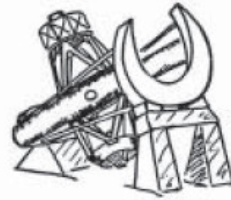


# The Big Eye



The Newsletter of the Friends of Palomar Observatory Vol. 6, No. 3

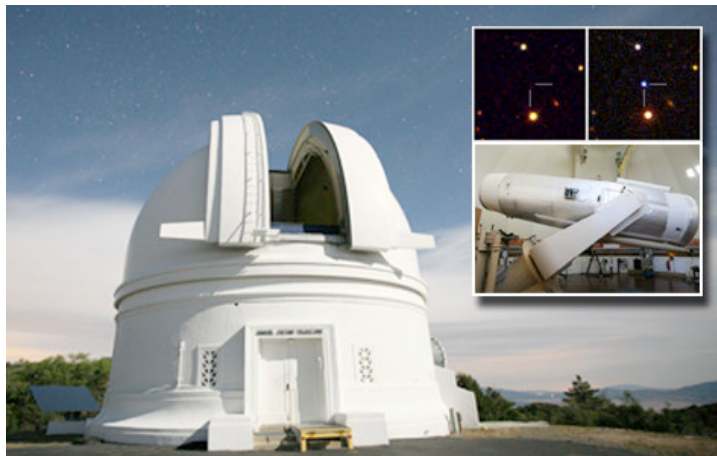
## Caltech-led Astronomers Find a New Class of Stellar Explosions

They're bright and blue—and a bit strange. They're a new type of stellar explosion that was recently discovered by a team of astronomers led by the California Institute of Technology (Caltech). Among the most luminous in the cosmos, these new kinds of supernovae could help researchers better understand star formation, distant galaxies, and what the early universe might have been like.

"We're learning about a whole new class of supernovae that wasn't known before," says Robert Quimby, a Caltech postdoctoral scholar and the lead author on a paper to be published in the June 9 issue of the journal *Nature*. In addition to finding four explosions of this type, the team also discovered that two previously known supernovae, whose identities had baffled astronomers, also belonged to this new class.

Quimby first made headlines in 2007 when—as a graduate student at the University of Texas, Austin—he discovered what was then the brightest supernova ever found: 100 billion times brighter than the sun and 10 times brighter than most other supernovae. Dubbed 2005ap, it was also a little odd. For one thing, its spectrum—the chemical fingerprint that tells astronomers what the supernova is made of, how far away it is, and what happened when it blew up—was unlike any seen before. It also showed no signs of hydrogen, which is commonly found in most supernovae.

At around the same time, astronomers using the Hubble Space Telescope discovered a mysterious supernova called SCP 06F6. This supernova also had an odd spectrum, though there was nothing that indicated this cosmic blast was similar to 2005ap.



Shri Kulkarni, Caltech's John D. and Catherine T. MacArthur Professor of Astronomy and Planetary Science and a coauthor on the paper, recruited Quimby to become a founding member of the Palomar Transient Factory (PTF). The PTF is a project that scans the skies for flashes of light that weren't there before—flashes that signal objects called transients, many of which are supernovae. As part of the PTF, Quimby and his colleagues used the 1.2-meter Samuel Oschin Telescope at Palomar Observatory to discover four new supernovae. After taking spectra with the 10-meter Keck telescopes in Hawaii, the 5.1-meter telescope at Palomar, and the 4.2-meter William Herschel Telescope in the Canary Islands, the astronomers discovered that all four objects had an unusual spectral signature.

Quimby then realized that if you slightly shifted the spectrum of 2005ap—the supernova he had found a couple of years earlier—it looked a lot like these four new objects. The team then plotted all the spectra together. "Boom—it was a perfect match," he recalls.

The astronomers soon determined that shifting the spectrum of SCP 06F6 similarly aligned it with the others. In the end, it turned out that all six supernovae are siblings, and that they all have spectra that are very blue—with the brightest wavelengths shining in the ultraviolet.

According to Quimby, the two mysterious supernovae—2005ap and SCP 06F6—had looked different from one another because 2005ap was 3 billion light-years away while SCP 06F6 was 8 billion light-years away. More distant supernovae have a stronger cosmological redshift, a phenomenon in which the expanding universe stretches the wavelength of the emitted light, shifting supernovae spectra toward the red end.

The four new discoveries, which had features similar to 2005ap and SCP 06F6, were at an intermediate distance, providing the missing link that connected the two previously unexplained supernovae. "That's what was most striking about this—that this was all one unified class," says Mansi Kasliwal, a Caltech graduate student and coauthor on the *Nature* paper.

Even though astronomers now know these supernovae are related, no one knows much else. "We have a whole new class of objects that can't be explained by any of the models we've seen before," Quimby says. What we do know about them is that they are bright and hot—10,000 to 20,000 degrees Kelvin; that they are expanding rapidly at 10,000 kilometers per second; that they lack hydrogen; and that they take about 50 days to fade away—much longer than most supernovae, whose luminosity is often powered by radioactive decay. So there must be some other mechanism that's making them so bright.

One possible model that would create an explosion with these properties involves a pulsating star about 90 to 130 times the mass of the sun. The pulsations blow off hydrogen-free shells, and when the star exhausts its fuel and explodes as a

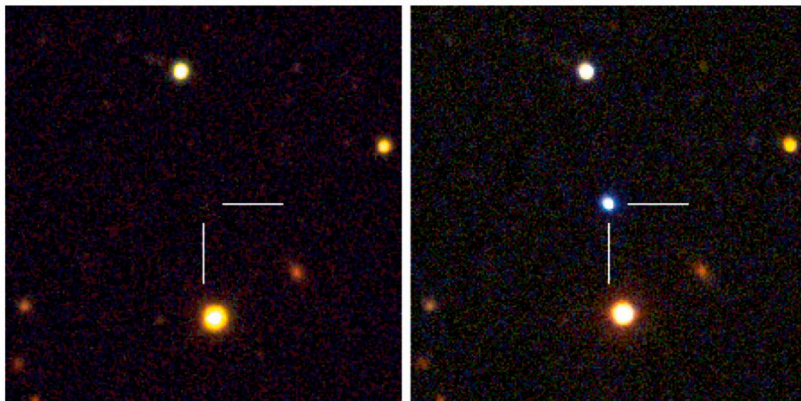
supernova, the blast heats up those shells to the observed temperatures and luminosities.

A second model requires a star that explodes as a supernova but leaves behind what's called a magnetar, a rapidly spinning dense object with a strong magnetic field. The rotating magnetic field slows the magnetar down as it interacts with the sea of charged particles that fills space, releasing energy. The energy heats the material that was previously blown off during the supernova explosion and can naturally explain the brightness of these events.

The newly discovered supernovae live in dim, small collections of a few billion stars called dwarf galaxies. (Our own Milky Way has 200–400 billion stars.) The supernovae, which are almost a hundred times brighter than their host galaxies, illuminate their environments like distant street lamps lighting up dark roads. They work as a kind of backlight, enabling astronomers to measure the spectrum of the interstellar gas that fills the dwarf galaxies in which the supernovae reside, and revealing each galaxy's composition. Once an observed supernova fades a couple of months later, astronomers can directly study the dwarf galaxy—which would have remained undetected if it weren't for the supernova.

These supernovae could also reveal what ancient stars might have been like, since they most likely originate from stars around a hundred times more massive than the sun—stars that would have been very similar to the first stars in the universe.

"It is really amazing how rich the night sky continues to be," Kulkarni says. "In addition to supernovae, the Palomar Transient Factory is making great advances in stellar astronomy as well."



In addition to Quimby, Kasliwal, and Kulkarni, 24 other authors—11 of whom are from Caltech—contributed to the work described in the *Nature* paper, "A new class of hydrogen-poor super-luminous stellar explosions."

This research was

supported by the National Science Foundation, the United States-Israel Binational Science Foundations, the Israeli Science Foundation, the Department of Energy, the Gordon & Betty Moore foundation, Gary and Cynthia Bengier, the Richard and Rhoda Goldman Fund, and the Royal Society. The Palomar Transient Factory is a collaboration between Caltech, Columbia University, Las Cumbres Observatory Global Telescope, Lawrence Berkeley Laboratory, UC Berkeley, University of Oxford, and the Weizmann Institute of Science (Israel).

## Summer Friends of Palomar Events

Saturday, June 25 at 4 p.m. Caltech's Christoph Baranec, principal investigator for the Robo-AO program, will describe the new ground-breaking projects taking place with the Palomar Observatory's 60-inch telescope and the 200-inch Hale Telescope in his talk "Pushing the limits of Adaptive Optics: P3K and Robo-AO".

This should be an exciting talk that will tell how the 60-inch telescope and the 200-inch Hale Telescope are pushing the frontiers of advanced high-resolution imaging. The image above shows three exoplanets – planets that orbit a star other than our sun. It was taken in infrared light with Palomar Observatory's 200-inch Hale Telescope.



On Saturday, July 16 at 4 p.m. renowned author and speaker Robert L. Piccioni will present "Einstein for Everyone", an engaging talk on Albert Einstein and his amazing career.

From Dr. Piccioni: "How did a young rebel, who seemed doomed to fail, overcome rejection to become the world's most famous scientist? In plain English, what do his theories mean? And how does Einstein impact our lives through DVDs, GPS, CCD imaging and digital cameras, computers, and smarter energy?"

Dr. Piccioni graduated from Caltech, has a Ph.D. in high-energy physics from Stanford University, and was on the research faculty of Harvard University. He is an expert on Einstein's theories and cosmology. Robert ran eight high-tech companies and holds patents in medical equipment, microelectronics, and smart energy. Since "retiring", Robert's mission is making science accessible. He is "Teacher of the Year" at the Osher Institute and hosts the online radio show "Guide to the Cosmos". Robert is the author of two books that won national and international competitions for "Best Popular Science Book of the Year": Everyone's Guide to Atoms, Einstein, and the Universe explores the exciting discoveries of modern astronomy, physics, and cosmology.

More events are on the way, including a talk in August by world-famous astrophotographer Dennis Mammana and some 60-inch observing nights in the fall. Be sure to check out the Friends Events page for details as they become available:

<http://www.astro.caltech.edu/palomar/friends/events.html>

Remember, advance reservations are required for all events!

E-mail [friendsofpalomar@astro.caltech.edu](mailto:friendsofpalomar@astro.caltech.edu) or call (760) 742-2131 or (760) 742-2111 to make reservations.

## **PALM-3000 Adaptive Optics**

After years of development, the PALM-3000 adaptive optics system has finally seen first light on the Hale Telescope. First results for the instrument are not available as this newsletter is going press, but it is the best such system on any telescope in the world for giving ground-based telescopes a clearer view of the universe. Below is a photo of the new instrument installed in the Cassegrain cage of the 200-inch telescope.



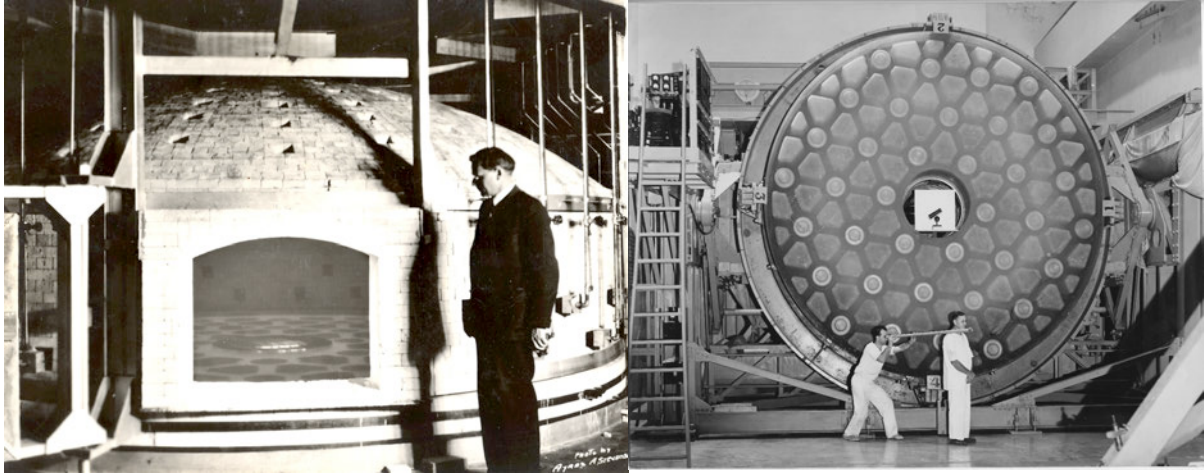
For more on PALM-3000 be sure to sign up to attend the Friends of Palomar Observatory talk on June 25.

### **Find Palomar Observatory on Facebook**

Do you have a Facebook account? If you do, you can become a fan of Palomar Observatory. Just search for “Palomar Observatory” and become a fan today.

## Palomar People: Keepers of the Glass

Dr. George McCauley of Corning Glass Works directed the project which successfully cast the 200-inch mirror. Dr. McCauley checked on the status of the disk every day between when it was poured December 2, 1934 and when the kiln was cracked open on October 25, 1935. The photo, below left, shows Dr. McCauley and the 200-inch disk. At the time of the photograph the disc made up of hot, glowing molten glass that revealed the pattern of the many hollow spots on its underside.



The glass disk was under McCauley's care until it arrived at the Caltech Optical Shop on April 10, 1936. From there it was the responsibility of Marcus Brown to oversee the polishing of the glass. Brown carefully directed the work until the mirror made its trip to Palomar in November 1947. Above right, Marcus Brown stands with a replica of Galileo's first telescope on his shoulder and the 200-inch behind him.

The day after the mirror arrived at Palomar, George McCauley, the first keeper of the glass, sent this letter to its second keeper, Marcus Brown:

*May I shake your hand and congratulate you and your men on a job well done. I hope you will now take some needed rest to get your mind thinking about something else for a diversion. The ghost of this mirror to which you gave some twelve years of your life, will be difficult to shake off. An association so intimate and of such long duration lives on. Along with the pleasure of knowing a job has been well done, you may feel a bit lonely with the object, which has been so much of your life, gone from the familiar shop at Pasadena to a strange old sheep pasture on Palomar Mountain; but be of good cheer. To one who has fraught with such skill, other tasks calling for equal interest will come; and you will find in them new and added pleasures.*

- Student/Senior citizen Member \$30**
- Individual Member \$45**
- Dual Membership \$75**
- Family Membership \$100**
- Donation \_\_\_\_\_**

Name \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Phone \_\_\_\_\_

Email \_\_\_\_\_

Check    Visa    Mastercard   (circle one)

Credit Card # \_\_\_\_\_

Expiration Date \_\_\_\_\_

Signature \_\_\_\_\_

Please print, complete this form, and mail it to:

Friends of Palomar Observatory  
P.O. Box 200  
Palomar Mountain, CA 92060-0200

For questions call (760) 742-2131,  
e-mail [friendsofpalomar@astro.caltech.edu](mailto:friendsofpalomar@astro.caltech.edu) or visit [www.friendsofpalomarobservatory.org](http://www.friendsofpalomarobservatory.org)