that could be seen with the naked eye.

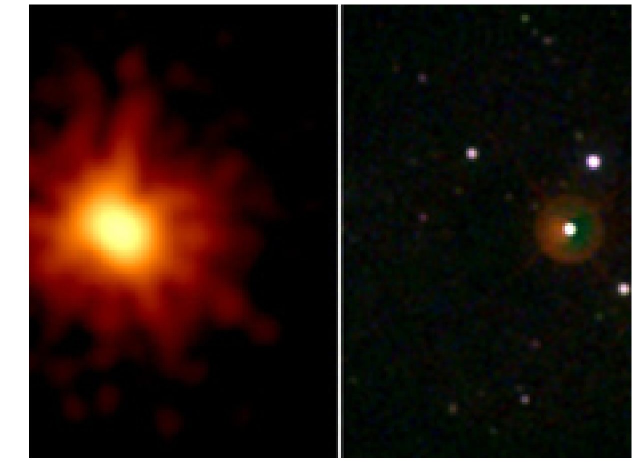
The explosion was a gamma ray burst. Most gamma ray bursts occur when massive stars run out of nuclear fuel. Their cores collapse to form black holes or neutron stars, releasing an intense burst of high-energy gamma rays and ejecting particle jets that rip through space at nearly the speed of light like turbocharged cosmic blowtorches. When the jets plow into surrounding interstellar clouds, they heat the gas, often generating bright afterglows. Gamma ray bursts are the most luminous explosions in the universe since the big bang.

"This burst was a whopper," said Swift principal investigator Neil Gehrels of NASA's Goddard Space Flight Center in Greenbelt, Md. "There is a tremendous amount we are learning about optical emission from bursts from this one event."

Swift's Burst Alert Telescope picked up the burst at 2:12 a.m. EDT, March 19, and pinpointed the coordinates in the constellation Boötes. Telescopes in space and on the ground quickly moved to observe the afterglow. The burst is named GRB 080319B, because it was the second gamma ray burst detected that day.

Swift's other two instruments, the X-ray Telescope and the Ultraviolet/Optical Telescope, also observed brilliant afterglows. Several ground-based telescopes saw the afterglow brighten to visual magnitudes between 5 and 6 in the logarithmic magnitude scale used by astronomers. The brighter an object is, the lower its magnitude number. From a dark location in the countryside, people with normal vision can see stars slightly fainter than magnitude 6. That means the afterglow would have been dim, but visible to the naked eye.

Later that evening, the Very Large Telescope in Chile and the Hobby-Eberly Telescope in Texas measured the burst's redshift at 0.94. A redshift is a measure of the distance to an object. A redshift of 0.94 translates into a distance of 7.5 billion light years, meaning the explosion took place 7.5 billion years ago, a time when the universe was less than half its current age and Earth had yet to form. This is more than halfway across the visible universe.


Extremely luminous afterglow. Credit: NASA/Swift/Stefan Immler, et al.

"No other known object or type of explosion could be seen by the naked eye at such an immense distance," said Swift science team member Stephen Holland of Goddard. "If someone just happened to be looking at the right place at the right time, they saw the most distant object ever seen by human eyes without optical aid."

GRB 080319B's optical afterglow was 2.5 million times more luminous than the most luminous supernova ever recorded, making it the most intrinsically bright object ever observed by humans in the universe. The most distant previous object that could have been seen by the naked eye is the nearby galaxy M33, a relatively short 2.9 million light-years from Earth.

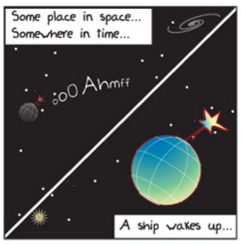
Analysis of GRB 080319B is just getting underway, so astronomers don't know why this burst and its afterglow were so bright. One possibility is the burst was more energetic than others, perhaps because of the mass, spin, or magnetic field of the progenitor star or its jet. Or perhaps it concentrated its energy in a narrow jet that was aimed directly at Earth.

GRB 080319B was one of four bursts that Swift detected, a Swift record for one day. "Coincidentally, the passing of Arthur C. Clarke seems to have set the universe ablaze with gamma ray bursts," said Swift science team member Judith Racusin of Penn State University in University Park, Pa.

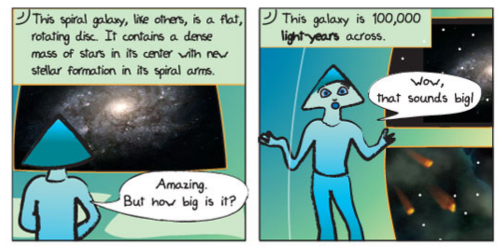
Epo's Chronicles Goes Galactic

By Chip McAuley, SSU E/PO

Epo's Chronicles, a new educational web comic created by the NASA Education and Public Outreach Group at Sonoma State University, is ready to be unveiled to the galaxy. The guiding concept behind the project is developing an engaging storyline with fictional characters that teaches real science both to students and science enthusiasts of all ages.



This weekly web comic follows the adventures of Epo, a sentient spaceship/observatory, in the distant future. Epo is joined by Alkina, a humanoid alien, as they quest to regain their memories and learn science along the way. The first series of 'Eposodes' explores galaxies.



The development team for Epo's Chronicles includes Kevin John, Chip McAuley, Logan Hill, Kamal Prasad and Aurore Simonnet. Each member of the team contributes to the overall creation of the storyline and characters, while Simonnet handles all of the illustrations.

John, Hill and Prasad, consider which scientific lessons will be the focus of the Eposode and take turns writing, while McAuley writes, creates storylines and focuses on the overall storytelling itself, making certain that the project is engaging to readers from across the globe. Epo's Chronicles is also being translated into Spanish, French and (we hope) Italian.

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Epo's Chronicles are available through a link on the newly revamped SSU E/PO Website

http://epo.sonoma.edu

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

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