The ASTERISM

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Behind the Scenes at Keck

By Alan Midkiff

In the summer of 2005, I began regular visits to the Mt Palomar Observatory under my "assistant to the night assistant" program with Karl, the 200-inch telescope operator. As part of a mutually beneficial arrangement, Karl allows me to shadow him during the observing runs he conducts for visiting astronomers, and at times, lets me operate the 200-inch Hale telescope. In exchange for his willingness to accommodate my astronomical indulgences, I use my employment for a major airline to facilitate travel for him and his wife. Recently, Karl and I were able to combine our vocational perks in order to travel to Hawaii with our wives and take advantage of Karl's status as a Caltech employee for a behind-the-scenes visit to the W. M. Keck Observatories on Mauna Kea (Caltech is also involved in the operation of the Keck facility, along with U. of Hawaii, and NASA). In addition, Karl was personally acquainted with the observers who were to be using both Keck I and II the night of our visit, since they frequently use the 200-inch for their research.

The Keck Observatory really consists of two facilities: the headquarters and operations center (HQ) in Waimea, which is located at the northwestern base of the dormant Mauna Kea volcano on the Big Island, and the two 10-meter telescopes (currently the world's largest) and supporting facilities on the 13,700' summit. Our visit started at HQ where the four of us signed waiver releases and received "hi-altitude" briefings in order to travel to the summit. We also toured the two (Keck I and II) data rooms where observers communicate with telescope operators on the summit who control the scopes and detectors in order to enable data collection. At HQ we also viewed the observer dorms and some instrumentation labs. It's interesting to note that from Waimea, one can look directly up the mountain and see the observatory site. An 80mm refracting telescope is set up in one of the lobbies for the purpose providing views of the domes.

The drive from HQ to the summit takes about an hour and 20 minutes. The route passes through lava fields on Saddle Road, which is so named because it rides the saddle between the two large Big Island volcanoes, and eventually leads to the observatory turnoff. At the 9200' level on the observatory road is a Visitor Center and gift shop. We stopped here for the recommended 30-minute acclimation period before pressing on up the hill. Access to the peak from this point is by 4-wheel drive only.

At the summit we met with Bill Bates, the summit day operations lead who is responsible for all daytime activities at the observatories, including instrumentation selection/calibration, maintenance, etc. Bill spent 1.5 hours giving us a complete tour including the two telescopes and control rooms, interferometer, mirror recoating lab, and numerous shops. I had my vidcam running the whole time to catch his narration, and took as many photos as I could at each facility we visited.

We started in the Keck I kitchen (yes, there are 2 of almost everything) where Bill briefed us on the overall operation and layout. We then moved to the Keck I control room where he explained the numerous displays and controls used to operate the telescope and detectors. From there we preceded to the Keck I computer room, which contains processors that control both telescope pointing and tracking, and the precise alignment of the mirror segments. Each Keck telescope has a 10-meter objective consisting of 36 hexagonal mirrors (each six feet wide) that are precisely controlled to act as a single mirror. The telescopes utilize an open tube frame on an alta-azimuth mount system for a total moving weight of 270 tons.

(Continued on page 2: **Scenes**)

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Exploring Mars, the Search for Life, and a Journey in 3-D

Dr. Ken Kremer

A comprehensive review of the ongoing NASA Rover Mission to Mars covering the explorations and adventures of Spirit and Opportunity from launch to the latest news, as they have journeyed many miles across the surface of Mars. See a full-scale model of the RAT science drill, a crucial element in the scientific search for evidence of past water on Mars. Missions to Saturn, Comets, and more will be put into the broader perspective of the search for life beyond Earth and extended into the realm of 3-D. Ken was a member of the four-person international team credited with a "Spirit" cover on the 14 November 2005 issue of Aviation Week and Space Technology magazine. It has also appeared in numerous other publications. Ken is the Program/Lecture Chairman of the Amateur Astronomers Association of Princeton (AAAP). 3-D glasses will be provided. Ω

Monthly Meeting

Friday, October 20th

at 8:00 PM

in the **Main Lecture Hall**

This month our speaker will be

Ken Kremer

NASA JPL

Solar System Ambassador

whose topic will be

"Exploring Mars, The Search for Life, and a Journey In 3D"

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Scenes Continued from page 1

Both the azimuth journal and altitude bearings ride on oil pads, which reduce the friction levels to the point where the entire assembly can be moved by hand. The DC stepper motors used for slewing and tracking draw a maximum of 4 amps each.

We moved from the Keck I computer room through a hallway and out onto the observatory floor under the massive telescope framework. The Nasmyth platforms, which are adjacent to the altitude bearings and contain most of the instrumentation and detectors, are 40 feet above the floor level. The top of the scope is another 40 feet higher. Keck I was pointed at zenith, so the plan was to make a closer inspection of Keck II (which, at the time, was pointed at the horizon). We did, however, get to see the man-lift boom, which is used by the day-crew to periodically dust off the mirrors with dry-ice snow between segment re-aluminization.

Upon entering the Keck II side, we took an elevator to the Nasmyth level to get a closer look at some of the instrumentation and detection equipment. The adaptive optics system (AO) was to be utilized that evening by the Keck II observer, Dr. Richard Ellis. Dr. Ellis' research includes investigating distant galaxies that have been magnified by the gravitational lending effect of (relatively) nearby galaxy clusters. The AO system is used to bring the actual resolution achieved by the scope closer to its theoretical value by minimizing image distortion created by atmospheric instability.

The system employs a 6-inch deformable mirror operating at 670 Hz to reduce errors in the light waveform reaching the detection equipment. The system can use either a field star for wavefront error measurement, or an "artificial star" created in the upper atmosphere by a dedicated laser. The seeing on Mauna Kea is typically around 0.6 arcsecond (a very impressive value in itself), however, using AO the resolution can be improved to 0.04 arcsecond. Dr Ellis would need all of that performance since he was taking localized spectra of different portions of single lensed galaxy (measuring only 11 x 0.5 arcsecond) in order to determine its dynamic characteristics.

We took the elevator down to the catwalk level to get a good look at the segmented objective mirrors. At that time Bill told us about a "favor" he and the crew did for a colleague whose skills had been essential during Keck II's installation and startup. At the time, there were no instruments yet installed on the Nasmyth platforms. Light from the Keck primaries is normally reflected by the secondary onto a 45 degree diagonal tertiary which sends it out either altitude bearing (which consist of rings about 3-feet in diameter) depending on which platform/instrument is in use. For this night, one of the optical engineers had placed a piece of tape on the Nas-plat floor right at the optical plane. This made it possible to stand with one's head in the optical plane and take in "primary" views of whatever the scope was aimed at. For this night they were pointed at Saturn, and Bill got to take his turn viewing an image he described as something on the order of volleyball in size, "with rings".

We left the telescope area and preceded to the basement level between the domes where most of the equipment used in the Keck interferometer is located. The interferometer combines/compares the light beams from both telescopes in such a way as to approach the resolution performance of a single telescope 85 meters in aperture (85m is the baseline distance between the two scopes). The basement apparatus consists of numerous movable mirrors used to adjust the light path length to a level of precision on the order of a wavelength of light.

After visiting the interferometer basement we came upstairs to the mirror re-aluminization room. Unlike most monolithic telescope mirrors that require the telescope to be taken out of service during re-aluminization, the Keck hexagons are removed three at a time by a special pick-off crane, and the availability of 12 spares allows a rotation strategy that keep the scopes continually in service. Each mirror segment cost $1 million (the mirror transport boxes are each $8000), and is stored in a "mirror barn" until moved back into service. The total aluminum used on both 10-meter scopes equates to about 1.5 beer cans.

We toured some more shops and labs, and then expressed our appreciation to Bill before heading back to the visitor center at 9200'. Here there is public observing every night in pristine conditions through a wide variety of telescopes. After enjoying some remarkable viewing, we went back down to Keck HQ where we caught up with the observers for the evening.

At HQ we met with Dr. Ellis and his team. Just about the time we arrived in the data room, the team had just downloaded an image for Mike Brown (discoverer of Xena) who had briefly "commandeered" the telescope under the target-of-opportunity program. On the screen was a very detailed image of Titan, whose 0.8 arcsecond diameter was covered in surface shadings and markings described by the team as "weather". This image was produced using AO, but without the laser guide star. Shortly thereafter, the team received permission from both air traffic control, and space command to fire up the laser "launch tube" which produced the guide star required to begin their 3+ hours of exposure of the lensed galaxy. This was around 11pm local time, and I was starting to feel the effects of the 6-hour time difference from the east coast. We received a final tutorial on advanced AO from one of the original AO designers who happened to be assisting the team that night. Shortly after a quick visit to the Keck I observer (in the adjacent room), we gave our thanks and farewells, and headed back to the hotel.

All in the entire trip turned out to be a great success. I got plenty of video and still images, and none of us passed out. Many thanks to the staff at HQ for granting inside access to the facilities, to Bill Bates for taking time out of his busy schedule to accommodate us and present a fascinating tour of the observatory itself, and to Richard Ellis and his team for their real-time explanations and narrations as the data was coming in.

(See photos of Alan and Cindy Midkiff's tour of Keck I and II in the May issue of *Asterism, Summer Edition*. Note added by RAS)

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The ASTERISM

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Dome Duty Schedule

Oct. 13	Team D
Oct. 20	Team E
Oct. 27	Team A
Nov. 3	Team B
Nov. 10	Team C

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Sounds of Stellafane 2006

by Bonnie B. Witzgall

Stellafane is a Telescope Maker's Convention hidden away in the Precision Valley area of Springfield, VT. Held once a year, depending on the moon phases in July or August, the Event is a non-stop saturation of colors, sounds, and sights in different wavelengths. The Springfield Telescope Makers (STM) goes through great efforts to provide educational discussions and hands-on demos of new techniques and novel ideas. There is such a full immersion into the living and breathing of amateur astronomers. From around the world, they come to see, taste, listen, learn, and share the wonderment of being with 'our own kind' of hands-on astronomer. The Convention is legendary for cramming too much activity in too big a space all wrapped up in too little time. With so many things happening at once all over the 36-acre site, one needs a space-time machine, no-doze drugs or Insta-Clone Copier to gather the full experience. Cloning oneself within the 1½-day convention has a time constraint and Vermont had tough drug laws. Eager attendees have but one option to race from one area to another, snatching pieces from each simultaneous event. The following is a snap-shot of 'sound bites' and servings of sounds all spliced together from the crazy quilt called the 71st Stellafane Convention:

The squeaking of aluminum folding chairs that open only once a year are spontaneously set up in the middle of Jordon Road. Then come jovial laughter and a congenial slap of welcoming handshakes as conventioneers await the official Convention Gate opening Friday morning.

"Hey, is that Irv Price? I know it's a mistake to say hello, but… 'Hey, Irv! How are you?"

"I love the smell of pitch in the morning. Smells like victory."

Try not to wander across the shot when Tim Ferris and crew are filming. Yeah, he is making his book 'Seeing in the Dark' into a PBS special and needs to record a lot of good stuff at Stellafane. I don't know, some time next year. No, but I did try to walk through the background. Of course, you remember Tim Ferris. He made only two record albums, but both went gold."

NOAA Weather Radio: "For August 2, 2006, for the southeastern section of Vermont: an 80% chance of heavy T-storms with damaging hail, and the threat of Neptune-like windstorms this afternoon and early evening."

"Irving says he can't remember where he parked his car."

"The new Flanders Pavilion is so big and beautiful! It makes the STM's tractor look like a toy Tonka truck."

"Irving says he found his car, but can't find a place for his tent."

Drumming sounds of early evening raindrops, gently patting the tent tarp. "The sound of tender rain is soothing, but not here! Anywhere but at Stellafane! What a letdown!"

"Well, a hot Summer Sol giving way to 6.5 magnitude skies with deep granulation from Sagittarius to Cygnus to Cassiopeia. The great rift lanes have a 3-D appearance! What does NOAA know?"

Exited shouts rise in unison from the observing field, cheering the minus-5 magnitude Iridium Flares.

It's so clear, I lost Hercules! I can't find Hercules!" Damn Jupiter is too bright."

"I'm flabbergasted with this clear sky and I take a lot to flabbergast."

We were caught flat-footed by this good sky. I didn't set up because I really thought a storm would blow our instruments to OZ. It's back to binoculars and that old fashioned naked eye viewing."

"You spent the last six hours viewing the sky and you need half a sleeping pill to knock you out? Why? So you can rise early to bargain at the Swap Table. Pushing drugs is wrong, but offering sleeping pills beneath a granulated Milky Way is anti-astronomy and outright subversive! Keep your darn pills. I'll sleep later when I'm under the New Jersey clouds."

The slap slam-bang of the porta-john doors at 2 AM local mean solar time Saturday morning indicates the viewing conditions are still good and no one surrendered to sleeping pills.

Simultaneous buzzing, raspy grate sounds of tent zippers signal the annual 5:30 AM Saturday morning migration to the Sunrise Seminar Stellafane Swap Table.

"Look, amid all this high-tech, super-electronic automated astronomical material; someone is selling a slide rule. I'll take it."

"Hey, Tim Ferris is filming again. Too bad, I didn't bring his books from my library for him to autograph. Wonder if he signed the copy of 'Galaxies' in the STM Library at the McGregor Observatory."

"Man, the afternoon is too sweltering to lug anything, too muggy to smear more greasy sun block and too damn hot to walk. Oh, here comes the bus up to the Summit. You got all the cameras, laptop, water, sunscreen, bug repellant, sun umbrellas and batteries? How about a book for Tim Ferris to sign?"

"is that a real speculum metal mirror?" "It's a modern ecological friendly speculum made without arsenic. "

It would not be Stellafane without the spurting spitting sizzle of the traditional Saturday night chicken dinners roasting on the giant BBQ grills.

The melancholy singing voices of STM members Natalie and Tony leading a tribute to their fallen member Sue Rugelis.

The sharp slam-bang of spring-loaded porta-john doors at 7 AM local mean solar time Sunday morning indicates the early breakdown of the base camp and end of Convention.

At the end of each Stellafane come the sounds of low indistinct grumbles and flapping of plastic tarps that cocooned the sentential scopes in the observing field. The clinking of tent struts, shaking of tent tarps, the droning of cold vehicles' motors and long sad faces signal the end of this non-stop noisy weekend.

Musical notes of a responsive digital camera now take the last images of a vacant observing field or the empty Flanders Pavilion. A few more photos of people who see each other only once a year and who vow to meet again in the same camping area. After the final shoulder slaps comes the strained rumble of departing vehicle motors overburdened with too much heavy equipment. Then the 36-acre convention site converts from an animated beehive of astronomical activity to emptiness and countryside peace.

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Stewart's Skybox

by Stewart Meyers

Sometimes, several things come together to inspire me as to when to do a column on a given topic. This was one of those times. First of all, President Bush has proposed sending people back to the Moon. Then, the ESA's SMART-1 lunar mission came to a crashing halt, literally, early this month. So, I am devoting this month's column to the nearest celestial object to the Earth, our Moon. Besides, if Gerry Anderson did his schlocky TV voodoo with a September Moon back an the mid 1970s, why can't I have some fun with it?

Rather than discuss the history of lunar science, I will instead debunk some popular myths about the Moon. I got the idea to do this because of a convention t went to in June. At the event was Dee Wallace, best known for playing the mom in *E.T. The Extraterrestrial*. She was quite nice, and she was also there to push DVDs of *The Howling*, a werewolf movie she was in. I rook the opportunity to explain to her that I didn't find werewolf stuff too interesting due to my knowledge of the Moon and the fact that it exerts no strange influences. Dee agreed,

(Continued page 4: **Skybox)**

Skybox (continued from page 3)

but she said that the myths about the Moon were quite pervasive in popular culture, even after the Apollo astronauts walked on the Moon without anything strange happening to them. So, let's take a detailed look at why the Moon, while interesting, is not mystical.

Time and Tides

People who believe in the mystical powers of the Moon often point out that it could exert its spooky actions through tidal forces. On the surface, this might seem reasonable. After all, anyone who has spent more than a few hours by the ocean or a bay has noticed that the water rises and falls due to tides. Some have argued that, since the ocean is water and people are mostly water in terms of composition, lunar tides should affect people and their behavior. They point to claims of increased weird behavior at times of full Moon, and then the old stories always say that werewolves change from people to beasts at full Moon.

However, the "Full Moon Effect" has been shown to be false by numerous statistical studies. Also, if one knows how tides work, it is easy to see that they cannot influence living beings. As stated in previous columns, tides result when the side of an object nearest a gravity source experiences a greater pull than the opposite side does. In the case of the oceans, the sea facing the Moon is about 8,000 miles closer to the Moon than the ocean on the opposite side of the Earth. Since the Moon is about a quarter of a million miles away, the diameter of the Earth is a measurable fraction of that distance, and the ocean feels the effect of the difference.

Now, consider the case of a human being. To make things as fair as possible to the werewolf buffs, our example will be a player from the NBA who is seven feet tall. The difference in the pull of lunar gravity between the top of his head and the soles of his feet is so close to zero that it can be considered zero for any practical purpose. Even the varying distance of the Moon from Earth (the Moon's orbit is slightly elliptical), while important for ocean tides, does not alter this conclusion.

It could be argued that fides do influence some living creatures since a number of sea animals lay eggs at times of very high tides. This is the result of their biological clocks, not lunar influence. And they are not infallible tide predictors as the large number of horseshoe crabs that die stranded on beaches each spring can attest.

Blinded By The Light

Anyone who has been in the domes of Sperry Observatory on a public night during a full Moon knows it can appear very bright, especially through the telescopes. This brightness is deceptive. Actually the Moon reflects light about as well as the pavement of the road outside the observatory (an aibedo of about 7%). It appears bright because the Moon is surrounded by nonreflecting space, so even a dark object like the Moon would appear bright. But that is not the whole story. It is known that the full Moon appears about ten times as bright as it does at first or third quarter. Before people knew much about the Moon, this must have appeared strange. But there are two reasons for this effect. First, during full Moon, the Sun is overhead as seen from the lunar surface. There are no shadows. At other times, there are always some shadows formed by mountains and crater rims. But the other reason was only discovered after the Apollo missions returned lunar samples to Earth.

Most of the Moon is covered in a layer of dust, which is essentially lunar rock that has been pulverized by eons of micrometorite impacts. When samples of this dust were studied on Earth, it was discovered that there were numerous tiny bits of glass in it. The glass formed as the impacts of micrometeorites melted little bits of surface material. The bits of glass give lunar dust a weak retro-reflective property like those reflectors embedded in many roads. Due to this effect, the Iunar dust actually reflects a bit more light towards Earth at full Moon.

No Cheese, Green or Otherwise

The final proof against strange lunar influence is the composition of the Moon itself. It is now widely believed that the Moon formed as the result of a collision between Earth and a Mars-sized planetesimal in the early days of the solar system, which sent debris from the Earth's mantle into space.

Because of this origin, only about a dozen minerals make up the Moon. Besides basalt and anorthosite (basic igneous rocks), most of these are oxides of iron, titanium, chromium, aluminum as well as some silicates, along with some minerals rich in potassium and rare earth elements. Recently, something new has been added to this list. In 1948, the Lunar Prospector probe found evidence of hydrogen-rich material in some permanently shaded craters near the lunar South Pole. While it could be buried water ice from ancient comet impacts, hydrated minerals and commetary hydrocarbons have not been ruled out, While this mix of minerals is interesting to those who want in build lunar bases, it is about as non-mystical as one can get.

Truth is Better Than Fiction

As this article has tried to show, the Moon is an interesting place with great potential importance for humanity's future. Now, isn't this far more interesting and exciting than mysticism and werewolf stories? Ω

The Discovery of the Planet Ceres

By Dr. Lew Thomas
Submitted on 8/19/06

On the night of January 1, 1801, the astronomer Piazzi of Sicily found an additional point of light in a star field, which he had been observing. After measuring its position with respect to the surrounding stars, he found that on the second night, this point of light had moved. Confirming the motion on -successive nights, he announced the discovery of a new planet! He named it “Ceres" after the Greek goddess for Sicily. Following a very few number of observations, Ceres had moved angularly so close to the sun that it was lost in its glare. About this time Piazzi became ill and when he recovered, Ceres could not be found.

A 23 year old, German mathematician by the name of Karl F. Gauss was intrigued by the problem and in about a month worked out a method of determining the orbit of a solar system body given just three observations. His work permitted the recovery of Ceres very close to its predicted position. Not only that, Ceres was found to be moving in an orbit within the large gap between Mars and Jupiter Where astronomers had hoped to discover a new planet. But Ceres was called a minor planet or asteroid. It remained an asteroid until the year 2006. Then something happened.

Meeting in Europe this August, the International Astronomical Union changed the status of Ceres. They defined a planet as any round body orbiting a star (and not orbiting another planet). Ceres qualified! It is about 500 miles in diameter and its gravity is sufficient to make it spherical. And so Piazzi, you did discover a planet in 1801. Ceres was the first "asteroid" to be discovered, but shortly thereafter, in 1802, Olbers accidentally discovered another asteroid, Pallas, while searching for Ceres. Harding, in 1804 found Juno and in 1807, Olbers discovered his second asteroid, Vesta. For several years thereafter, astronomers searched in vain for additional asteroids. Then in 1845, after the "asteroid craze" had subsided, Hencke, an amateur astronomer, discovered Astraea at the end of a 15 year search!

(Continued page 5: **Ceres**)

THEATER IN THE SKY

by Ron Ruemmler

October 2006 is a challenge for every sky-watcher. Stars, planets, and the Moon; all are at their least impressive for the year this month.

First, the autumn constellations have fewer bright stars than those of other seasons, and all the easy stars, like Arcturus, Capella, Aldebaran, and the big dipper are all huddled along the northern horizon. The Great Summer Triangle stands nearly overhead. Fomalhaut, low in the south, is the only comfortably located first magnitude object.

Second, every October has a handicap for prime-time planet-watchers since the ecliptic, the plane of Earth's orbit and, roughly, that of the whole Solar System, makes a very small angle with the western horizon each evening. Add to this the fact that most of the planets happen to be unusually close to the Sun, and you have an essentially planet-free night sky.

Finally, this year's crazy Moon is at its southernmost during its pretty waxing (growing) crescent phase, so it sets before total darkness until it is almost four days old. The one-day-old Moon actually sets before the Sun!

If you want to say goodbye to Jupiter for the year, look low in the southwest in the late twilight. The Giant Planet is easier near the beginning of October, but just after the middle of the month, Mercury drifts up to float under it for a couple of weeks. Mercury has a long, low apparition that started way back in August and will not end until November when the speedy little planet will actually pass across the face of the Sun. For now, you might try to spot Mercury below Jupiter and to its right before the 18th, or below and to its left after that date.

Normally, the morning sky in October makes up for the dreary evening counterpart. All the beautiful, bright winter constellations are high in the south and Daylight Saving Time shifts them into view of many commuters. Also, the morning ecliptic makes a big, bold angle with the horizon, pushing the Moon and planets high into the eastern sky. But this month, Mars and Venus both pass beyond the Sun, invisibly passing within a degree of each other. Saturn, rising around 2 AM, is the only planet visible in a dark sky this month.

Very early on the 14th, the Moon comes about as close to Pollux as it can ever get. Two days later, it skims past Saturn and Regulus. The super-low evening crescent Moon can help you find Jupiter and Mercury on the 24th. On the evening of the 26th, the southernmost Moon of the month is located almost exactly between the Earth and the center of the Milky Way. The following evening the Moon is inside the Teapot of Sagittarius, just below the star at the junction of the handle, body, and lid.

October sky calendar

6 FRI 11:13 PM Full Moon
13 FRI 8:26 PM Last Quarter Moon
14 SAT 1:00 AM Fat crescent Moon just below Pollux
16 MON 6:30 AM Saturn lower right of crescent Moon
17 TUE 6:00 AM Regulus upper right of crescent Moon
22 SUN 1:13 AM New Moon
23 MON 3:00 AM Mars passes beyond the Sun into the morning sky
24 TUE 6:30 PM Mercury and Jupiter far right of crescent Moon
25 WED 3:00 AM Invisible conjunction of Venus and Mars
26 THU 7:00 PM Crescent Moon located in front of galaxy center
27 FRI 1:00 PM Venus passes beyond the Sun into the evening sky
27 FRI 7:00 PM Crescent Moon within Teapot of Sagittarius
29 SUN 2:00 AM Change clocks back one hour to Standard Time
29 SUN 4:25 PM First Quarter Moon

Ceres (continued from page 4)

These discoveries were all before the advent of photography. Now through ground based photos by large telescopes, the use of Charge Coupled Diode cameras on the ground and on-board orbiting satellites, hundreds of thousands of "new" asteroids have been found since then.

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Note: The version of this issue that was printed on paper was edited by Aaron Zuckerman. The digital file from which this online version was made was delivered in damaged and incomplete form. My thanks go to Phil Salimbene who scanned several pages of the paper version, and processed them with Optical Character Recognition software. From Phil's work, I was able to reconstruct this issue for display on the AAI website. – Ray Shapp