Fireworks are a long-time tradition when celebrating Independence Day, the 4th of July. But in addition to the standard Earth-based displays, a truly celestial version will take place this year. Near the start of July 4th, an 820 pound (370 kg) copper bullet is scheduled to hit a three-mile wide target more than 83 million miles from Earth at a speed of 23,000 miles/hr or 6.3 miles/second (10.3km/sec). The participants in this cosmic fireworks will be the unsuspecting comet 9P/Tempel 1 and NASA’s Deep Impact spacecraft. This comet’s designation arises because it was the ninth comet whose orbit was computed and used to successfully predict when it would repeatedly return to the vicinity of Earth, and it was the first of these comets discovered by Wilhelm Tempel. The name of the Deep Impact spacecraft simply comes from what it is intended to do to the comet.

Comets have been involved in impacts before, but always as the projectile rather than as the target. The craters and basins on the moon were caused by asteroids and comets, mostly during the first 800 million years after the moon’s formation. And an asteroid or comet hit the Yucatan Peninsula near the Gulf of Mexico 65 million years ago, causing the demise of dinosaurs and many other species. The most recent collision of a comet with another body occurred when pieces of the fragmented Comet Shoemaker-Levy 9 hit Jupiter during a week-long interval in 1994, whose explosion “splashes” created temporary splotches in Jupiter’s atmosphere nearly as large as the planet Earth (even though each impacting fragment was less than a mile in diameter)!

So why is NASA “attacking” Comet Tempel 1, and what is expected to happen? In the past 20 years, several spacecraft have conducted flybys of comets and some have obtained images of the comet’s core or nucleus – composed of ice and dirt – and to obtain detailed measurements of the composition of the gases in a comet’s coma – gases which result from vaporized ice from the surface of the nucleus due to heating from the Sun. As the most pristine objects remaining from the time our solar system formed, which are also accessible to detailed investigations, comets permit us to probe the chemical composition and physical conditions that existed at that time.

The physical structure of comets is important from the point of view of self preservation (ours, not the comet’s). If a comet were detected on a collision course with Earth, how might we protect ourselves without making the situation worse? Nuclear bombs are often suggested, but if “nucs” were used to breakup the body, would we simply be hit by lots of pieces in several locations on Earth? But detailed studies of the structure and composition of the nucleus itself are very difficult unless one soft-lands on the nucleus, and it will likely be many years before such a mission is attempted. As was learned in the case of Shoemaker-Levy 9 and Jupiter, however, much can be learned about a target’s properties by seeing

"The coma of Comet Tempel 1."

Continued next page
how it reacts to an explosive release of energy.

For Tempel 1 and Deep Impact, the encounter is currently scheduled to take place at 1:52 a.m. EDT July 4 (10:52 p.m. MST July 3 in Arizona). Note that this is the evening prior to our normal 4th of July celebration. (The impact will actually occur 7 minutes earlier, but it will take 7 minutes for the light of the explosion to reach Earth.) A very brief flash of light (less than a second in duration) is expected from the explosion’s fireball, followed by a slow brightening of the coma’s interior from about 9th magnitude to perhaps 6th or 7th, as light is reflected from the plume of dust and gas ejected during the creation of the crater. Simulations predict that this plume of material will take up to several days to disperse, so the comet might remain noticeably brighter for a few nights, but a small telescope will still likely be needed to detect Tempel 1.

To obtain a closeup view of the event, only part of the Deep Impact spacecraft will actually crash into the comet’s nucleus. About a day prior to impact, the spacecraft will split into two primary components. One part is the impactor itself, composed of a copper “cratering mass” and a camera to view the nucleus right up to the time of impact, and is about one-half the size of a refrigerator and weighs about 820 lbs. The other part is the main flyby spacecraft, and includes maneuvering thrusters, numerous instruments, and a communication antenna. This component will slow down enough so that it reaches the comet about 15 minutes after the impactor, and so will have a ring-side seat. Also, by slowing down, it will avoid hitting the nucleus itself and, after flying by the nucleus, will point its instruments back towards the comet as it moves away.

Obviously, having a small “refrigerator” simply run into a mountain-sized iceberg would not be expected to have much effect on the iceberg. But the key is that this copper bullet is traveling very fast, more than 6 miles every second, and so has tremendous kinetic energy. Predictions are that this kinetic energy will be nearly instantaneously released with an explosion equivalent to about 5 tons of TNT, vaporizing both the projectile and a portion of the nucleus. The size of the resulting crater might be as small as a house or nearly as large as a football stadium, depending on the density and structure of the impact site. In fact, the primary goal of the entire mission is to determine the physical makeup and strength of the nucleus, and this will be determined by seeing how large a crater is formed. The second goal is to examine the structure and composition of the plume of material excavated and released from the nucleus from the explosion. Finally, there is hope that the crater itself will have sufficient ice newly exposed to sunlight so that it becomes a new “active region” on the surface, slowing vaporizing and releasing gas and dust on an on-going basis. While the first of these scientific objectives

The logarithm of the rate at which water ice is vaporizing off of the surface of Comet Tempel 1’s nucleus is plotted as a function of time prior to the comet’s closest approach to the Sun (perihelion). Note that the pattern is much lower in 2005 than in 1983, probably due to a decrease in the amount of ice exposed to sunlight.
(imaging the resulting crater) can only be attained with the cameras on the flyby spacecraft, the second and third goals will be addressed both by the spacecraft and by telescopes on and near the Earth.

As might be expected for this rare event, numerous telescopes around the globe as well as the Hubble Space Telescope will be used to observe Tempel 1 at and in the days surrounding the impact. Here at Lowell Observatory we intend to observe with three telescopes: Lowell planetary astronomer Dr. Marc Buie will obtain infrared images with the 72-inch Perkins using the new MIMIR instrument (see Lowell Observer issue #61, page 5) to study the dust released from the explosion, while I will be attempting to measure the brightness of the fireball and the amount of new gas and dust released into the coma with the 42-inch Hall telescope. In addition, (NAU?) students will assist in acquiring visible images with a CCD camera at the 31-inch. But many astronomers have been observing Tempel 1 for a much longer time. For instance, using the 31-inch telescope in robotic mode, Marc Buie has been monitoring the brightness of Tempel 1 over the past few years as part of a collaboration to determine how fast the nucleus rotates. Results from his and several others’ efforts have yielded a rotation period of about 42 hours. My own monthly observing runs at the 42-inch began in early March. As I’ve mentioned in previous reports in the Lowell Observer (Winter 2003 and Spring 2004 issues), I use a set of filters to isolate the light emitted by several different molecular species to determine the abundances of these gases in a comet’s coma, and to map out their spatial distribution. The former project uses the filters with an old-fashioned photometer with a light-detecting phototube, while a CCD camera is used to obtain the images needed for the mapping.

A surprising result has already come to light: when the abundances of each of the gas species measured in the past three months are compared to similar measurements obtained at Lowell Observatory when Tempel 1 was last observed using the same techniques, less than one-half as much gas is currently in the coma as was measured at the corresponding times in 1983. This is very unusual as the rate at which ice vaporizes on the surface of a nucleus usually repeats from orbit to orbit simply because the amount of sunlight each orbit is the same. If this newly detected trend of a decrease in activity continues, it would be strong evidence that the surface either is exhausting its supply of ice or that the surface is crusting over and preventing the sunlight from reaching the ice. Both possibilities have been suggested to explain why much of the surfaces of comet nuclei are inert, but such a large and rapid reduction in vaporization rates has never been detected before. Thus, Tempel 1 has already proved to be a very interesting object even before the fireworks begin.*

To follow the action, and for more details of the Deep Impact mission, go to one or more of the following Web sites:
http://www.nasa.gov/deepimpact
http://deepimpact.jpl.nasa.gov
http://www.deepimpact.umd.edu

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**Stellar System Formation and Young Binaries**

By Lisa Prato

The question “Where did we come from?” is so compelling that it fuels a vast array of research fields and specialties, from evolutionary biology to cosmology. Humans seek to understand the origins of our species, of single-celled organisms, of the Earth, moon, Sun, and of other stars, faraway stars, even of our entire Milky Way galaxy as well as the origin of distant galaxies. Indeed, humans seek to understand the origin of the entire Universe, and the possibility of the origin of other universes. So the seemingly simple query, where did we come from, is actually a profound and multifaceted one.

More than 200 years ago, Charles Messier was fastidiously searching for comets. He carefully documented his non-cometary discoveries so as to not re-observe these disappointing interlopers. The philosopher Immanuel Kant was a contemporary of Messier’s. He also took an interest, if somewhat more abstract, in astronomy, and knew, as was common knowledge in their day, that the planets of our solar system orbit the Sun in the same direction in a relatively flat orbital plane. Kant became interested in Messier’s rejected objects and although his interpretation was flawed, he surmised a fundamental truth about the formation of solar systems in general. Many of Messier’s objects are actually spiral galaxies, exterior to our Milky Way, but like our galaxy, beautifully delineated by spiral arms braided with bright massive stars, luminous clouds of gas, and dark lanes of dust. With the telescopic resolution available at the time, these objects looked sufficiently disk-like so as to inspire Kant, who made an intuitive leap. He thought that perhaps these fuzzy objects in fact were other star and planet systems like our own, but in the process of formation from some primordial disk.

In the last decade astronomical instrumentation has advanced to such a level that we are now able to take detailed images of young stars and their surrounding proto-planetary nebulae. We know now that Messier’s fuzzy objects are actually vast galaxies, systems of billions of stars, millions of light years away from our own Milky Way. Even so, Kant, inspired by these galaxies yet without knowing their true nature, certainly had the right idea about how stars and planets form. Observing at multiple wavelengths, from visible light to infrared, millimeter, and even to ultraviolet and X-ray light, astronomers today have accumulated a wealth of data on young stars at various stages in the formation process. Some of these data, particularly in the millimeter and infrared, show resolved disks of gas and dust with diameters similar to the extent of our own planetary system. But most of what we know about proto-planetary disks around young stars we infer from indirect observations; for example, astronomers have a pretty good idea of how
much light to expect a star to produce at different wavelengths. If there is excess light in the near-infrared, that is a likely sign that there is warm dust located not far from the star. If the spectrum of the star shows narrow emission lines of hydrogen gas, we infer that material in the circumstellar disk is spiraling onto the central star, in a process called accretion. Both an infrared excess and hydrogen emission lines are good indirect evidence for the presence of at least a small planet-forming disk, at least several astronomical units in radius.

The nearest regions where very young stars are still forming from cool clouds of molecular gas are in Taurus, Ophiuchus, Corona Australis, Chameleon, Lupus, and Aquila. These star forming regions are located in different parts of the sky, yet all of them are at a similar distance from Earth: about 500 light years. About 10 years ago we learned a surprising thing about the newly formed stars in Taurus: almost all of them are multiple systems with two or more stars orbiting around their common center of mass, a point in between the stars. In fact, about half of the stars in our solar neighborhood, the ones you see with the naked eye on a dark night, are actually doubles. Therefore, about two-thirds of local field stars reside in binary systems. This is quite distinct from our own solar system with just a single central star.

Since large numbers of young binary stars were discovered in the early 1990s, I have been studying them, mostly in the Taurus and Ophiuchus regions. There are several problems that interest me, the first of which I’ll discuss in more detail below: (1) How can we accurately measure the most fundamental stellar property – mass – using binary stars? (2) If we look at the frequency, separation, and other unique properties of binary stars, what can we learn about the differences in star formation and evolution from one region to the next? (3) What happens to our nice scenario of planet formation, a la Kant, in a circumstellar disk of dust and gas if we have not one star but two or more stars?

I observe at the world’s largest optical-infrared telescope, one of the twin 10-meter Kecks, on the 14,000 foot summit of Mauna Kea, a dormant volcano on the biggest island in the Hawaiian chain. Mauna Kea’s peak, however, is nothing like the lush images we associate with Hawaii! A barren, seemingly lifeless landscape of volcanic rock and cinder, this mountaintop is one of the premier sites for astronomical observations. Seeing, the jitter of turbulent air in the Earth’s atmosphere, is relatively good over Mauna Kea, so stellar images are sharp. The air is very dry (not unlike Northern Arizona) so absorption of starlight by water vapor is minimal. And the skies are wonderfully dark – the towns on the Big Island are small, and the light restrictions favorable to astronomy. Even the vast, bright sprawling glow of Los Angeles doesn’t make it that far over the Pacific Ocean!

To measure the masses of stars in a binary system I need to know the mass ratio of the two stars plus either the total mass of the whole system, or else the inclination of the orbit. My specialty is measuring mass ratios of multiples called spectroscopic binaries. These systems are described in this way because even the biggest telescopes have so far been unable to resolve them into two points of light – only one point of light, one star, is observable. Then how do we know it is a binary?!

White light from the hot interior of a star passes out through the cooler stellar atmosphere where trace amounts of atoms and molecules absorb the white light at certain wavelengths, creating the stellar absorption spectrum (and recall, for a star with accretion from a circumstellar disk, this spectrum could also contain hydrogen emission lines). So we have two stars, each with a unique spectrum, which depends on the stellar temperature and the composition of trace elements. Their separation is very small as they orbit around their common center of mass. As one star approaches us, its spectral lines will be Doppler shifted to shorter wavelengths. Meanwhile, its companion star is moving away from us (as the two stars are always on opposite sides of the center of mass), and its spectral lines are therefore Doppler shifted to longer wavelengths (if you doubt this, stand by the train tracks as a fast freight goes through Flagstaff or elsewhere – the pitch is higher as the train approaches and lower as it recedes because the sound waves get shifted to shorter and longer wavelengths in just the way light gets shifted).

So, when I use the giant Keck telescope to take spectra of this point of light, a young star spectroscopic binary system hundreds of light years away, what do I see? From one month to the next the spectrum changes completely! Depending on how close the stars are (there are some systems with orbital periods as short as 2 days), it may be possible to see spectra change from one hour to the next. This results from the way the spectra of the two stars blend together as each star’s individual spectrum shifts back and forth because of the Doppler effect. Therefore, we know that there are actually two stars there, members of a spectroscopic binary, and furthermore, we can measure the velocities of both stars by comparing the shifted lines to the rest wavelengths of these spectral lines. And the mass ratio? It’s the inverse of the velocity ratio!

Because we can measure the mass ratios of spectroscopic binaries very accurately, they are excellent systems to use for comparing different star forming regions. They are also fascinating objects in which to study circumstellar disks – in some cases these systems have small disks around each star, or a big disk encircling the two stars, or both! Unfortunately, to identify a spectroscopic binary and then to measure its mass ratio requires many repeat observations – it takes a lot of telescope time. This can either be accomplished with a few observations at a big facility like the Keck telescope, where observing time is unfortunately very limited and competitive, or with more numerous observations and longer integrations at a medium-sized telescope. Projects like this will be very well suited for Lowell Observatory’s future Discovery Channel Telescope. I’m looking forward to the opportunity to continue this work there in a few years’ time!★
Karl Isbrecht
Retires from
NPOI

Karl Isbrecht retired May 13 after 11 years of service to the Navy/Lowell interferometer project, NPOI. A poet, artist, electronics designer, trouble shooter, and metal worker, Karl has been a loyal, conscientious, friendly, and valuable member of the interferometer team. His mark on the interferometer will be apparent for many years in the form of sundry modular control units, clever solutions to everyday problems like door stops, shelves, and parts storage, as well as artistic arrangements of bits and pieces destined for the recycle bin. Best wishes Karl!

To Mars (Hill) on a Bike

For a week in mid May, Lowell Observatory-Discovery Channel Telescope project staff participated in “Bike to Work Week” in the associated workplace challenge. Lowell bike commuters came out in force, and the Observatory won this new Breezer bike for being the Flagstaff outfit (over 25 employees) with the highest bike to work participation. A big, special thanks to Flagstaff Biking.org and Absolute Bikes for promoting Flagstaff’s bike to work week, and for the new bike, now part of the Lowell fleet! Pictured are Observatory bike commuters, with extra big smiles since we also had Mars Hill to conquer during our bike commutes, from left to right: Rich Oliver, Byron Smith, Mariana DeKock, Jeff Hall, Lisa Prato, Tom Bida, Rusty Tweed, Bev Welling, and Kim Westcott (other Lowell bike commuters not pictured).
Friends of Lowell

Honeywell Supports Education and Outreach Program

Honeywell Hometown Solutions has generously offered to help support the Navaho-Hopi Astronomy Outreach Program in the 2005/2006 school year, marking Honeywell’s fifth year of support for this program. Now in its ninth successful season, the program was started in 1996 by Lowell astronomers Deidre Hunter and Amanda Bosh as a way to bring the excitement of astronomy to Navajo and Hopi schools. Under this program, Lowell astronomers make visits to teachers’ middle school classrooms throughout the school year. Program activities typically include a field trip to our Visitor Center, a night of observing using the Observatory’s research telescopes, star parties at the various schools, hands-on science experiments, and classroom visits by astronomers to each participating school.

This year, the Observatory was honored to host a visit from Arizona Governor Janet Napolitano who expressed interest in participating in the program first hand. Governor Napolitano joined fifth and sixth grade students from a Navajo immersion school in Ft. Defiance, Arizona while they were treated to a “Cosmic Cart” presentation in our Visitor Center. (See related story about the Governor’s visit, page 11.)

In addition to support from Honeywell, the Observatory thanks other important sponsors of this unique program for the 2004/2005 and 2005/2006 school years, including O.P. and W.E. Edwards Foundation, which has supported the program for four years with two more years of support pledged, America West Airlines, Flagstaff Community Foundation, Forest Highlands Foundation, Bank of America, NASA/SST-EPO, and the Tuba City Regional Community Foundation.

Thank You Wells Fargo!

Thanks to a generous gift from the Wells Fargo Foundation, the Inner Solar System Exhibition in our Visitor Center will soon be complete. The Wells Fargo Foundation provided $25,000 towards the development and installation of the new exhibition. From left to right: Brady Brogni of Wells Fargo Bank, Observatory Director, Bob Millis, Observatory Development Manager, Rusty Tweed, and Veronica Brogni of Wells Fargo Bank. In the background are the new panels highlighting objects in the Inner Solar System. In the foreground is the “gravity well” used to demonstrate the laws of planetary motion.

Foundation Grants Help Preserve the Past

As the Friends of Lowell Observatory already know, there are many important historical artifacts at the Observatory, and the task of preserving these items is immense. Our preservation efforts are largely coordinated by the efforts of the Observatory’s Librarian, Antoinette Beiser.

Thanks to grants from the Raymond Educational Foundation and the Southwestern Foundation for Education and Historical Preservation, the preservation of the correspondence, working papers, and manuscripts of Earl C. Slipher has begun. Slipher began his life-long career as a planetary astronomer at Lowell Observatory in 1906, with a special focus on the planet Mars. He was especially well known for his photographic images of the planets, many of which were published in two books: “Mars: The Photographic Story” and “The Brighter Planets.”

Funds will be used to purchase essential preservation materials, such as acid-free boxes and paper, in addition to support for Library intern, Lauren Demuth. $1,000 each has been awarded by long-time Observatory supporter, The Raymond Foundation, which has supported the Observatory since 1981, and the Southwestern Foundation, which has supported the Observatory since 1999. We are very appreciative of the current and previous support of these foundations.
Public Program Changes
By Kevin Schindler

Hello from the Public Program Department. I have met many of you throughout my years at Lowell, and look forward to more interaction with you in my new role as the manager of Lowell’s outreach efforts.

You are an important part of Lowell and have been vital to the success of the Public Program through the years. Your kind donations have helped fund numerous exhibits, programs, and instruments, all of which have strengthened our program. With your help, we will continue our pursuit of offering a quality educational experience at Lowell.

On your next visit to Lowell, you’ll see a lot of changes, such as a new look to the daytime tours. In response to visitor and staff feedback, we’ve changed these tours to a more user-friendly format. The lecture portion was dropped, and the total tour time is now 45 minutes, rather than 90 minutes. This shorter tour, with stops at the Clark and Pluto domes as well as the Rotunda, is now offered hourly. In place of the lecture, Jeff Hall created a stunning multimedia presentation that highlights Lowell research. Lasting 16 minutes, this program runs every half hour throughout the day.

The result of these changes is more flexibility for our visitors. No matter what time you arrive, you won’t have to wait long for a tour or program to begin.

For nighttime programs we have also made a number of changes, mostly relating to hours of operation. Firstly, we are expanding our holiday hours to accommodate increased attendance during those times. For example, during the Christmas holidays, we will be open every night between Christmas and New Year’s.

Secondly, we will now be open a Sunday night each month. These special Sunday evening programs will feature star parties and new presentations not normally offered on other nights.

Finally, we now feature “Flagstaff Night at Lowell Observatory”. Starting this past June, the first Wednesday night of every month is “Flagstaff Night,” with all Flagstaff residents admitted for only half price. We hope this will encourage our community members to visit Lowell more regularly.

We hope these changes will make Lowell even more accessible while increasing the quality of the Lowell experience. I encourage you to contact me (kevin@lowell.edu) with any questions or suggestions you have about the Public Program. If you haven’t visited Lowell lately, come and check us out. We think you’ll like the changes!

LOWELL STAR PARTY III
SEPTEMBER 29-OCTOBER 2
Visit http://kraken.lowell.edu/lsp3/index.html

Join us for the Third Annual Lowell Star Party from September 29-October 3. This year we will feature a new observing site, Mars viewing through the 24-inch Clark Telescope, exciting new presentations, and more.

The new observing site is on the edge of Observatory Mesa, about four miles west of Lowell’s campus. This site is at an elevation of 7,500 feet and offers spectacular views and dark skies. The San Francisco Peaks are visible to the north, a small cinder cone known as A-1 Mountain sits to the northwest, and other horizons are unobstructed.

The popular observing safaris utilize the 24-inch Clark refractor. These private viewing sessions last for 90 minutes and are offered every night from September 25 through October 2. These safaris offer a great opportunity to see Mars through Percival Lowell’s own telescope.

Registration for the Star Party is $60 for all attendees 18 years of age or older (single day registration is $30.) Youth 17 and under who are accompanied by one or more registered parents may attend at no charge. If you choose an observing safari when you register, an additional $125 will be added to your registration fee. For members of Friends of Lowell Observatory, registration is only $40, while observing safaris are only $95 each.

Commemorative Star Party t-shirts are also available for only $15, and may be ordered when registering.

For more information about the Star party, contact Kevin Schindler (phone: 928-233-3210, e-mail: kevin@lowell.edu) or visit the Star party Web site mentioned above.
FINANCIAL REPORT

LOWELL OBSERVATORY
STATEMENT OF FINANCIAL POSITION
DECEMBER 31, 2004 (UN-AUDITED)

**Assets**

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
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</thead>
<tbody>
<tr>
<td>Cash and Cash Equivalents</td>
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<td>Certificate of Deposit</td>
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<td>Contribution Receivables</td>
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<td>Inventory and other Assets</td>
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<td><strong>Total Current Assets</strong></td>
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<td>Contributions Receivable, long term</td>
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<td>Investments, unrestricted</td>
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<tr>
<td>Investments, restricted</td>
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<td>Collection Item (Stevens Duryea)</td>
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<td>Beneficial Interest - Charitable</td>
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<td>Remainder Unitrust</td>
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<tr>
<td><strong>Total assets</strong></td>
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**Liabilities and Net Assets**

**Current Liabilities**

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<td>Accounts payable</td>
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<td>Accrued liabilities</td>
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<td>Deferred research grant revenue</td>
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<td><strong>Total current liabilities</strong></td>
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**Net Assets**

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<td>Permanently restricted</td>
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<td><strong>Total net assets</strong></td>
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**Total liabilities & net assets:**

<table>
<thead>
<tr>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>$59,785,217</td>
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</tbody>
</table>

LOWELL OBSERVATORY
ACTIVITY INFORMATION
DECEMBER 31, 2004 (UN-AUDITED)

**Sources of Revenue**

1% - Miscellaneous income
12% Contributions
27% Grant and contract revenue
55% Investment income
5% Public program revenue

**Revenue and other support**

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<th>Source</th>
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<td>Public program revenue</td>
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<td>Investment income</td>
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<td>Miscellaneous income</td>
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<td><strong>Total support and revenue</strong></td>
<td>$10,127,279</td>
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**Expenses by Category**

25% Management and general operations
4% Fundraising
9% Public programs
62% Research

**Expenses**

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<th>Category</th>
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<td>Fundraising</td>
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<td><strong>Total expenses</strong></td>
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1% - Miscellaneous income
12% Contributions
27% Grant and contract revenue
55% Investment income
5% Public program revenue
The History of the Perkins

By Nat White

On May 23, 1923, 82 years ago, Professor Perkins, at the age of 93, turned the first shovel of dirt at the Perkins Telescope groundbreaking ceremony. The location was about 20 miles north of Columbus, Ohio, near the town of Delaware. This July, Lowell will celebrate a groundbreaking of its own with the start of construction of the Discovery Channel Telescope. It is appropriate that we review the history of the venerable Perkins Telescope, currently Lowell Observatory’s largest telescope.

Hiram M. Perkins, benefactor of the Perkins telescope, was born on an Ohio hog farm in 1830, twenty-five years before the birth of Percival Lowell. He educated himself sufficiently to be admitted to Ohio Wesleyan in 1853. Upon graduating, Hiram was hired as a mathematics tutor and eventually became a professor of mathematics, retiring in 1907.

At six feet four inches tall, Professor Perkins was a shy and modest man. He and his wife Caroline were childless and very frugal. They shared a dream to build a college observatory. A fortune based on wise investments using profits gained from selling hogs to the Union Army during the Civil War enabled the couple to finance a career-long goal. “My object,” he wrote in 1906, “first is to interest and educate the public in one of the noblest and grandest of all sciences…”

After completion of the telescope in the spring of 1925, there was no source nor prospects for manufacturing a mirror 60 inches in diameter. Glass of this dimension had been produced in Europe but war had destroyed the factories. Through the persuasion of Dr. Clifford Crump, the observatory’s first director (and the author’s college mentor nearly 40 years later), the United States government, under the auspices of the National Bureau of Standards, agreed to produce a mirror blank as encouragement for establishing such U.S.-based industry.

After several tries, the fifth attempt at casting a mirror was successful. They had mastered the annealing process, which required cooling the glass slowly from 2,400 °F to room temperature in nine months. Upon opening the cooling tank, the 3,300-pound glass blank did not crack like the previous attempts. In fact, the blank was large enough to produce a 69-inch diameter mirror. The original 60-inch telescope tube was replaced with a 69-inch diameter tube using the new technique of arc welding. On December 14, 1931 the finished mirror was installed and the Perkins Telescope began Chapter One of its long career in research and education.

At the time, the Perkins was the third largest telescope in the world with a total cost of $300,000. On May 16, 1935, a collaborative agreement was signed between Ohio Wesleyan University (OWU) and the much larger Ohio State University (OSU) in order to make full use of its extraordinary research capability and share the cost of operation. It was obvious, however, that Ohio weather and low elevation restricted the research potential of this large telescope and thus began Chapter Two, a telescope on the move.

Under the leadership of Lowell Observatory’s fifth director, Dr. John S. Hall, an agreement was forged between Lowell, OWU, and OSU to move the Perkins Telescope to its current location on Anderson Mesa. The Arizona Daily Sun reported on January 7, 1960 that “The huge 69-inch Perkins reflecting telescope, the fifth largest in the United States, would be moved to Flagstaff this year…”

If a telescope can be identified by the size of its primary mirror, the Perkins telescope has suffered several identity crises. The telescope was planned as a 60-inch, became a 69-inch by chance, and currently is fitted with a 72-inch mirror, the largest diameter that could fit without extensive tube modification. The new mirror was needed to take full advantage of the astronomical quality on Anderson Mesa, which proved far superior to the quality of the 69-inch mirror. A new mirror system using modern low expansion glass was installed in 1965, beginning Chapter Three.

During the last forty years, improvements to the telescope and the attached instruments have kept pace with new technologies. Originally driven by clock drives and large electric motors, the telescope is controlled by a computer and motors the size of a can of beans. OSU and now Boston University have collaborated in outfitting the telescope with modern instruments and detectors.

Chapter Four began in 1998, when the agreement between Lowell, OWU, and OSU was dissolved and Lowell purchased the telescope from Ohio Wesleyan University. A month later in March, a collaborative agreement with Boston University was signed providing shared access to the Perkins telescope. Through this collaboration, fine new state of the art instruments are being commissioned on this seemingly ageless telescope.

Whether or not the final chapter is close at hand, Professor Perkins could never have imagined that 82 years after the groundbreaking, the Perkins Telescope would continue to fulfill his dream of education and research. A ground breaking ceremony for the 4.3 meter (169 inches) Discovery Channel Telescope – the fifth largest in the United States by coincidence – is planned for July 12, 2005. What will be its legacy and status 82 years later in 2087?
Governor Janet Napolitano Visits Mars Hill, Designates Lowell Observatory an “Arizona Treasure.”

By Steele Wotkyns

Arizona Governor Janet Napolitano visited Lowell Observatory on April 19th of this year and she had a welcome surprise up her sleeve. The Governor arrived on Mars Hill with several aides, including the Director of her Northern Arizona Office, Virginia Turner. Immediately after introductions with Trustee Bill Putnam, Kathryn Putnam, and Lowell staff, Arizona’s First Lady participated in a student field trip, part of the Observatory’s Navajo-Hopi Astronomy Outreach program. It had been years since a sitting Grand Canyon state Governor had visited Lowell, and long-time Observatory staff had to reach far back in their memories to recall a couple of informal past visits from years earlier.

Governor Napolitano’s April visit marked a high point of her active recent support of and communication with the Observatory. In February, she had issued a special proclamation commemorating the anniversary celebration of planet Pluto’s 75th birthday (see the Lowell Observer issue 66, Spring 2005).

This official visit was certainly a milestone for Lowell Observatory’s Navajo-Hopi Astronomy Outreach Program as well. Students from the Tsehootsooi Dine Bi’olta’ school in Ft. Defiance, Arizona were here in the Giclas Lecture Hall for a special “Cosmic Cart” presentation as part of their field trip, a component of the educational program. Lowell’s Tim Rodriquez gave an animated and informative presentation with students participating as Governor Napolitano took it all in from her front row seat (see related story and visit our Web site for the press release about the Governor’s visit and the Navajo-Hopi Astronomy Outreach program, http://www.lowell.edu/press_room/releases/recent_releases/GovtoLowell.html).

After the astronomy outreach presentation, the Governor and her staff were given a guided tour by Lowell Observatory Trustee, Bill Putnam and Associate Director, Jeff Hall. The two stops on this tour were the Slipher Building Rotunda and the Clark Telescope. During the mini-tour, there were many magic moments packed into a short time, but a few stand out. Jeff Hall adjusted the blink comparator used by Clyde Tombaugh to discover Pluto while the Governor peered at the Pluto discovery plates, and Governor Napolitano spent several minutes soaking in the history of the founding of Lowell Observatory while reading a story board describing the new first Lowell telescope exhibit in the Rotunda.

But, it was during the tour of the Clark Telescope where the real, most memorable action unfolded. Bill and Jeff gave a lively description of research highlights and accomplishments Lowell astronomers have made over the years using the Clark Refractor. Bill encouraged Governor Napolitano as she pushed the huge Clark telescope into a new position. Then, near the very end of the tour, KNAU-Arizona Public Radio News Director, Mitch Teich, who was covering the Governor’s visit, pulled me aside and said, “You know, she’s going to declare Lowell Observatory an Arizona Treasure.” I was stunned. But, I wasn’t as surprised as others inside the Clark Dome when a short few minutes later her staff pulled out specially made T-shirts and Governor Napolitano presented them to Bill and Jeff, formally declaring the Observatory an Arizona Treasure. With this designation, Lowell Observatory is added to a select list of special Arizona destinations.

For more information see Governor Napolitano’s Arizona Treasures Web site: http://www.arizonatreasures.gov/go/flagstaff/ has more information on the program plus a description and link for Lowell Observatory.