The Big Eye

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Unique Sky Survey Brings New Objects into Focus

Partnership involves Caltech's Palomar Observatory and other world leaders in astronomy

San Diego, Calif.–An innovative sky survey has begun returning images that will be used to detect unprecedented numbers of powerful cosmic explosions–called supernovae–in distant galaxies, and variable brightness stars in our own Milky Way. The survey also may soon reveal new classes of astronomical objects.

All of these discoveries will stem from the Palomar Transient Factory (PTF) survey, which combines, in a new way, the power of a wide-field telescope, a high-resolution camera, and high-performance networking and computing, with rapid follow-up by telescopes around the globe, to open windows of discovery for astronomers. The survey has already found 40 supernovae and is gearing up to switch to a robotic mode of operation that will allow objects to be discovered nightly without the need for human intervention.

The Palomar Transient Factory is a collaboration of scientists and engineers from institutions around the world, including the California Institute of Technology (Caltech); the University of California, Berkeley, and the Lawrence Berkeley National Laboratory (LBNL); Columbia University; Las Cumbres Observatory; the Weizmann Institute of Science in Israel; and Oxford University.

During the PTF process, the automated wide-angle 48-inch Samuel Oschin Telescope at Caltech's Palomar Observatory scans the skies using a 100-megapixel camera. The flood of images, more than 100 gigabytes every night, is then beamed off of the mountain via the High Performance Wireless Research and Education Network-–a high-speed microwave data connection to the Internet–and then to the

LBNL's National Energy Scientific Computing Center. There, computers analyze the data and compare it to images previously obtained at Palomar. More computers using a type of artificial intelligence software sift through the results to identify the most interesting "transient" sources–those that vary in brightness or position.

Within minutes of a candidate transient's discovery, the system sends its coordinates and instructions for follow-up observations using the Palomar 60-inch telescope and other instruments.

Soon all of the steps in the process will be completely automated, including decisions about which transients merit a second look. When follow-up observations indicate that candidate transient detections show promise, a prioritized list of candidates is brought to the attention of astronomers from the PTF member institutions. Finally, an astronomer becomes personally involved, by performing detailed observations using telescopes such as Palomar's 200-inch Hale Telescope, a Keck Telescope in Hawaii, or other partner telescopes around the world.

The PTF is designed to search for a wide variety of transient sources with characteristic timescales ranging from minutes to months, giving astronomers one of their deepest and most comprehensive explorations of the universe in the time domain.

"By looking at the sky in a new way, we are ushering in a new era of astronomical discovery," says PTF principal investigator Shrinivas Kulkarni, MacArthur Professor of Astronomy and Planetary Science at Caltech and director of the Caltech Optical Observatories. "Nimble automated telescopes and impressive computing power make this possible."

"No one has looked on these timescales with this sensitivity before. It's entirely possible that we will find new astronomical objects never before seen by humans," says Nicholas Law of Caltech, the project scientist for PTF.

Because it looks for anything changing in the sky, the PTF survey covers a vast variety of different astronomical targets. The wide range of the survey extends across the entire universe. Astronomers expect to discover everything from stars exploding millions of light-years away to near-Earth asteroids that could someday impact our planet.

Much of the survey's time is spent searching for so-called Type Ia supernovae. These supernovae, formed from the explosion of a class of dead star known as a white dwarf, are very useful to astronomers because they can help determine the distance to galaxies located across the universe. Those distances allow astronomers to probe the origin, structure, and even the ultimate fate of the universe.

By operating more rapidly than previous surveys, PTF will also detect objects of a completely different nature, such as pulsating stars, different types of stellar explosions, and possibly planets around other stars.

PTF's innovative survey techniques also have raised astronomers' expectations of finding new, unexpected, astronomical objects.

The PTF already has found many new cosmic explosions, including 32 Type Ia supernovae, eight Type II supernovae, and four cataclysmic variable stars. Intriguingly, PTF also has found several objects with characteristics that do not exactly match any other objects that have been seen before. PTF astronomers are eagerly watching these objects to see how they change, and to determine what they might be.

The quantity and quality of incoming data have astonished astronomers working in the field. On one recent night, PTF patrolled a section of the sky about five times the size of the Big Dipper–and found 11 new objects. "Today I found five new supernovae before breakfast," says Caltech's Robert Quimby, a postdoctoral scholar and leader of the PTF software team. "In the previous survey I worked on, I found 30 in two years."

Palomar Stories: Paul Jett & Walter Baade

Years ago Walter Baade was the night assistant's (as the telescope operators are referred to at Palomar) favorite astronomer. When he came, he always arrived for his observing run with exotic cheeses and sausages, which he kept in the refrigerator at the 200-inch dome. A new full time night assistant was hired named Paul Jett, who was an eager, gung-ho person and was starry eyed to be working with Baade and other world famous scientists.

One evening while working with Walter Baade, Paul put the telescope in the vertical position, sent the prime focus elevator up for Walter Baade to come down for midnight lunch. Walter met Paul in the galley where he had lunch ready and they sat down to eat. The coffee was particularly good this night and Walter had one cup and then a second. As he was pouring the third, something went "clunk" in the cup. He said to himself, surely this cannot be coffee grinds, so he took his spoon and fished around and pulled out a cockroach. Paul turned white and then red and grabbed the coffee pot. He scoured it out and put on another pot to brew. Now Walter didn't want more coffee but Paul was in such a state that he sat and waited.

Soon the coffee was ready and Paul poured a fresh cup of coffee in a clean cup. Walter tasted it and then could not resist. He said, "Paul it just isn't as good, go find another cockroach."

Baade's tremendous sense of humor was demonstrated later that summer when he attended a meeting of astronomers in Rome. He sent Paul a postcard saying "Paul, Come to Rome. We can make a million dollars. The coffee here is terrible."

Before coming to Palomar Walter Baade worked at the Hamburg and Mt. Wilson Observatories. A 6.5-meter telescope located in Las Campanas Observatory in Chile is named for him.

A New Exoplanet Discovered Using the Hale Telescope

A long-proposed tool for hunting planets has netted its first catch -- a Jupiter-like planet orbiting one of the smallest stars known.

The technique, called astrometry, was first attempted 50 years ago to search for planets outside our solar system, called exoplanets. It involves measuring the precise motions of a star on the sky as an unseen planet tugs the star back and forth. But the method requires very precise measurements over long periods of time, and until now, has failed to turn up any exoplanets.

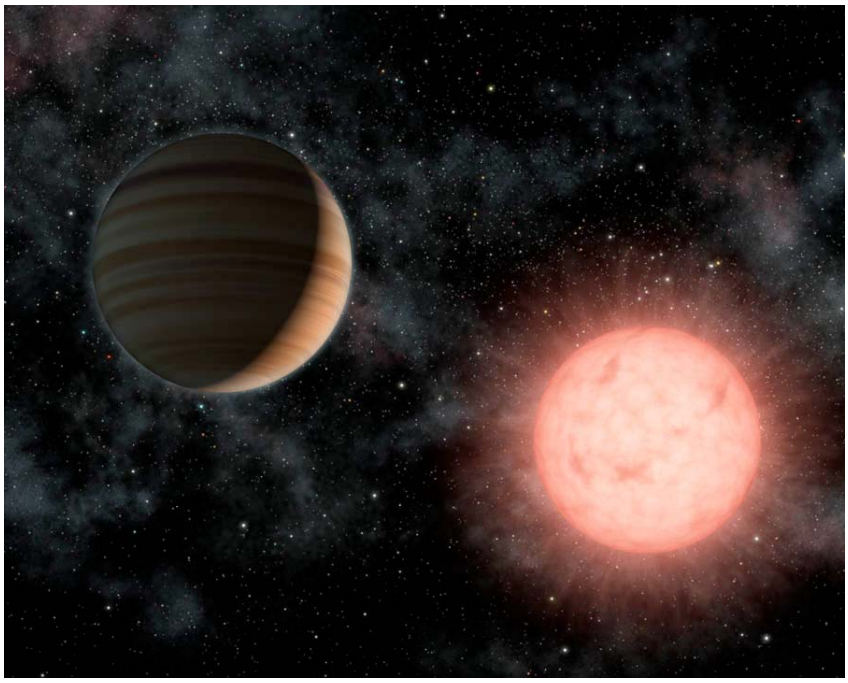
A team of two astronomers from NASA's Jet Propulsion Laboratory, Pasadena, Calif., has, for the past 12 years, been mounting an astrometry instrument to a telescope at the Palomar Observatory near San Diego. After careful, intermittent observations of 30 stars, the team has identified a new exoplanet around one of them -- the first ever to be discovered around a star using astrometry.

"This method is optimal for finding solar-system configurations like ours that might harbor other Earths," said astronomer Steven Pravdo of JPL, lead author of a study about the results to be published in the Astrophysical Journal. "We found a Jupiter-like planet at around the same relative place as our Jupiter, only around a much smaller star. It's possible this star also has inner rocky planets. And since more than seven out of 10 stars are small like this one, this could mean planets are more common than we thought."

The finding confirms that astrometry could be a powerful planet-hunting technique for both ground- and space-based telescopes. For example, a similar technique would be used by SIM Lite, a NASA concept for a space-based mission that is currently being explored.

The newfound exoplanet, called VB 10b, is about 20 light-years away in the constellation Aquila. It is a gas giant, with a mass six times that of Jupiter's, and an orbit far enough away from its star to be labeled a "cold Jupiter" similar to our own. In reality, the planet's own internal heat would give it an Earth-like temperature.

The planet's star, called VB 10, is tiny. It is what's known as an M-dwarf and is only one-twelfth the mass of our sun, just barely big enough to fuse atoms at its core and shine with starlight. For years, VB 10 was the smallest star known -- now it has a new title: the smallest star known to host a planet. In fact, though the star is more massive than the newfound planet, the two bodies would have a similar girth.



Because the star is so small, its planetary system would be a miniature, scaled-down version of our own. For example, VB 10b, though considered a cold Jupiter, is located about as far from its star as Mercury is from the sun. Any rocky Earth-size planets that might happen to be in the neighborhood would lie even closer in.

"Some other exoplanets around larger M-dwarf stars are also similar to our Jupiter, making the stars fertile ground for future Earth searches," said Stuart Shaklan, Pravdo's co-author and the SIM Lite instrument scientist at JPL. "Astrometry is best suited to find cold Jupiters around all kinds of stars, and thus to find more planetary systems arranged like our home."

Two to six times a year, for the past 12 years, Pravdo and Shaklan have bolted their Stellar Planet Survey instrument onto Palomar's five-meter Hale telescope to search for planets. The instrument, which has a 16-megapixel charge-coupled device, or CCD, can detect very minute changes in the positions of stars. The VB 10b planet, for instance, causes its star to wobble a small fraction of a degree. Detecting this wobble is equivalent to measuring the width of a human hair from about three kilometers away.

Other ground-based planet-hunting techniques in wide use include radial velocity and the transit method. Like astrometry, radial velocity detects the wobble of a star, but it measures Doppler shifts in the star's light caused by motion toward and away from us. The transit method looks for dips in a star's brightness as orbiting planets pass by and block the light. NASA's space-based Kepler mission, which began searching for planets on May 12, will use the transit method to look for Earth-like worlds around stars similar to the sun.

"This is an exciting discovery because it shows that planets can be found around extremely light-weight stars," said Wesley Traub, the chief scientist for NASA's Exoplanet Exploration Program at JPL. "This is a hint that nature likes to form planets, even around stars very different from the sun."

JPL is a partner with the California Institute of Technology in Pasadena in the Palomar Observatory. Caltech manages JPL for NASA. More information about exoplanets and NASA's planet-finding program is at http://planetquest.jpl.nasa.gov .

Fred Givant: 1943 - 2009

Fred Givant, one of the Palomar Observatory's docents, passed away on Sunday June 28, 2009.

Fred volunteered at the observatory for a year and a half. During that time he was very active in the observatory's public outreach program. Fred felt passionately about the observatory and especially the need to educate young people about science. He backed up that passion with frequent visits to the observatory to help with our public outreach program.

In spite of the fact that Fred had a fulltime job (working as a risk manager for a company building the next generation of GPS satellites) he was very committed to making the trek to Palomar Mountain to volunteer often during his limited free time.

It has been a record-breaking year for tours at the observatory and Fred was a big part of that. He was volunteering here three of the four weekends in June and four of the five in May! The staff and docents of the observatory will miss Fred's enthusiasm and dedication.

Fred's wife Carole has asked that donations in Fred's memory be made to Palomar Observatory. Anyone wishing to make a donation can send it to:

Palomar Observatory

Fred Givant Fund

P.O. Box 200

Palomar Mountain, CA 92060

100% of the donations to the fund will be used to help kids to learn about astronomy. Fred would have wanted it that way.

Friends of Palomar Observatory Annual Membership Application

☐ Student/Senior Citizen Member $30

☐ Individual Member $45

☐ Family Membership $75

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