Astronomers have uncovered rhythmic pulsations from a rare type of black hole 12 million light-years away by sifting through archival data from NASA's Rossi X-ray Timing Explorer (RXTE) satellite.

The signals have helped astronomers identify an unusual midsize black hole called M82 X-1, which is the brightest X-ray source in a galaxy known as Messier 82. Most black holes formed by dying stars are modestly-sized, measuring up to around 25 times the mass of our sun. And most large galaxies harbor monster, or supermassive, black holes that contain tens of thousands of times more mass.

“Between the two extremes of stellar and supermassive black holes, it’s a real desert, with only about half a dozen objects whose inferred masses place them in the middle ground,” said Tod Strohmayer, an astrophysicist at NASA’s Goddard Space Flight Center in Greenbelt, Maryland.

Astronomers from Goddard and the University of Maryland, College Park (UMCP) have suspected M82 X-1 of being midsize for at least a decade, but compelling evidence excluding it from being a stellar black hole proved elusive.

“Because the whole of observing these objects have resisted standard measurement techniques,” said Richard Mushotzky, a professor of astronomy at UMCP.

By analyzing six years of RXTE data, the team located X-ray variations that reliably repeat about 5.1 and 3.3 times a second, a 3:2 relationship. The combined presence of slow QPOs and a faster pair in a 3:2 rhythm sets a standard scale allowing astronomers to extend proven relationships used to determine the masses of stellar-mass black holes.

The results of the study were published online in the Aug. 17 issue of the journal Nature.

Launched in late 1995 and decommissioned in 2012, RXTE is one of NASA’s longest-serving astrophysics missions. Its legacy of unique measurements continues to provide researchers with valuable insights into the extreme environments of neutron stars and black holes.

A new NASA X-ray mission called the Neutron Star Interior Composition Explorer is slated for launch to the International Space Station in late 2016. Pasham has identified six potential middle-mass black holes that NICER may be able to explore for similar signals.

Above: A still from the video exploring how astronomers used X-ray fluctuations to determine its status as an intermediate-mass black hole. Image credit: NASA/Goddard

By: Felicia Chou and Lynn Chandler
THE FUTURE OF CUBESATS

By: Max Gleber

To investigate climate change, scientists and engineers at NASA’s Goddard Space Flight Center are developing the IceCube satellite, which will be no larger than a loaf of bread. In 2016, this satellite will mature technology that scientists will use to analyze cloud ice in the atmosphere.

“We’re using IceCube to test a radiometer that we want to fly on a big space mission,” said Jeffrey Piepmeier, associate head of Goddard’s Microwave Instruments and Technology Branch. “Climate scientists have never used this frequency to measure cloud ice from space before.”

The project highlights a growing trend toward testing instruments and running scientific experiments aboard CubeSats. “Every pound that you send into space costs a phenomenal amount of money,” said Todd Bonalsky, an electrical engineer at Goddard. “Hence in the investment in CubeSats, which are tiny, complete satellites that are cheaper and easier to build than their larger counterparts.”

Bonalsky’s Dellingr CubeSat is slated to launch in March 2015. Employing a magnetometer system Bonalsky miniaturized for CubeSat use, Dellingr will measure magnetic fluctuations to help scientists better understand how space weather affects Earth. Dellingr will be the first CubeSat to fly this type of science grade magnetometer system.

Scientists however face a number of challenges when working on CubeSats. Because of their size, CubeSats cannot power many of NASA’s formidable scientific instruments, and there are limits to what can be miniaturized. The Hubble Space Telescope for example uses a mirror nearly eight feet wide to capture light and translate it into images that a smaller mirror could not produce.

Doug Rowland, a solar scientist at NASA, faced this dilemma when gathering data from his Firefly CubeSat. He built it to investigate the correlation between lightning and gamma radiation, but his CubeSat can only download 20 milliseconds slots of data to Earth each day. “The Firefly just doesn’t have enough electrical power to simultaneously run its GPS receiver, its communications antenna and our experiment at the same time,” Rowland said. “On a big spacecraft, you’d have a thousand times as much data, at least, and you’d have other ways to transmit the data down to Earth.”

Despite such drawbacks, the size and cost of CubeSats open up new strategies for scientific investigations. In conventional missions, every component must function exactly as designed, but, depending on the mission, a single CubeSat is expendable.

CubeSats can thus slash a scientific mission’s budget and allow scientists to measure multiple data points that would be unobtainable otherwise.

Advances in the mobile phone industry opened the door for smaller solar panels and more efficient batteries. NASA develops such technology both to advance methods of cost-effective data collection and to test technology that will lead to larger missions down the road. Pioneering CubeSat missions may open new doors in the future of space exploration.

“Instead of pouring money into one big satellite, we try to make a swarm,” said Robert Clayton, a Goddard intern from Dartmouth College. “It’s okay if we lose two or three from our swarm of 20. We instead focus on making each CubeSat as cheap and reproducible as possible.”

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Using multiple spacecraft for a single mission is by no means a novel concept. The Solar Terrestrial Relations Observatory for example is a pair of nearly identical observatories that trace solar matter as it flows from the sun. However losing one of these expensive observatories would spell catastrophe for the mission, as opposed to losing one CubeSat in a swarm.

Opposite: Three cans of soda would fill the Firefly CubeSat to the brim. But don’t let its size fool you—NASA has big plans for these tiny satellites. Photo credit: NASA/Goddard/Bill Hrybyk.

Below: Todd Bonalsky holds the solar panel that will power the Dellingr satellite. Photo credit: NASA/Goddard/Kristen Basham

“...CubeSat missions may open new doors...”
Budinoff is developing both to show that telescope and instrument builders would benefit enormously—particularly those interested in building infrared-sensing instruments, which typically operate at super-cold temperatures to gather the infrared light that can be easily overwhelmed by instrument-generated heat. Often, these instruments are made of different materials. However, if all the instrument’s components, including the mirrors, were made of aluminum, then many of the separate parts could be 3-D printed as single structures, reducing the parts count and material mismatch. This would decrease the number of interfaces and increase the instrument’s stability, Budinoff added.

Next year, he also plans to experiment with printing instrument components made of Invar alloy, a material being prepared for 3-D printing by Goddard technologist Tim Stephenson. The 100-year-old iron-nickel alloy offers extreme dimensional stability over a range of temperatures. The material is ideal for building super-stable, lightweight skeletons that support telescopes and other instruments.

“Anyone who builds optical instruments will benefit from what we’re learning here,” Budinoff said. “I think we can demonstrate an order-of-magnitude reduction in cost and time with 3-D printing.”

Above: an exploded view of the CubeSat-class, 2-inch imaging instrument that technologist Jason Budinoff is manufacturing with 3-D-printed parts. It shows the mirrors and integrated optical-mechanical structures. Image credit: NASA/Goddard/Jason Budinoff.
A t times, the sun erupts, hurling a magnetic super heated cloud of gas toward Earth. Racing at thou sands of miles per second, and hundreds of times bigger than the sun, this cloud of solar particles can cause a magnetic storm near Earth, disrupting satellite communi cations and—in worse case scenarios—overloading power transformers.

Here on Earth, Dhanshvaran Krishnarao monitors satel lite footage for this type of activity. He started at NASA in 2013 as a space weather forecaster after his professor at American University recommended the internship. Krish narao returned to NASA’s Goddard Space Flight Center in Greenbelt, Maryland, to continue his work this summer.

“We’ll be looking at images, like x-ray data and UV data,” Krishnarao said. “We monitor everything to see if something crosses a certain threshold. If it does, we would send out notifications for NASA robotic mission operators. Sometimes we respond to requests that the Air Force or other agencies would make to us. "

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But our technology also allows us to monitor these solar events and take necessary preparations. Goddard trains intern forecasters in a space weather boot camp for two weeks. During this orientation period, presentations and lectures train the interns to study past space weather events so they would know how to respond to certain space weather events.

“I now forecast eight hours a week,” Krishnarao said. “The rest of the time, I work on a project to use preexisting spacecraft to monitor solar conditions. This new system will allow mission operators to select a spacecraft and ascertain the likelihood of different risks occurring.”

Krishnarao hopes to continue working in astrophysics and heliophysics in grad school. He found the environment at NASA conducive to his education.

“They’re really pushing us and encouraging us,” Krish narao said of his mentors. “They’re really pushing us and encouraging us.”

“Serious” Career Advice

Some people hate graduate school so much that they drop out. Science comedian Adam Ruben did something even more outrageous. He finished his Ph.D. in molecular biology and wrote a book called “Surviving Your Stupid, Stupid Decision to Go to Grad School.”

On August 1, 2014, Ruben shared book excerpts and his graduate school experiences—mostly hilarious, unfortunate wows—with current, future and past graduate students at NASA’s Goddard Space Flight Center. According to Ruben, if you think going to graduate school is awful, you are wrong. It is worse than you imagined, and you should know what to expect.

“I really didn’t know what to expect in grad school, and that’s the message I’m trying to convey—not that people should avoid going to grad school, but that they should go in with eyes wide open,” said Ruben, who received his Ph.D. in molecular biology at Johns Hopkins University.

Ruben shared several widespread issues that many doctoral candidates experience, such as receiving contradictory advice from thesis committee members and taking seven years to complete a five-year Ph.D. program. But rather than listing complaints or presenting a tirade, Ruben uses humor to illustrate his points.

“Okay, let me do a quick commercial.”

“You can say that graduate stipends are so low that grad students have difficulty affording groceries, or you can offer tips on how to steal unguarded bagels from other departments’ seminars,” said Ruben. “Both make the same point, but the second makes it with some humor, which hopefully makes you likelier to want to read it.”

Ruben is one of a handful of professional comedians who specialize in science. He is more unique in that he travels around the world to deliver horror stories and quirky advice to students. His interest in stand-up comedy started when he entered a stand-up comedy competition at Princeton University, where he was studying molecular biology as an undergraduate student. In the first year, he placed second. He then won the competition for the next three years.

During the day, Ruben works as a molecular biologist developing a malaria vaccine at Sanaria Inc.—a highly rewarding job where he sees the practicality and applicability of his research, unlike his graduate school research that was in service to his dissertation that very few people will read.

“I can’t imagine a more rewarding job than being part of the group that spends every day trying to bring that vaccine from concept to prototype to small clinical trials to large clinical trials to a licensed vaccine that saves lives,” said Ruben. “It’s exactly why I went into science.”

Ruben received his Ph.D. in molecular biology at Johns Hopkins University. He worked on developing vaccines for malaria, the most deadly disease in the world. He tells the audience that it is worse than you imagined, and you should know what to expect.

Ruben is an example of someone who is both a scientist and a comedian. He uses his humor to make his point, and that’s what makes him likelier to want to read it.

“This is exactly why I went into science.”

Ruben also writes a book called “Surviving Your Stupid, Stupid Decision to Go to Grad School.” He tells the audience that it is worse than you imagined, and you should know what to expect.

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For nearly 13 years, Ruben has performed at storytelling venues and comedy clubs. He has been featured as a comedic scientist on the Food Network’s “Food Detectives,” the Science Channel’s “Head Rush” and Discovery Channel’s

By: Max Gleber

By: Kasha Patel

Monitoring Solar Activity with SDO

Photo credit: NASA

By: Adam Ruben. Photo provided by Adam Ruben
NASA's Goddard Space Flight Center creates and shares hundreds of images and visualization a year. NASA Goddard is home to some of the most amazing images, visualizations and videos NASA has to offer.

Click on any of these images to learn more and to download high resolution versions of each.

See more images on Goddard's Flickr page. You can follow NASA Goddard on Twitter. Join Goddard on Facebook. Find Goddard on Instagram.

Photo credit: NASA
Not everyone’s idea of relaxation is walking around the wilds of South Africa admiring elephants, giraffes and otters, but supervisory contract specialist Eric Newman did just that several times to get to know his father’s South African side of the family. His first trip was at 18 months, but the first trip he remembers was when he was 26 years old in 2005.

“I went to South Africa for their summer, arriving on Christmas Day for a barbeque and a swim at the beach,” Newman said. “It was not a bad way to spend Christmas.”

He went on a three-day wilderness walk with his uncle, who had been on many safaris. They drove into Kruger National Park and met the group consisting of a guide, a tracker and six other vacationers at a designated location. He packed hiking clothes and good hiking boots.

“You are in the malaria zone, so it is a good idea to cover up. The key is to wear natural colors like greens, tans and brown as camouflage so you don’t spook the animals,” Newman said.

The area looks like it did 500 years ago. There are no power lines. The airspace is restricted. All they could see was wilderness. Newman experienced greater clarity of thought when completely unplugged from the modern electronic world.

“I found it to be humbling. It made me realize that this land was here long before me and will be here long after me,” Newman said.

One of the highlights was the evening sundowner, a typical South African pastime in which everyone takes a break before dinner, has a drink and watches the sun go down. The group was driven to big, open vistas, giving them a sense of the vastness of the wilderness.

Although they were in the middle of nowhere, the tour included three hearty, home-cooked meals a day complete with ice for cold drinks. They slept in beds in A-frame cabins with nearby modern bathrooms and showers. The cabins were designed to allow a breeze no matter which way the air was blowing.

After dinner, everyone sat around a campfire talking about what they’d seen that day. The group sighted all kinds of deer including curly-horned kudu, elephants, giraffes and rhino, but the most exciting of all were the extremely rare cheetahs and African wild dogs.

“It was such a unique experience, which opened me up to how different the world is in different places,” Newman said. “This is the way the world is there and you’re just peeking into it.”

In 2009, Newman returned to South Africa, during which he, his cousin and his fiancée, went on a hut to hut hike along 40 miles of the Otter Trail along the east coast. Only 12 people are allowed on the trail each day. There are no guides; the coast serves as a constant point of reference. They carried all their food and clothing, about 40 pounds total, in backpacks, but slept in huts equipped with mattresses and bathrooms scattered along the trail.

“You shower on the beach with waves crashing 20 feet away.”

Walking seven to eight hours a day proved to be physical demanding. The South African coast is not a straight line; it is full of twists and turns, some up and others down.

Although the area is not known for big game, they were very excited to see otters on their last night, especially the otters lying on their backs, knocking clamshells together to open them and then dining on the innards using their stomachs as tables.

“Without the comfort of a guide, I felt much more self-sufficient in the wilderness. Next time I’ll pack less because you really can get by with very little for four or five days. I also realized that my fiancée and I get along well,” Newman said.

Newman next plans to go on a combination walking safari and canoe trip in Botswana’s Okavango delta, one of the richest wildlife habitats in the world. Before that, he and his fiancée are getting married.

“For the honeymoon, I promised running water,” Newman said. “There will be some wilderness involved, but I’m not sure about a safari.”

Center: Newman and his fiancée, Cecilia D’Antonio, take a break to rest and rehydrate on a safari walk. Photo courtesy of E. Newman