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GoddardView

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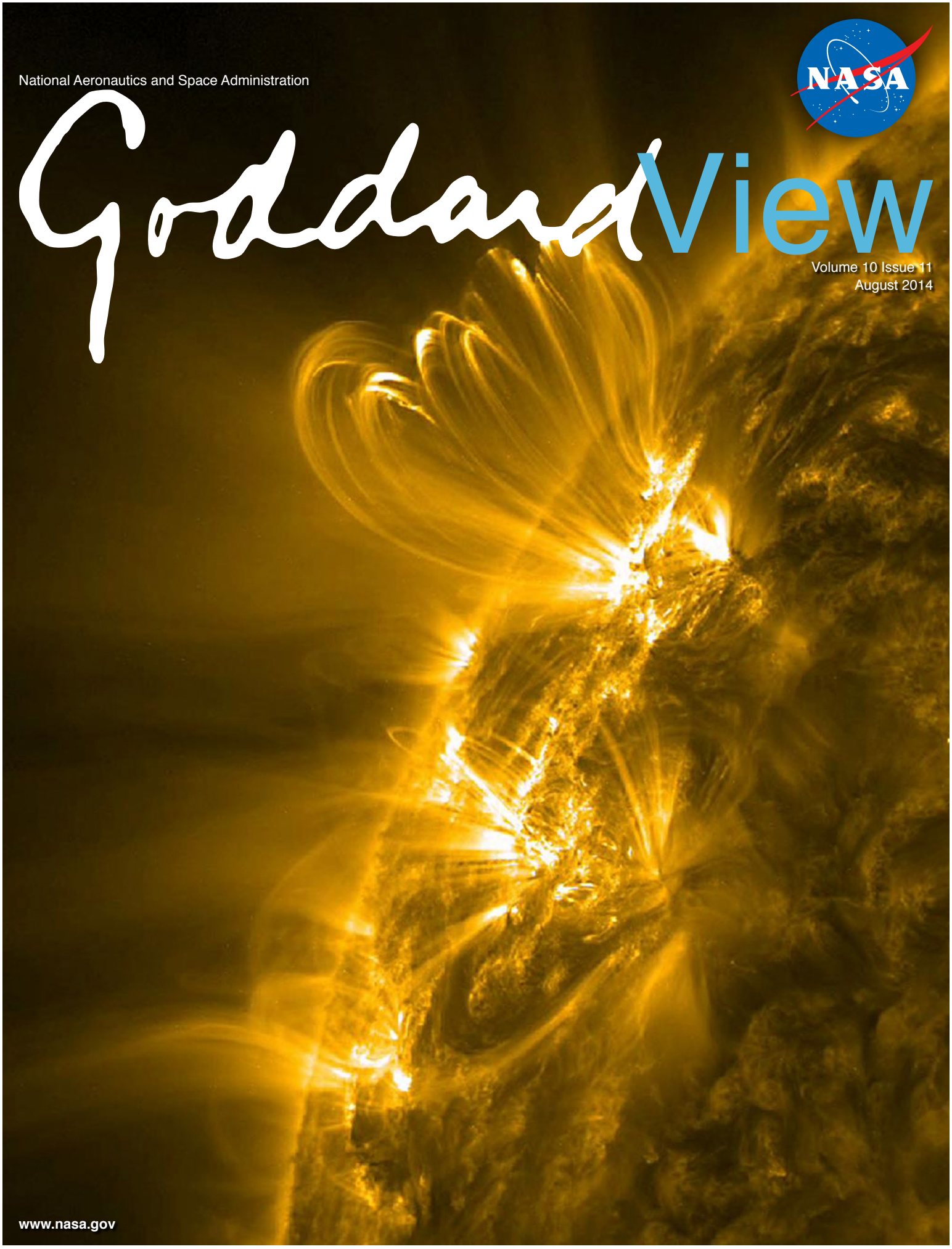

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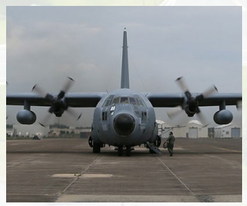
TRENDING

Making Room for Webb's Mirrors
Engineers inside the world's largest clean room at NASA Goddard are working on the engineering test unit for the James Webb Space Telescope. Webb's Pathfinder acts as a spine supporting the telescope primary mirror segments. See more by clicking on the photo.

Conversations with Goddard
James Webb Space Telescope Spacecraft Manager Richard J. Lynch relies on teamwork to get the job done. Discover more and read all of the Conversations with Goddard by clicking on the photo.



NASA to Study Impacts of Sea Ice Loss
A new NASA field campaign will begin flights over the Arctic this summer to study the effect of sea ice retreat on Arctic climate. ARISE will conduct research flights Aug. 28 through Oct. 1, covering the peak of summer sea ice melt. Learn more and see the video by clicking on the photo.

Happy Camp and July Complex Fires
The Moderate Resolution Imaging Spectroradiometer aboard the Aqua satellite collected this natural-color image on August 15, 2014. Actively burning areas, detected by MODIS's thermal bands, are outlined in red. Learn more. Click on the image.

GoddardView

On the cover: Four of the telescopes on the Solar Dynamics Observatory observe extreme ultraviolet light activity on the sun that is invisible to the naked eye. Find out more about why NASA studies the ultraviolet sun. Image credit: NASA/SDO

GoddardView Info

Goddard View is an official publication of NASA's Goddard Space Flight Center. Goddard View showcases people and achievements in the Goddard community that support Goddard's mission to explore, discover and understand our dynamic universe. Goddard View is published by NASA Goddard's Office of Communications.

You may submit contributions to the editor at john.m.putman@nasa.gov. Ideas for new stories are welcome but will be published as space allows. All submissions are subject to editing.

CONTENTS

RXTE DECODES THE RHYTHM OF AN UNUSUAL BLACK HOLE

By: Felicia Chou and Lynn Chandler

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.

"For reasons that are very hard to understand, these objects have resisted standard measurement techniques," said Richard Mushotzky, a professor of astronomy at UMCP.

By going over past RXTE observations, the astronomers found specific changes in brightness that helped them determine M82 X-1 measures around 400 solar masses. As gas falls toward a black hole, it heats up and emits X-rays. Variations in X-ray brightness reflect changes occurring in the gas. The most rapid fluctuations happen near the brink of the black hole's event horizon, the point beyond which nothing, not even light, can escape. Astronomers call these rhythmic pulses quasi-periodic oscillations, or QPOs. For stellar black holes, astronomers have established that the larger the mass, the slower the QPOs, but they could not be sure what they were seeing from M82 X-1 was an extension of this pattern.

"When we study fluctuations in X-rays from many stellar-mass black holes, we see both slow and fast QPOs, but the fast ones often come in pairs with a specific 3:2 rhythmic relationship," explained Dheeraj Pasham, UMCP graduate student. For every three pulses from one member of a QPO pair, its partner pulses twice.

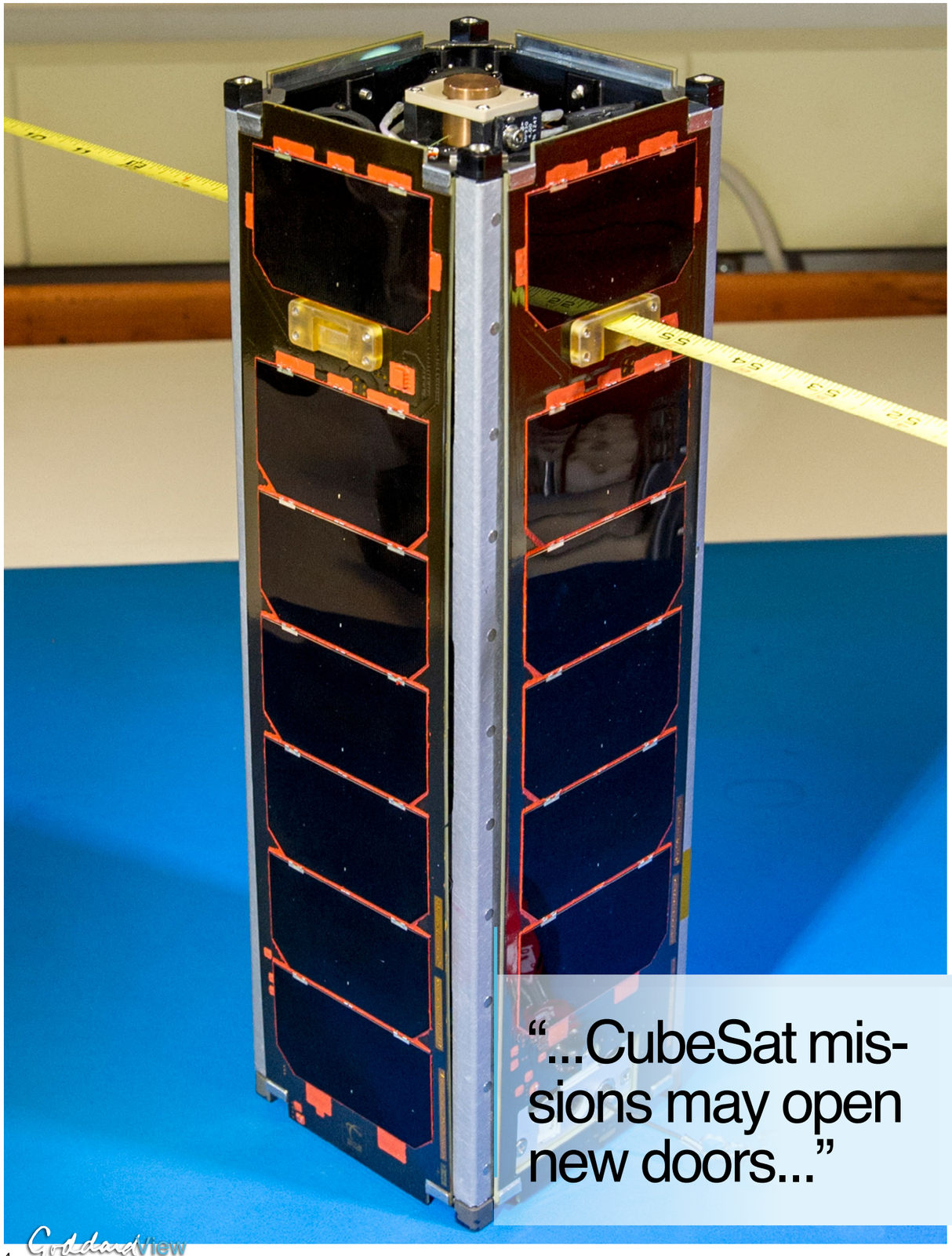
By analyzing six years of RXTE data, the team located X-ray variations that reliably repeat about 5.1 and 3.3 times a second, a 3:2 relationship. The combined presence of slow QPOs and a faster pair in a 3:2 rhythm sets a standard scale allowing astronomers to extend proven relationships used to determine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



“...CubeSat missions may open new doors...”

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.

“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.”

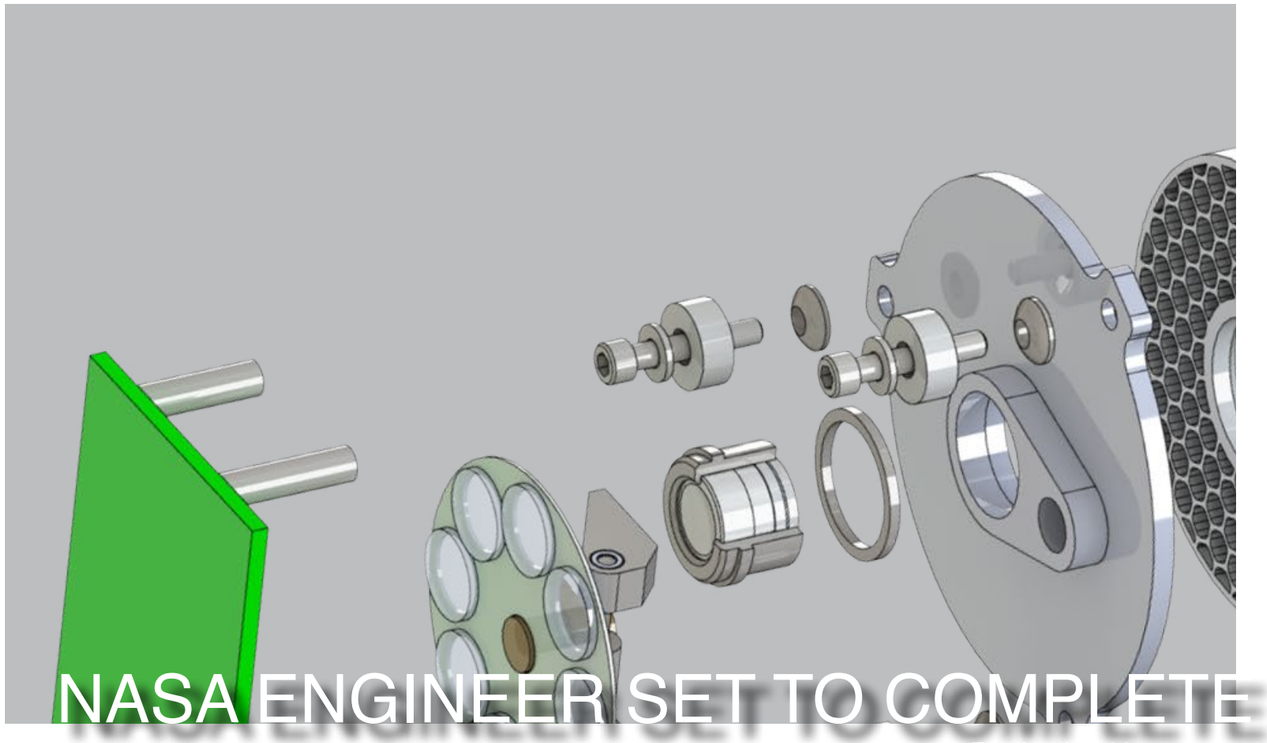
CubeSats can thus slash a scientific mission’s budget and allow scientists to measure multiple data points that would be unobtainable otherwise.

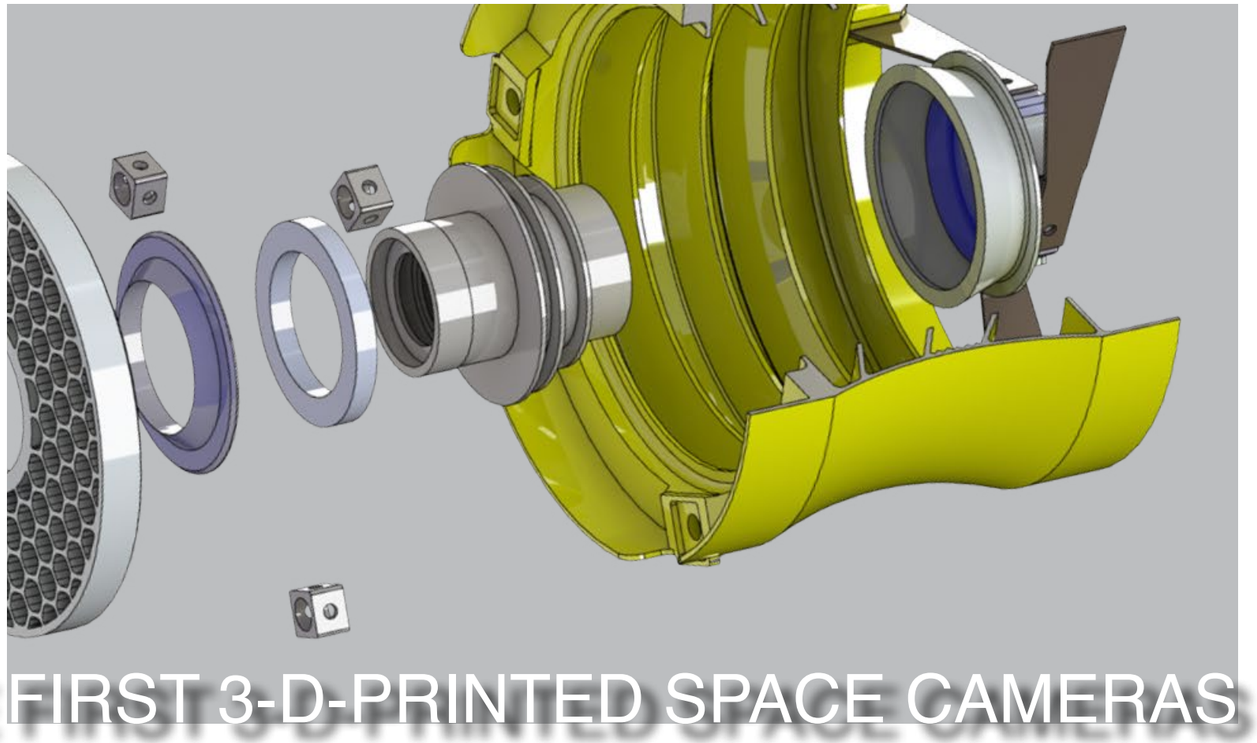
Using multiple spacecraft for a single mission is by no means a novel concept. The Solar Terrestrial Relations Observatory for example is a pair of nearly identical observatories that trace solar matter as it flows from the sun. However losing one of these expensive observatories would spell catastrophe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

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. ■

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





NASA ENGINEER SET TO COMPLETE FIRST 3-D-PRINTED SPACE CAMERAS

By: Lori J. Keesey

By the end of September, NASA aerospace engineer Jason Budinoff is expected to complete the first imaging telescopes ever assembled almost exclusively from 3-D-manufactured components.

“As far as I know, we are the first to attempt to build an entire instrument with 3-D printing,” said Budinoff, who works at NASA’s Goddard Space Flight Center in Greenbelt, Maryland.

Under his multi-pronged project, funded by Goddard’s Internal Research and Development (IRAD) program, Budinoff is building a fully functional, 50-millimeter (2-inch) camera whose outer tube, baffles and optical mounts are all printed as a single structure. The instrument is appropriately sized for a CubeSat, a tiny satellite comprised of individual units each about four inches on a side. The instrument will be equipped with conventionally fabricated mirrors and glass lenses and will undergo vibration and thermal-vacuum testing next year.

Budinoff also is assembling a 350-millimeter (14-inch) dual-channel telescope whose size is more representative of a typical space telescope.

Budinoff is developing both to show that telescope and instrument structures can benefit from advances in 3-D, or additive, manufacturing. With this technique, a computer-controlled laser melts and fuses metal powder in precise locations as indicated by a 3-D computer-aided design model. Because components are built layer by layer, it is possible to design internal features and passages that could not be cast or machined using more traditional manufacturing approaches.

The goal isn’t to fly them, at least not yet. “This is a pathfinder,” Budinoff said. “When we build telescopes for science instruments, it usually involves hundreds of pieces. These components are complex and very expensive to build. But with 3-D printing, we can reduce the overall number of parts and make them with nearly arbitrary geometries. We’re not limited by traditional mill- and lathe-fabrication operations.”

In particular, the 2-inch instrument design involves the fabrication of four different pieces made from powdered aluminum and titanium. A comparable, traditionally manufactured camera would require between five and 10 times the number of parts, he said. Furthermore, the instrument’s baffling—the component that helps reduce stray light in telescopes—is angled in a pattern that instrument builders cannot create with traditional manufacturing approaches in a single piece.

When he completes the camera’s assembly at the end of the fiscal year—ready for space-qualification testing—the project will have taken a mere three months to complete for a fraction of the cost. “I basically want to show that additive-machined instruments can fly,” he said. “We will have mitigated the risk, and when future program managers ask, ‘Can we use this technology?’ we can say, ‘Yes, we already have qualified it.’”

Budinoff also wants to demonstrate that he can use powdered aluminum to produce 3-D-manufactured telescope mirrors—a challenge given how porous aluminum is, which makes it difficult to polish the surfaces. Under his plan, a 3-D-manufacturing vendor will fabricate an unpolished mirror blank appropriate for his two-inch instrument. He then will place the optic inside a pressure chamber filled with inert gas. As the gas pressure increases to 15,000 psi, the heated chamber in essence will squeeze the mirror to reduce the surface porosity—a process called hot isostatic pressing.

“We think this, combined with the deposition of a thin layer of aluminum on the surface and Goddard-developed aluminum stabilizing heat treatments, will enable 3-D-printed metal mirrors,” Budinoff said.

Should he prove the approach, Budinoff said NASA scientists 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

By: Max Gleber

MONITORING SOLAR ACTIVITY WITH SDO

At times, the sun erupts, hurling a magnetic superheated cloud of gas toward Earth. Racing at thousands 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 communications and—in worse case scenarios—overloading power transformers.

Here on Earth, Dhaneshvaran Krishnarao monitors satellite 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. Krishnarao 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."

Modern technology makes society more susceptible to the blackouts caused by solar storms. When struck by one of these huge clouds of solar material, called a coronal mass ejection, our planet's magnetic fields jostle back and forth. As the atmosphere changes, GPS satellite frequencies that must pierce the ionosphere now betray exact coordinates by a couple of yards. For airplanes, military operations, farmers' vehicles, and financial transaction that rely on GPS, this can prove devastating. Another type of eruption from the sun, called a solar flare, can interfere with shortwave radios. These low frequency radio waves use the ionosphere as a mirror to reflect transmissions around the globe; but during a solar storm, they simply disappear up into the sky—unable to bounce off of an atmosphere so changed by these storms.

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 lecturers 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," Krishnarao said of his mentors. "They are our friends." ■

Above: Dhaneshvaran Krishnarao monitors explosions on the sun that can cause magnetic solar storms near Earth. Photo credit: NASA

SCIENCE COMEDIAN GIVES "SERIOUS" CAREER ADVICE

By: Kasha Patel

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 woes—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.

"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.

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 "Outrageous Acts of Science." He also teaches a popular three-week-long undergraduate stand-up comedy course at Johns Hopkins University and a storytelling course with SpeakeasyDC. He currently writes the humor column "Experimental Error" in Science magazine where he addresses serious concerns in the scientific community, such as coping with budget cuts, being a postdoc and finding last-minute holiday gifts when stuck in lab.

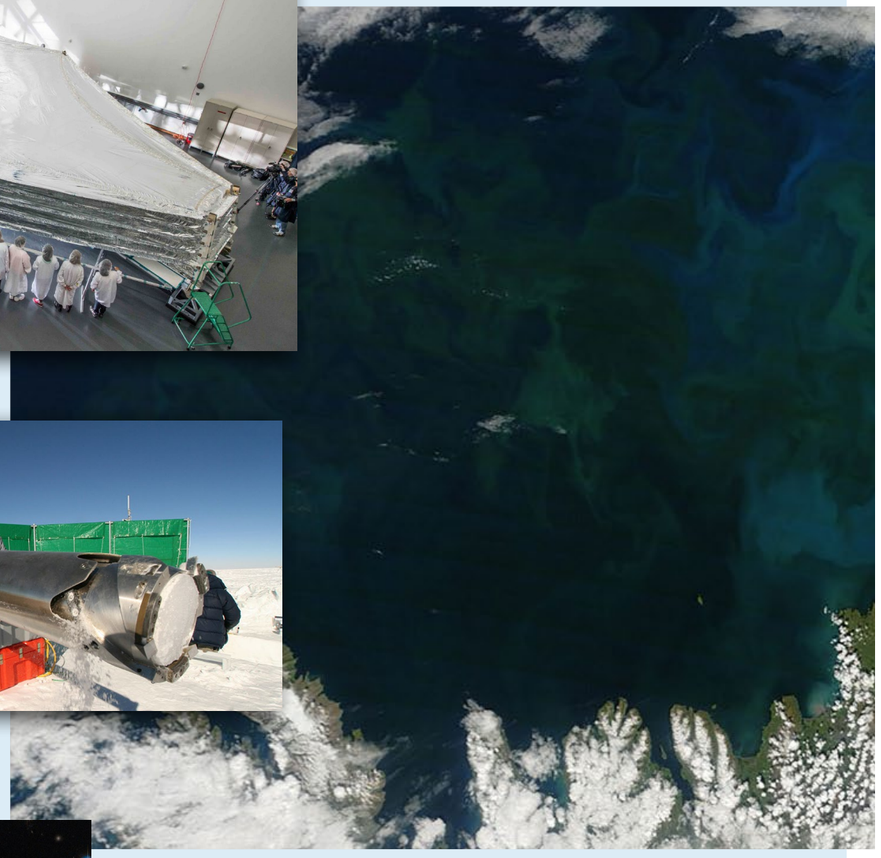
"Making people laugh is something I've always wanted to do, maybe as a result of many friendless years during childhood. Growing up, I felt intimidated talking to other people, but performing stand-up comedy has helped me feel more confident in social situations," said Ruben.

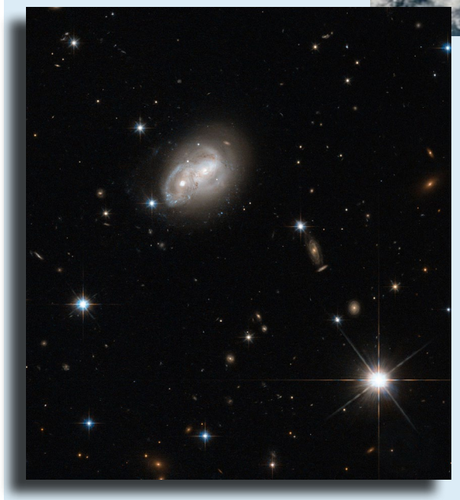
During the day, Ruben works as a molecular biologist developing a malaria vaccine at Sanaria Inc.—a highly rewarding job where he sees the practicality and applicability of his research, unlike his graduate school research that was in service to write his dissertation that very few people will read.

"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." ■

Below: Adam Ruben. Photo provided by Adam Ruben

GODDARD MULTIMEDIA





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.

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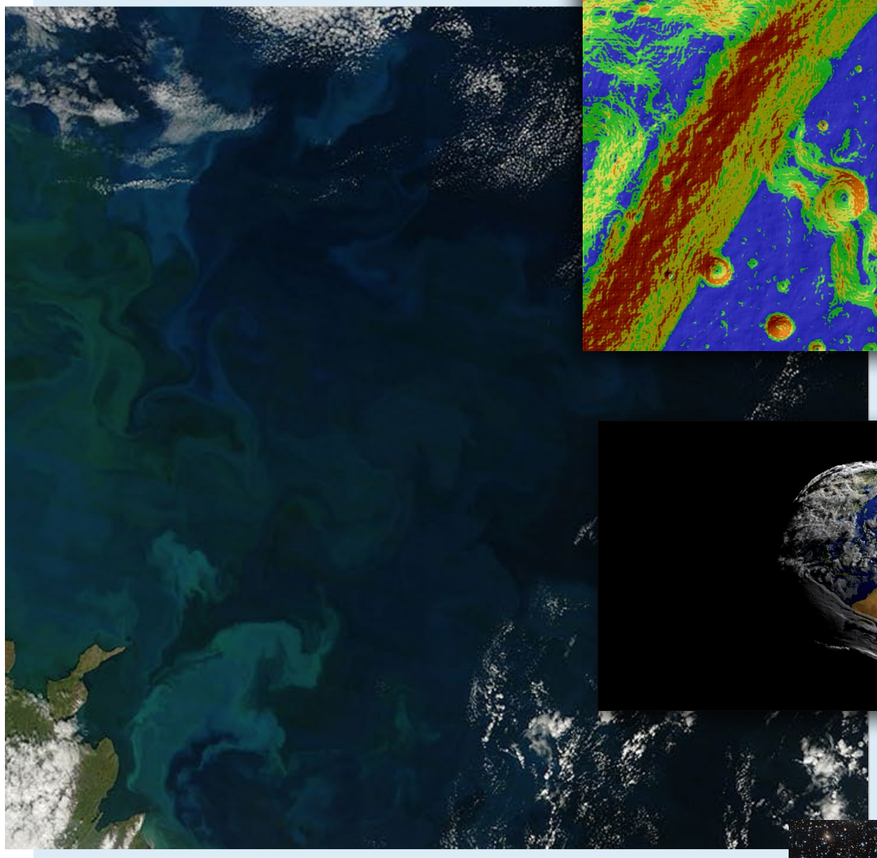
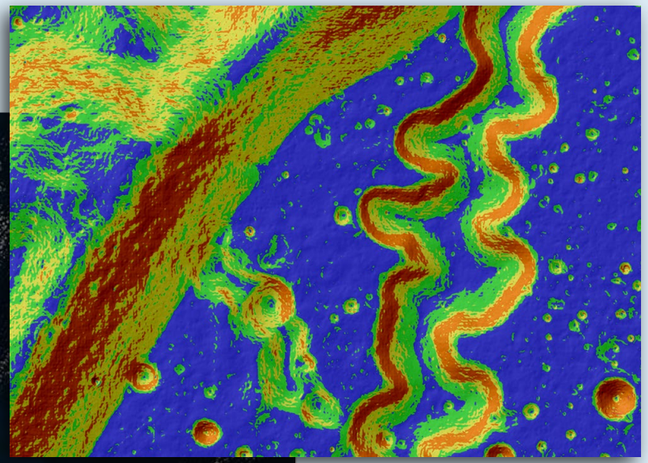
Photo credit: NASA





OUTSIDE GODDARD

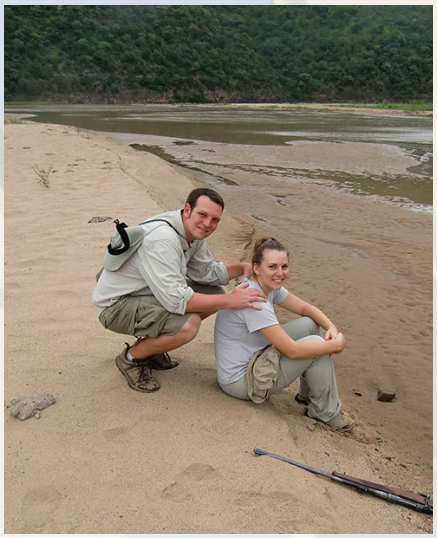
By: Elizabeth M. Jarrell

Walking into South Africa

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