NEWS

Hanging on to the stars

N.C. astronomy institute aims to archive a treasure trove of celestial photos

BY LISA SORG

Every 20 minutes on most nights in the 1950s, two telescopes in the New Mexico desert, weather permitting, took pictures of the sky. Standing 80 miles apart, the telescopes were equipped with fish-eye lenses, allowing them to photograph a 52-degree span—much wider than conventional lenses were capable of. When the Harvard-Smithsonian Meteor Study shoot ended in the late 1950s, thousands of pictures had documented that wedge of the universe.

More than 40 years later, North Carolina astronomers Bob Hayward and Mike Castelaz of the Pisgah Astronomical Research Institute (PARI) began examining the first 100 of the 40,000 images in the New Mexico archive when they discovered something unexpected on one of the film negatives. "We saw a star that may have just exploded," Castelaz recalls.

Novae, formed by a nuclear explosion on the surface of a white dwarf star, are common. About 100 occur in the Milky Way galaxy each year. However, these days it is less common that an astronomer would consult the original glass plates to pinpoint the moment of a nova's inception nearly a half-century ago.

About 3 million of these images—shot on film or photographic emulsion on plates of glass slightly smaller than an iPad—have been taken worldwide over the past 130 years. Supplemented by data logs and observer notes, these images can be used as evidence to challenge or verify the scientific record. They can help astronomers track the orbits of asteroids, the chemical composition of comets and the life cycles of stars—essentially weaving a narrative of the universe.

Yet these photos are endangered. Universities and observatories are running out of space, and to make room for a lab or an office, the plates, some of which are 19th-century daguerrotypes, have been stashed under desks, stacked in closets, stored in flood-prone basements and, in the worst cases, tossed in the trash.

The Apollo missions, space shuttles and interstellar exploration: Astronomy is about the cutting-edge, the Next Big Idea. Within the small astronomy community, only a handful of people—and fewer funding dollars—are devoted to a project as seemingly routine as preserving and digitizing what amounts to a vast photo album.

But it's a vital photo album. The physical object contains an inherent value, longevity and emotional component that the digital does not. Now astronomers shoot only digitally, presenting significant archival and preservation challenges that are different from their analog counterparts.

"We can never go back in time and take the images again," says Castelaz, science director at PARI. "The night sky is always changing, even over a few days."

Thousands of these glass plates reside, waiting to be digitized, at PARI. Located at a former NASA facility that later became a U.S. Department of Defense satellite-tracking post, it is tucked into 350,000 acres of mountain wilderness northwest of Rosman, N.C.

Here you can see vestiges of late '60s Cold War paranoia: A dank, quarter-mile tunnel, better described as a chute, connects two largely windowless buildings. Forty-five years ago, trees were strategically planted in uniform rows to allow military police to patrol the property. Now wild turkeys roost in the branches. A satellite dish near the entrance is emblazoned with a smiley face. Defense Department employees, rightfully suspecting that Soviet satellites were photographing the compound, painted it.

Today the facility is as public as its predecessors were secretive. On this afternoon, dozens of gifted high school students huddled over laptops analyzing digitized versions of these old photos. With an annual $1 million budget funded by PARI president Don Cline, grants and donations, the nonprofit educational and research facility offers tours, "dark sky" nights, science camps and other public programs.

Down the hall, 69-year-old astrophysicist Thurburn Barker donned a pair of white gloves before gently placing a glass-plate photograph on a light table. Through a microscope, the untrained eye sees black blobs surrounded by specks, as if the glass were peppered with flea dirt. But Barker sees two intersecting galaxies, NGC2207 and IC2163, and hovering above them, a nova. That image is from 1975. A year later, the same spot appeared blank. The nova, having expelled its outer shell, had dimmed. (See photo, this page.)

"Within the astronomical community there is an understanding that these are valuable for not only historic purposes, but modern usage," says Barker, director of PARI's Astronomical Photographic Data Archive. "As astrophysics progresses, people may look at objects they have seen before but they didn't know the significance at the time. Now they can dig deeper into the universe."

In November 2007, astronomers from Europe, the U.S. and Canada converged on PARI to discuss the preservation of historic astrophotographic plates. "There was an agreement that there's a problem," Barker says, "because of finances and storage and the changes from film to digital. What came out was that PARI could be designated as a national repository of photographic plates."

PARI has amassed more than 140,000 plates of stars, planets, comets, asteroids, satellites and other celestial bodies taken in North and South America since the late 1800s. In a climate-controlled room, tall metal cabinets are filled with neatly filed photographs that are protected in manila envelopes. These photos were shot at observatories throughout North and South America and had been housed at 16 universities, including the University of Texas, Vanderbilt and Case Western, which donated them to PARI because they had no further use for them.

PARI's initial batch of plates came from University of Michigan research scientist emeritus Nancy Houk, who in 2004 donated her collection to PARI. Castelaz and Hayward drove a U-Haul more than 600 miles to Ann Arbor and brought back 30 boxes containing 3,000 pictures.

Word traveled in the astronomy community that PARI was accepting orphaned photos, and they arrived—by the truckload: 1,300 plates of asteroids, a trove of pictures from the 1973 Skylab complete with NASA documentation. And the collection keeps growing: Last year, PARI traveled to the U.S. Naval Observatory in Virginia to pick up 35,000 plates the federal government no longer wants.

"If we lost all these plates, we'd have just 20 years of history, when we began using digital cameras," Barker says. "That's not enough."

However forward-thinking the field of astronomy, professional and amateur stargazers are always looking into the past. The light emanating from distant celestial bodies has traveled millions of light-years before we see it. Some stars may have already died—supernovas exploding in a last gasp before ejecting their mass into space. We may not know their fate for another million years.

One of PARI's radio telescopes

PHOTO COURTESY OF PARI

"The idea is to understand objects," explains Wayne Osborn, an adjunct professor at Yerkes Observatory at the University of Chicago in Williams Bay, Wis. "Very few people take the time to go back and look at these photos. But there is a lot of data that can be mined and put in a modern context."

For example, in 1904 American astronomer Edward Barnard discovered a nova, a star later named Ross 4, which had exploded. In subsequent photos, Ross 4 dimmed as it aged. But in 1948, Ross 4 exploded a second time. And just last year, it exploded again. Without the photographic record, the recent conflagration would lack context.

What does it mean? "It means that's not a typical nova," Osborn says. It's likely part of a double system in which the collapsed white dwarf—in this case, Ross 4—siphons fuel from its companion star. The hydrogen accumulates on the surface of the white dwarf, igniting a nuclear outburst.

The physical object takes on even greater importance when you consider the data includes not only the contents of the photographs but the photographs themselves. Historians can use astronomers' observation notes to piece together biographies. Scientists can gather pollen from the plates to determine what plants may have been in season when the photo was taken—information that can aid botanists. And since these images were shot through the earth's atmosphere, the photographic spectra—bands of light that contain information about the chemical composition and other properties of the subject—can tell meteorologists and climatologists about the nature of the ozone layer.

At PARI, Barker says he doesn't usually clean the plates unless he has a detailed scan of them

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FULL OF STARS *continued from page 5*

"because there are often marks on the non-emulsion side where the observer made a mark. That's valuable in the provenance of the plate and I want to get a scan of that."

"They're irreproducible. For older astronomers it's sacrilege [to throw them out]," says Osborn, who is among a handful of astronomers devoted to salvaging the photos. "It was the gold standard that you kept your photographs. It's like saying, 'No one's using books anymore. They're all online, so let's get rid of libraries.'"

These plates can also correct the scientific record. Predecessors occasionally introduced errors into star catalogs, sometimes merely clerical, other times gross miscalculations.

"There are a lot of ways to go wrong in science," says Brian Skiff, a research assistant at the Lowell Observatory in Flagstaff, Ariz. He consulted PARI's cache of photos for a research paper on stars. After receiving a scan of the plate, Skiff determined that the original astronomer had misclassified the type of star, based on its colors. "The star is broadcasting information about itself," he says. Skiff then could correct the error in the star catalog, a bible of sorts, for astronomers.

"It's arcane," Skiff says. "Preserving the raw data is very important. They're not lost in the mist of time."

On a recent afternoon, Mike Brown, professor of planetary astronomy at the California Institute of Technology, descended from the 14,000-foot summit of Mauna Kea in Hawaii. There, at the Keck Observatory, he was using a powerful telescope to photograph a part of the sky in search of moons orbiting objects in the Kuiper Belt, a region beyond Neptune populated by icy chunks of material, including water, ammonia and methane.

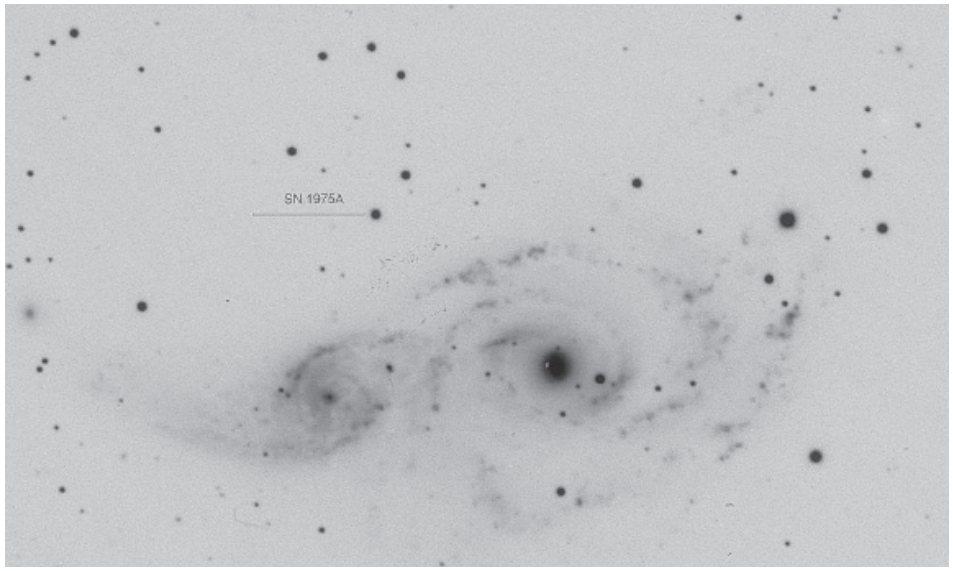
He says that in the early 2000s, many astronomers acted as if they were amateur shutterbugs, mindlessly deleting pictures as if they were bad shots of a birthday party. "No one thought about it," Brown says. "We've lost a part of a generation to the world."

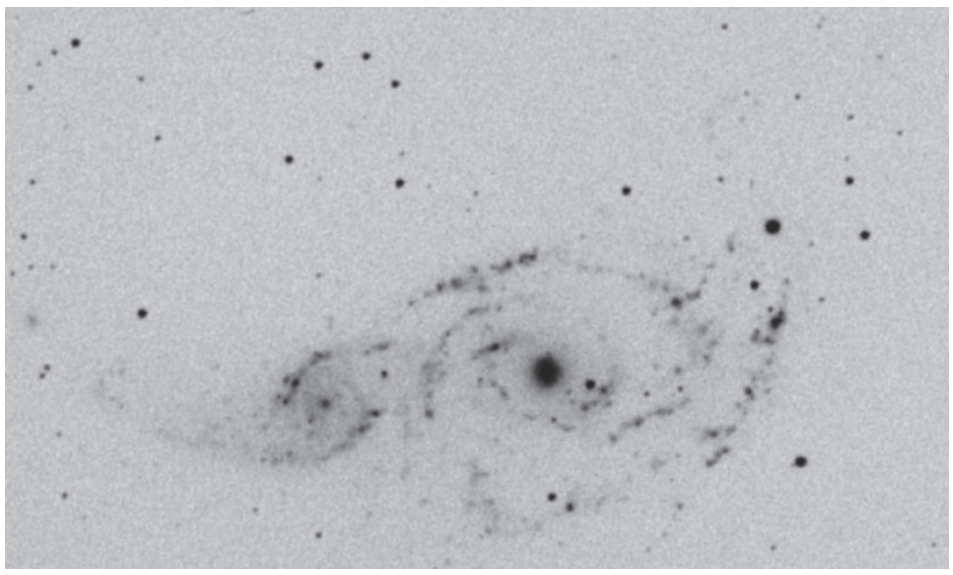
Brown stored many of his digital photos on disc drives. "They're dead," says Brown, author of the book *How I Killed Pluto and Why It Had It Coming*. "I should have been archiving them—but that's boring, so I didn't do it."

Digital archiving and preservation presents challenges archivists continue to grapple with. "It takes only one accidental click to get rid of a file," says Stephen Fletcher, photographic archivist for the North Carolina Collection at UNC libraries. A physical photograph or negative, while fragile, can last for at least 100 years if properly stored, as have many of PARI's plates.

"But with a digital file," Fletcher says, "there's machine obsolescence, bit rot or malfunctioning equipment. You can't store a digital file and presume it will be sitting on the same shelf for 50 years."

Earlier in the digital age, film had the advantage because it could photograph wide expanses of the sky; however, it wasn't sensitive enough to pick up faint objects. While sophisticated digital cameras used in astronomy can photograph less luminescent bodies, because of the enormous file sizes they only recently became useful for analyzing large areas of the firmament.





Above: This photo, shown here in negative, was taken at Kitt Peak National Observatory in Arizona in January 1975. Supernova 1975 is marked as SN 1975A. The distance to the two colliding galaxies is approximately 80 million light-years. Below: This photo was taken at Cerro Tololo InterAmerican Observatory in Chile in January 1976. SN1975 had expelled its outer shell and dimmed. It is not visible in the photo. PHOTOS COURTESY OF PARI

PARI's digital collection is so valuable that EMC Corporation, based in Research Triangle Park, donated hundreds of sophisticated hard drives for servers with multiple layers of redundancy. There hasn't been a disc failure at PARI, even though just one high-resolution scan—and there are 140,000 of these scans to be made—can approach a file size of 1 gigabyte.

"We're going to need storage space," Fletcher says of digital archiving. "We're dealing with servers and secure systems. As a profession, we're trying to adapt our tenets of provenance and respect for the original to the digital world."

Archiving and digitizing 140,000 glass-plate photos is time-consuming and expensive. At PARI, Barker and several volunteers painstakingly pick away at the collection. There are virtually no federal grants, including through NASA or the National Science Foundation, available for the project, in part because it is viewed as mundane.

"We are known as an innovation agency at the forefront of the outermost frontiers of knowledge," says NSF spokesperson Lisa Van Pay. This year the NSF, which funds research in non-medical science fields, is expected to greatly reduce the number of astronomy and astrophysics grants, according to space.com.

That money generally is awarded to major projects—the construction of huge telescopes or research into sexy topics like the "co-evolution of supermassive black holes" or "observations of near-earth asteroids."

At the NSF, proposals are peer-reviewed, but Skiff says few astronomers "recognize the value" of these plates. "It's producing new knowledge, but it's more intangible."

Digitizing these photographs allows not only for efficient computer analysis but also for sharing online with professional and amateur astronomers and the public.

Through PARI's SCOPE website (scope.pari.edu), the public can contribute to the body of knowledge by examining digital images of stars and classifying them.

PARI's herculean task of collecting, preserving and digitizing the plates serves science and stokes our curiosity and sense of wonder. When we gaze at the night sky, we cannot help but note our relative insignificance and marvel at the celestial mechanics that drive the farthest reaches of the universe.

"When people come to the [Yerkes] observatory, they're taken by the immensity of it, but also the spirituality of it," Osborn says.

Sometimes that immensity and spirituality can be captured on one small plate, a snapshot of discovery. Brown still has the plate on which astronomer Charles Kowal shot "Object X" in 1977. Kowal, who died last year, had discovered a celestial object, a minor planet, between Jupiter and Neptune. It was named Chiron.

However, the image is not a screensaver on his computer, Brown says. "It's next to my desk so I can look at it." ☒

To read a history of astrophotography published by the McCormick Museum at the University of Virginia, go to www.indyweek.com.

About PARI

From the Triangle, the Pisgah Astronomical Research Institute is about five-hour drive to Rosman, a mountainous and deeply forested area near Brevard.

Located at the former Rosman Research Station, which in the 1960s was the primary East Coast facility for tracking satellites and monitoring manned space flights.

In 1981, NASA transferred the property to the Department of Defense, which closed the facility in 1995 and transferred its satellite data collection activities elsewhere.

The U.S. government planned to dismantle the site until Greensboro businessman and philanthropist Don Cline intervened and established a nonprofit foundation in 1998. With private funds, the foundation purchased the property in 1999.

PARI is funded through private donations from individuals and foundations and grants.

Over the past 13 years, private investment in PARI has totaled more than $15 million. In addition to the photo archive and digitization project, PARI hosts researchers and astronomers who use its radio telescopes and other equipment to study a range of topics, including pulsars, galaxies and the Earth's atmosphere.

PARI is open to the public and hosts science camps for K–12 students and teachers, internships, citizen scientists, tours and educational programs such as "star parties" and Space Day.

For more information, go to pari.edu.

SOURCES: 2011 PARI ANNUAL REPORT AND WEBSITE