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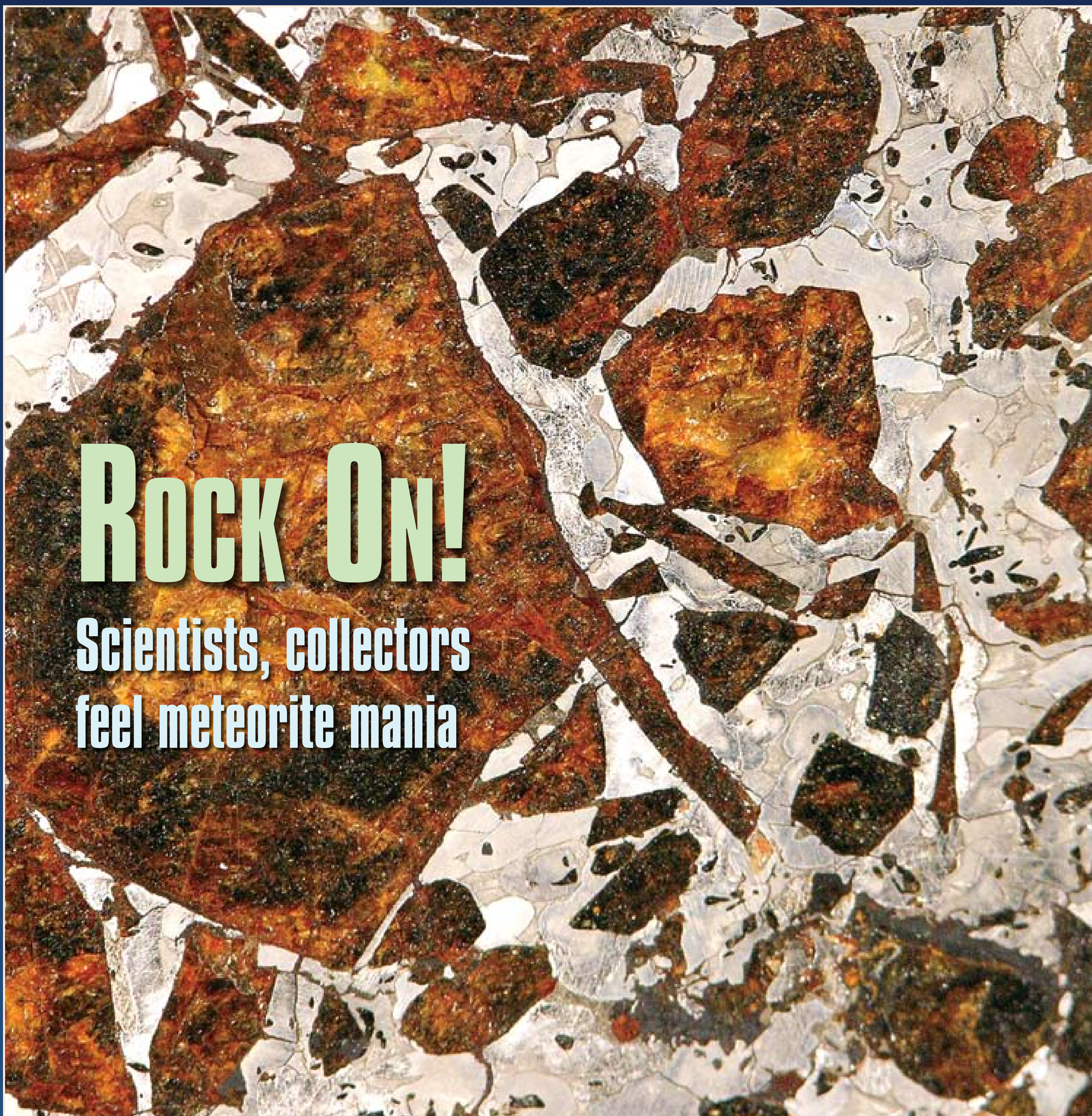
MARCH/APRIL 2007 $5

PLANET DEBATE NOTHING NEW
Page 4



ROCK ON!

Scientists, collectors feel meteorite mania

THE UNIVERSITY OF TEXAS AT AUSTIN McDONALD OBSERVATORY

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Features

Departments

MONNIG METEORITE GALLERY, PHOTOGRAPH BY GEOFFREY NOTKIN/AEROLITE.ORG

On The Cover

This stony-iron meteorite found in Australia is called a pallasite. The light-colored areas are an alloy of iron and nickel. The glassy orange inclusions are the gemstone peridot. For information on meteorite collecting, see page 16.

This Page

Comet McNaught glows above Santiago, Chile. Discovered in August 2006 when it was too faint to see without a telescope, it later became the brightest comet in more than 40 years. McNaught passed behind the Sun in January. When it reemerged, it was visible only from the southern hemisphere.

Coming Up in May/June

Our May/June issue will bring you feature-length excerpts from some of the latest books in astronomy — from planetary science to cosmology — to help you plan your summer reading.

ESO/STEPHANE GUISARD

Merlin

Dear Merlin,

How far in space would our Sun be visible to the naked eye? I heard 55 light-years, but I think it would be farther than that.

Daniel Weisman
Van Nuys, California

For the 12-eyed arthropods of Alpha Lyncis d, a couple of hundred light-years. (Their night vision is among the best of any intelligent race in the galaxy.) For human beings, depending on visual acuity and sky conditions, 55 light-years is about right.

Dear Merlin,

Why does the Moon appear red when there is a lot of smoke in the air from nearby fires?

Denise Heatley
Winthrop, Washington

For the same reason that the Moon and Sun look redder when they are rising or setting than when they stand high in the sky. Fine particles in the atmosphere scatter blue wavelengths of light but allow the red to shine through. When the Moon and Sun are low in the sky, they shine through a thicker layer of air than when they are high overhead, which means their light must pass through more dust, pollen, and other fine particles. Fires add a lot of fine particles to the sky, too, making the Moon and Sun look redder than normal.

Under certain circumstances, fires and volcanoes can make the Moon look blue, not red. This occurs when the ash contains lots of particles of a particular size, which absorb red light, and no particles of other sizes, which absorb blue light. In fact, an early meaning of "blue Moon" was quite literal: the Moon turned blue.

Dear Merlin,

What is the origin of the term "gibbous Moon?"

JoAnn Bisogno
Albany, New York

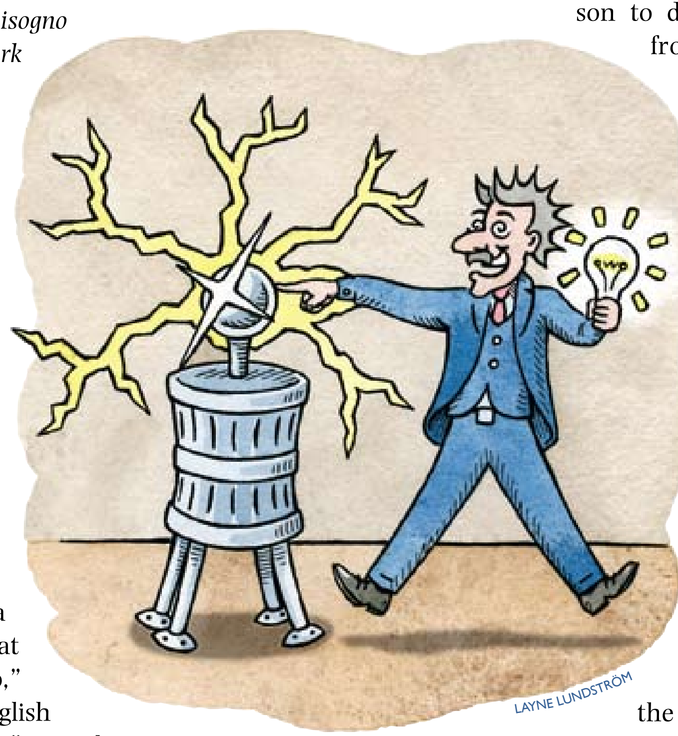
The Moon is "gibbous" between first quarter and full, or full and last quarter, when sunlight illuminates more than half of the lunar hemisphere that faces Earth. The word gibbous comes from a Latin word that means "hump," and in early English means "bulging." In a gibbous phase, the Moon does indeed look like it has a hump or bulge.

Dear Merlin,

I've heard that Nikola Tesla, the enigmatic genius who worked with electrical and magnetic technologies, had theories about "free energy" — energy that was all around us and could be collected and harnessed for mankind's use. What light can you shed on this mysterious subject?

James Barberousse
Shreveport

Merlin was always fond of Niko. He really knew how to light up a party.



And there's no doubt that he was a genius. He developed most of the technology that's used in today's electrical generation and transmission systems, as well as early radio, remote control, and lots of other handy devices. He spent years trying to develop a way to transmit electricity directly through the Earth without wires. This would have provided cheap power to all, but he never made it work.

Tesla conducted many other experiments with electricity and radio waves, developing the concept for radar, among other things. And he may have been the first person to detect radio waves from astronomical objects. Around 1900, while conducting experiments in Colorado, he detected signals from the sky that he interpreted as communications from an extraterrestrial civilization. Today, some radio astronomers think that he had instead detected natural radio signals from the planet Jupiter.

Dear Merlin,

What is the glow around the Moon that appears to be a halo?

Toni L. Accardi
Boca Raton, Florida

A halo of ice crystals. When moonlight passes through small, six-sided ice crystals that are found in high, thin clouds, it is bent at a 22-degree angle. This forms a glowing ring 22 degrees away from the Moon. Most of the time the halo appears white, but under the right conditions, it can look like a circular rainbow. The same kind of halo can encircle the Sun, too.

Merlin is unable to send personal replies. Answers to many astronomy questions are available through our web site:

stardate.org/resources/faqs

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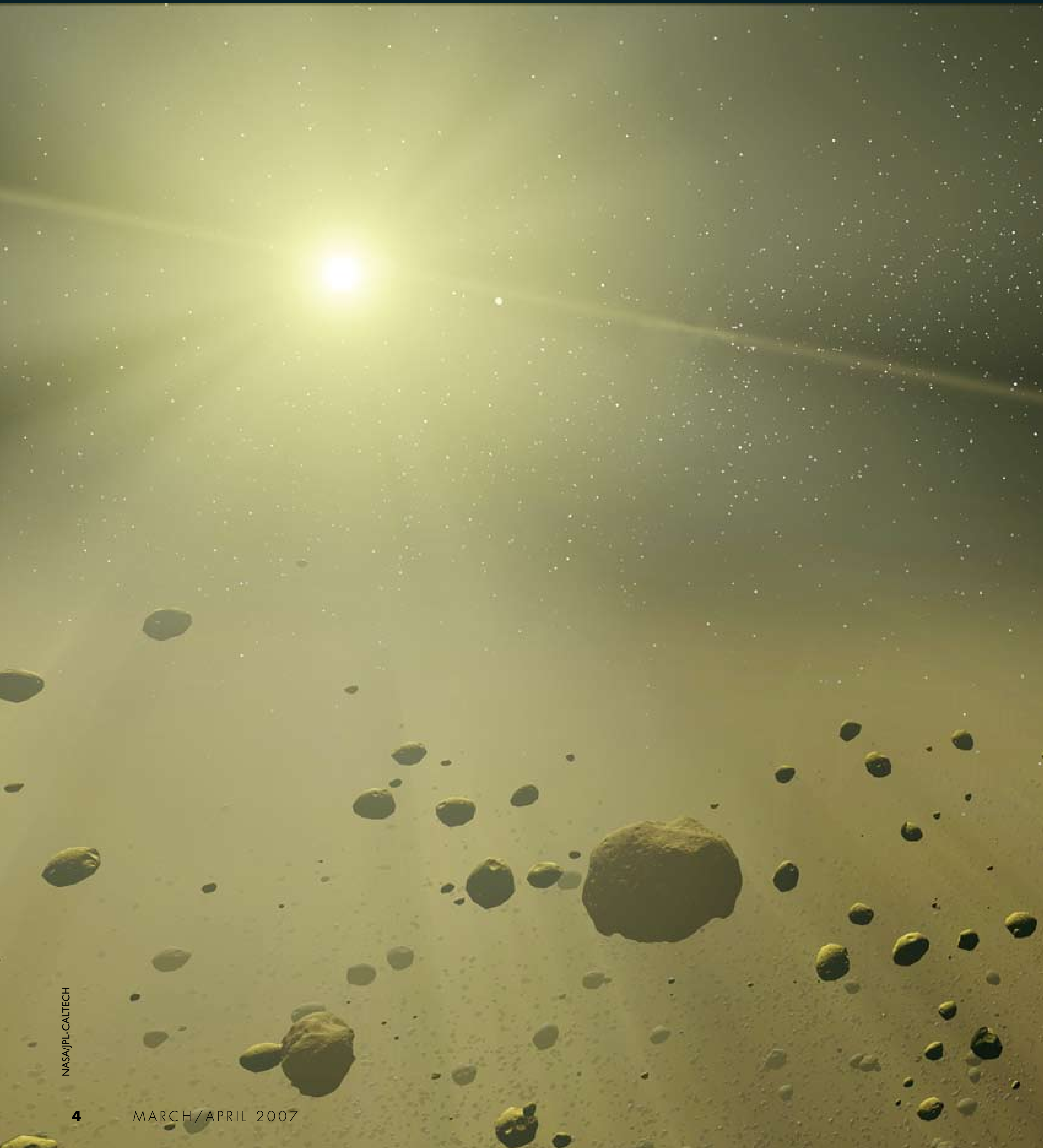
A Planet is a Planet is



NASA/JPL-CALTECH

a Planet … or is It?

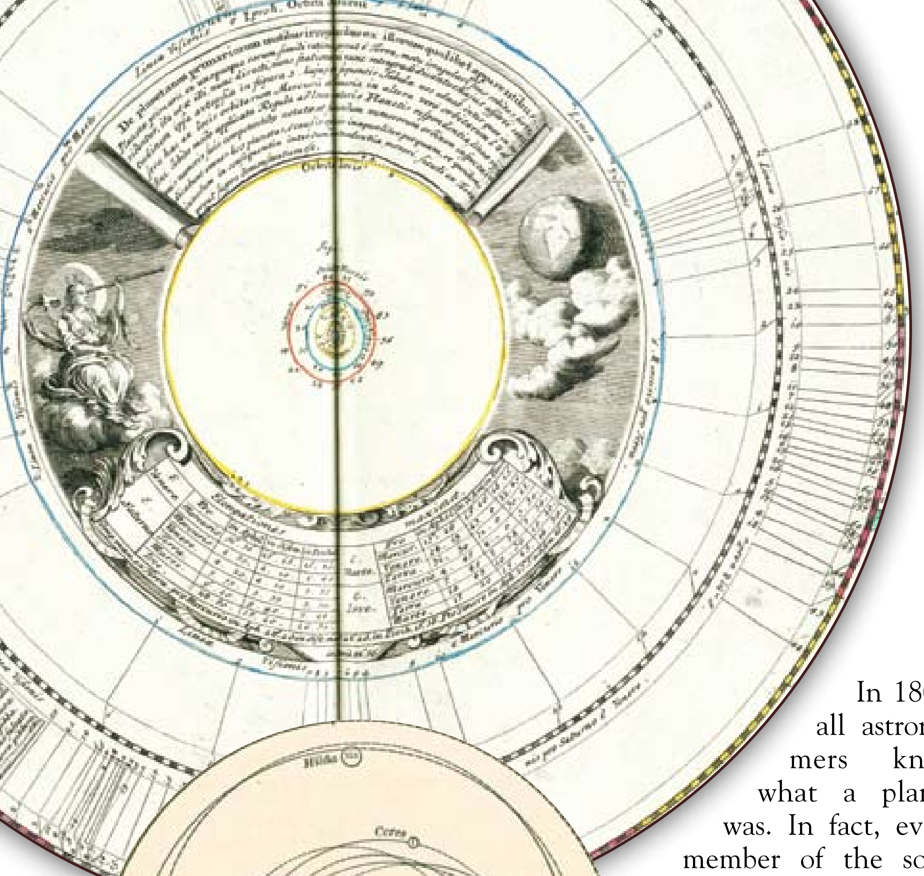
Pluto isn't the first 'planet' to face demotion; two centuries ago, astronomers debated the status of another solar-system 'dwarf'

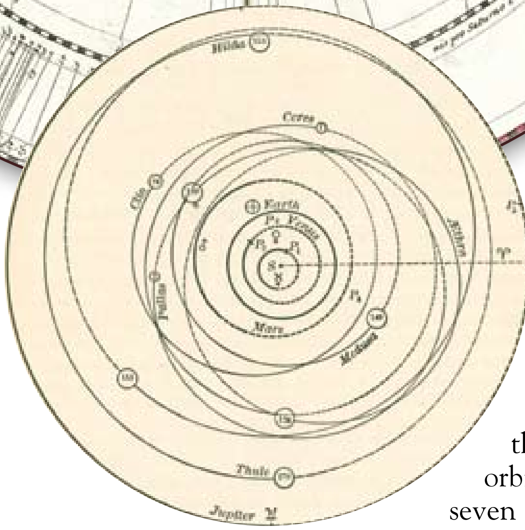
By Barbara Ryden

In the past decade, astronomers mining the heavens in the farthest ranges of our solar system have found dozens of new bodies — some quite large — in the region beyond Neptune known as the Kuiper Belt. Their findings have shaken up longstanding ideas about the demographics of our solar system. Some have been upset at the destabilization of their long-held picture of our celestial neighborhood: Nine planets orbit the Sun, and planets are either gas giants or rocky like Earth.

We've been through this debate before. Pretty much the same questions arose more than two centuries ago, when the discovery of new bodies in the solar system caused people to ask: "What is a planet?"

Asteroids are the debris left over from the formation of solar systems, as in this artist's concept.





A 1742 drawing of the solar system (top) shows a great void between the orbits of Mars and Jupiter. Above, an 1892 diagram shows the orbits of some of the asteroids discovered in the 'void.'

In 1800, all astronomers knew what a planet was. In fact, every member of the solar system could be assigned to a neat, cleanly defined category. The Sun itself obviously was unique, by far the biggest and brightest object in the solar system. Planets were fairly large spherical bodies that orbited the Sun on nearly circular orbits; at the time, there were seven known planets. Moons were objects that orbited planets; there were 14 known moons, including Earth's Moon. Finally, comets were small objects orbiting the Sun, distinguished by their highly eccentric, tilted orbits, their fuzzy appearance through a telescope, and their long, glowing tails.

Although the number of categories was small, during the eighteenth century astronomers had been busy looking for fresh examples of planets, satellites, and comets. Most spectacularly, on March 13, 1781, William Herschel discovered what he at first described as a "nebulous star or perhaps a comet." A few nights of observation revealed that it was moving perceptibly, and thus could not be a distant star. For months, however, astronomers debated whether Herschel's object was a comet or a planet. Further observations resolved the debate by revealing that the new object was on a nearly circular orbit beyond that of Saturn; at that distance, to appear "nebulous," rather than as a simple point of light, it had to be bigger than Earth. The new object was definitely a planet.

The new planet, which eventually was named Uranus, vaulted Herschel to fame. Previously, he had been a professional musician in the resort town of Bath. After the discovery of Uranus, however, he was elected to the Royal Society and King George III appointed him to the newly created post of King's Astronomer.

The fame and (modest) fortune that came to Herschel inspired other astronomers to search for planets. One obvious place to look was in the large gap between Mars and Jupiter. It was possible that a planet in the gap might have gone unnoticed if it were particularly small or dark. One assiduous and systematic planet hunter was an Austrian baron named Franz Xaver von Zach. A prominent and widely traveled astronomer, with memberships in many of Europe's scientific societies, von Zach was ideally placed to organize what he called the "Himmels Polizei," or "celestial police." A group of two dozen astronomers divided the zodiac — those constellations that the Sun travels through — into sectors 15 degrees across, and each pledged to scour his own sector for the possible missing planet between Mars and Jupiter.

1781 William Herschel discovers Uranus

1801 Piazzi discovers Ceres

1802 Herschel coins term 'asteroid'

1846 Adams and Leverrier discover Neptune

1867 Daniel Kirkwood suggests that Jupiter's gravity prevented the chunks of debris known as the asteroids from coalescing to form a planet between Jupiter and Mars

1868 100th asteroid discovered

Despite von Zach's organizational skills, the celestial police were beaten to the goal by a most unlikely rival: an Italian monk named Giuseppe Piazzi who had not become an astronomer until after his fortieth birthday.

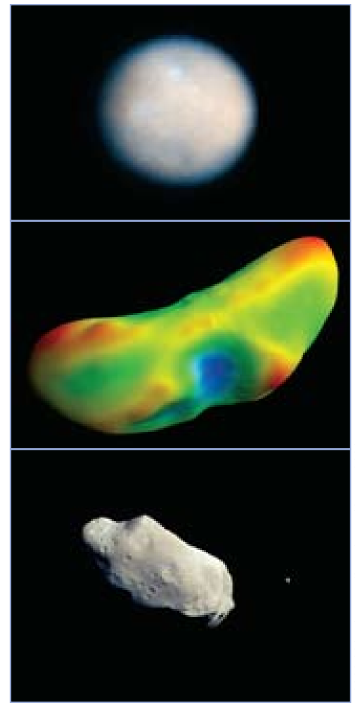
Piazzi was born in 1746 in the Valtelline Valley of the Alps, near the present boundary between Switzerland and Italy. Piazzi was the ninth of 10 sons, and followed a traditional career path for younger sons: He entered the church, becoming a monk of the Theatine Order. Since Piazzi was a talented scholar, with a particular taste for mathematics, his superiors sent him to teach math, philosophy, and theology at universities throughout Italy. Piazzi was summoned to Sicily in 1780 to become professor of mathematics at the Academy of Palermo. Despite his lack of astronomical background, he was appointed to the Academy's sole chair in astronomy in 1787 (apparently because no outside candidates were willing to move to Sicily, which then was regarded as a scientific backwater).

Entrusted with the task of founding an observatory at Palermo, Piazzi pursued the job with vigor. He traveled to England to purchase astronomical instruments from the legendary optician Jesse Ramsden of London. While Piazzi was in England, it was natural for him to make an astronomical pilgrimage to the observatory of William Herschel at Slough. Herschel and his sister, Caroline, demonstrated their observational techniques to the inexperienced Piazzi. Although Piazzi learned a great deal from his stay with the Herschels, it was not without cost. As Caroline wrote in her idiosyncratic spelling, "poor Piazi did not go home without getting broken cheenes [shins] by falling over the rack-barr which projects in high altitudes in front of the telescope." Nursing his injured legs, Piazzi returned to Sicily with one of Ramsden's finest transit circles, an instrument capable of measuring stellar positions with great precision.

With the transit circle installed at the new Palermo Observatory, Piazzi started compiling a catalog of stars. With state-of-the-art instrumentation, at a location farther south than any other European observatory, Piazzi was able to provide a unique service to astronomers by providing accurate star positions far into the celestial southern hemisphere. Piazzi diligently observed each star several times to reduce observational error.

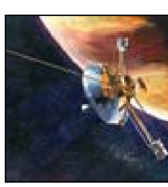
On the evening of January 1, 1801, Piazzi saw a star in Taurus not listed in the star catalog he was working from. He duly noted its location on the sky, not doubting it was an ordinary star. On the next evening, however, when Piazzi went back to double check its location, the "star" had moved, leading Piazzi to suspect it was a comet. Suspicion was converted to certainty on the following nights, when he saw the object continue to move. By January 24, Piazzi was confident enough of his discovery that he went public, sending letters to a number of fellow astronomers. In one letter, he wrote, "I have announced this star as a comet, but since it is not accompanied by any nebulosity … it has occurred to me several times that it might be something better than a comet."

By the middle of February, Piazzi's object had moved too close to the Sun to be observed. Piazzi computed a tentative orbit for his discovery; the orbit was consistent with being circular, and was located between the orbits of Mars and Jupiter. By the definition in use at the time, Piazzi had undeniably



NASA/ESA/J. PARKER (SWRI), JHU/APL, NASA/JPL

Asteroids Ceres, Eros, and Ida (with moon Dactyl).



1923 — 1,000th asteroid discovered, named Piazzia

1930 — Tombaugh discovers Pluto

1972 — Pioneer 10 is first spacecraft to pass through the asteroid belt

1980 — Walter and Luis Alvarez suggest that an asteroid impact killed the dinosaurs

1991 — First close encounter with an asteroid: Galileo at Gaspra

2001 — NEAR spacecraft lands on asteroid Eros

2005 — Brown discovers Eris

2006 — IAU develops new definition of planet, coins term 'dwarf planet'

NASA (5), NMSU, CALTECH

discovered a planet. As a compliment to Sicily and its king, he named the planet Ceres Ferdinandea. Ceres was an ancient Roman goddess of agriculture, closely associated with the fertile island of Sicily; the tag "Ferdinandea" was a tribute to King Ferdinand III of Sicily. Although the name Ceres was soon accepted, since it matched the mythological Roman names of the other planets, the suffix "Ferdinandea" was rejected by non-Sicilian astronomers.

Von Zach and his fellow celestial policemen, because they were fully prepared to observe new planets, were quick to recover Ceres when it emerged from behind the Sun. Von Zach and his young colleague Wilhelm Olbers independently found Ceres at the predicted position, confirming that its orbit was mildly noncircular (with an eccentricity equal to that of Mars' orbit) and mildly tilted with respect to the Sun's path across the sky, called the ecliptic (with an inclination slightly greater than that of Mercury's orbit).

For a while, Piazzi reveled in the distinction of being only the second astronomer to discover a planet. It was not to last; less than three months after recovering Ceres, Olbers found yet another object in the gap between Mars and Jupiter. The new object, which Olbers named Pallas, had an orbit that was similar in size to that of Ceres but which was even more eccentric and more inclined to the ecliptic. When writing about the orbit of Pallas, however, Olbers had to relieve his feelings with multiple exclamation points: "What a great unexpected inclination! and how curious its position with regard to Ceres! The two cross each other like the interlocked rings of a chain."

The discovery of Ceres and Pallas caught the attention of William Herschel. Herschel estimated the angular sizes of Ceres and Pallas by comparing them to the apparent size of a small illuminated disk placed at the far end of his garden. Herschel concluded from his measurements that Ceres had a diameter of 162 miles (260 km) and Pallas had a diameter of 110 miles (178 km). Herschel underestimated the actual sizes: the true diameter of Ceres is 595 miles (957 km), while that of Pallas is 325 miles (524 km). Nevertheless, Herschel had pointed out something quite true: Ceres and Pallas are tiny compared to Mercury, the smallest planet known prior to their discovery. Mercury is more than five times greater in diameter, and 130 times greater in volume, than Ceres.

In a paper read to the Royal Society on May 6, 1802, Herschel pointed out the odd natures of Ceres and Pallas. Their orbits were more eccentric and more inclined than those of typical planets, but less eccentric and less inclined than those of typical comets. Similarly, Ceres and Pallas were tiny compared to planets, but large compared to comets. Herschel concluded, "Since, therefore, neither the appellation of planets, nor that of comets can with any propriety of language be given to these two stars [Ceres and Pallas], we ought to distinguish them by a new name." Since the appearance of Ceres and Pallas, even in Herschel's excellent telescope, was similar to that of a star, Herschel's proposed name for this new class of object was *asteroid*, meaning "star-like."

Some astronomers quickly adopted the term. Olbers wrote to Herschel, saying, "I agree with you, honored Sir, in your sagacious suggestion that Ceres and Pallas differ from the true planets in several respects, and the name asteroid seems to me to fit these bodies very well." However, Piazzi also wrote to Herschel. In a respectful letter to his astronomical mentor, he ventured to ask, "Could we not call these little planets planetoids? To me, the name asteroid seems more appropriate for little stars." Piazzi was doubtless correct that planetoid would have been a less confusing term than asteroid. However, when two additional small bodies, Juno and Vesta, were discovered between Mars and Jupiter, the need for a collective label for these small planets was acknowledged; the prestige of William Herschel made the label "asteroid" emerge as the winner.

However, as late as the year 1838, when Herschel's son John wrote a widely used astronomy textbook, the term "asteroid" was not in universal usage. John Herschel simply referred to the solar system as containing 10 planets besides Earth: the zodiacal planets Mercury, Venus, Mars, Jupiter, Saturn, and Uranus plus the ultra-zodiacal planets Ceres, Pallas, Juno, and Vesta. John Herschel nowhere used his father's word "asteroid."

By 1865, when John Herschel issued an expanded version of his textbook, things had changed. After a decades-long lull, there had

WILLIAM K. HARTMANN/UCLA

A New Dawn

Scheduled for launch this summer, Dawn will travel to the asteroid belt to rendezvous with Ceres and Vesta. These two asteroids are among the largest, and have widely different characteristics. Dawn will reach Vesta in 2011, and study its lava flows, deep crater, and other surface features for several months. It will then travel on to Ceres, reaching it in 2015 to study its more pristine surface and look for icy polar caps. Comparisons of the two asteroids should help astronomers understand the transition from the rocky inner regions to the icy outer regions of the solar system.

been a fresh outburst of asteroid discoveries starting in the year 1845. By the time Herschel revised his textbook, there were over 50 asteroids known.

Although Herschel referred to the solar system as containing more than 50 planets, he qualified this statement by stating that most of them belonged to "a peculiar and very remarkable class or family of planets to which the name Asteroids has been assigned."

By the 1860s, the name "asteroids" had come into wide use, but an asteroid was still thought of as a type of (admittedly small) planet, just as a chihuahua is a type of (admittedly small) dog. With new techniques for photographic detection of asteroids, the list of known asteroids started ballooning at the end of the nineteenth century. The general public, overwhelmed by the number of new asteroids, regarded them as being of secondary importance compared to the eight real planets (including Neptune, discovered in 1846).

'Since, therefore, neither the appellation of planets, nor that of comets can with any propriety of language be given to [Ceres and Pallas], we ought to distinguish them by a new name.'

By 1930, dozens of asteroids were being discovered each year. However, when Clyde Tombaugh discovered Pluto in the spring of 1930, it obviously was not a dime-a-dozen asteroid. It lay beyond the orbit of Neptune; although it appeared as only a pinpoint of light in Tombaugh's discovery photographs, to be readily visible at such a great distance, it had to be bigger than Ceres. Rather than create a new class of objects just for Pluto, it was decided to declare Pluto the ninth (major) planet.

This decision was made easier by early overestimates of Pluto's size. The respected astronomer Gerard Kuiper, for instance, measured Pluto's diameter to be 3,700 miles (5,900 km), bigger than Mercury. Although Pluto's diameter was later revised dramatically downward to only 1,485 miles (2,390 km), Pluto remained in the "Planet Club" partly due to tradition, but partly due to a lack of an alternate label. Pluto's orbit is moderately eccentric and inclined, like that of an asteroid, but it lies far outside the asteroid belt between Mars and Jupiter. It is larger than Ceres, but smaller than Mercury.

The lonely, odd status of Pluto began to be revisited starting in the 1990s, with the discovery of additional icy bodies in the region beyond Neptune. These trans-Neptunian objects have a range of sizes; it was only a matter of time until one was found that was bigger than Pluto. The discovery of the object Eris by Michael Brown and collaborators in 2005 brought matters to a head. Eris is slightly larger than Pluto. Should Eris be labeled the tenth major planet, astronomers asked, or would it be more useful to create a new category, just as William Herschel created the category "asteroid" in 1802?

To the dismay of headline writers across America, who talked of the "demotion," "disgrace," or "banishment" of Pluto, the International Astronomical Union decided to apply the new label "dwarf planet" to Eris, Pluto, and Ceres. To qualify as a dwarf planet, rather than simply a garden-variety comet, asteroid, or piece of space junk, an object must be large enough to be squashed into a spherical shape by its own gravity. Ceres, the largest of the asteroids, is massive enough to be compressed to a spherical shape; the remaining asteroids, it seems, are not. Note that the category "dwarf planet" is not exclusive; it can overlap with other categories. Ceres, for instance, is both an asteroid and a dwarf planet. Eris and Pluto are both trans-Neptunian objects and dwarf planets.

All human-made categories, of course, are provisional. Astronomers are still debating where the boundary between a planet and a dwarf planet should be drawn. Learning more about extrasolar planetary systems, and how planets form in general, will help us to make more useful categories for sorting out celestial objects. In the meantime, a word to Pluto-lovers everywhere: Being a dwarf is no disgrace. There are more dwarf stars in the Milky Way than giants, and more dwarf galaxies in the universe than any other kind. Time will tell how many dwarf planets are hiding in the darkness of the outer solar system.

Barbara Ryden is an associate professor of astronomy at Ohio State University and a frequent contributor to StarDate *magazine.*

RESOURCES

Internet

StarDate Guide to the Solar System
stardate.org/resources/ssguide

DAWN mission
dawn.jpl.nasa.gov

NEAR mission
near.jhuapl.edu

Discovery of Eris
gps.caltech.edu/~mbrown/planetlila

New Horizons mission
pluto.jhuapl.edu

Books

Asteroids, a History by Curtis Peebles, 2000.

The Herschel Chronicle by Constance A Lubbock, 1933.

Is Pluto a Planet? by David A. Weintraub, 2006.

Sky Calendar

by Alan MacRobert

As if to brighten the dying weeks of winter, Venus shines brilliantly in the western twilight. I can almost imagine Venus as a second, tiny sun coming into view after the real Sun sinks below the horizon — as if Earth were in a double-star system. That's not implausible. For an actual twin of the Sun to shine in our sky with the same brightness as Venus, it would have to be half a light-year away, 30,000 times farther than the Sun. Some very wide binary stars indeed match those specs.

MARCH 1 - 15

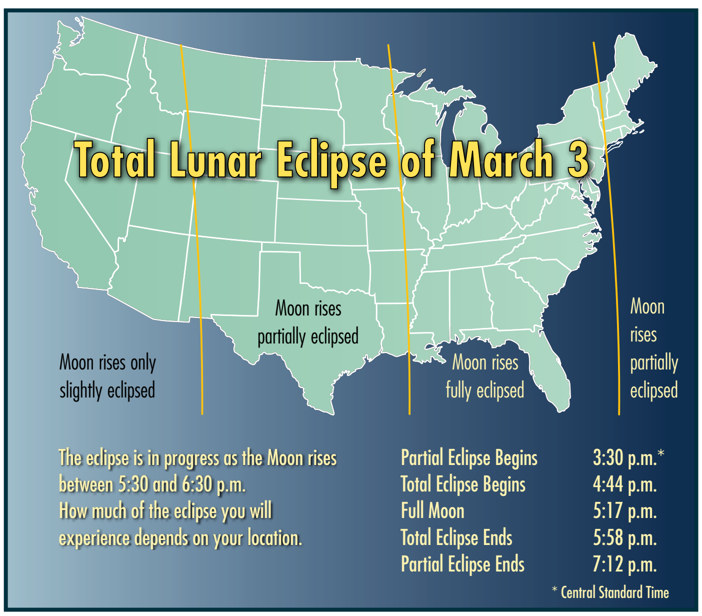
After Venus, Sirius is next in brightness these evenings, shining higher in the south as twilight fades and Venus gets lower. Sirius is 8.6 light-years from the Sun and no relation at all. Not only is Sirius much too distant to stay gravitationally bound to the Sun in our busy stellar neighborhood, it's also moving too fast, passing through our region on a different trajectory. Still, it's the closest naked-eye star that's visible from north temperate latitudes.

Look above Sirius by about two fist-widths at arm's length, and a bit to the left in early evening, for Procyon. This is another nearby stellar neighbor at 11 light-years, passing through in a different direction.

Sirius and Procyon are the Big and Little Dog stars, respectively, in the constellations Canis Major and Canis Minor. Purely by coincidence, Sirius and Procyon are each orbited by tiny white-dwarf stars: dense stellar cinders left behind after the death of a binary companion that, hundreds of millions of years ago, must have outshone each.

The yellowish planet Saturn glows farther left of Procyon, with lesser Regulus underneath it. Regulus is 77 light-years away. This is a more typical distance for bright naked-eye stars, though their range of distances is pretty huge. Orion is two fists to the upper right of Sirius. The three stars of Orion's Belt, in the constellation's middle, are almost horizontal. The belt stars are roughly 1,500 light-years from us.

On the other hand, Saturn, as a member of our solar system, is just a stone's throw (or literally a spacecraft's throw) away: It's 70 light-minutes from Earth just now.



MARCH 16 - 31

The divide between winter and spring, which comes on March 20 this year, is symbolized by the divide between bright winter constellations now in the west after dark and milder spring constellations in the east.

Orion leads any list of winter star groups. It's still high in the southwest after twilight's end. To the right of Orion, by about two fist-widths, is orange Aldebaran in Taurus. The fingertip-sized Pleiades star cluster is to the right of Aldebaran, but not as far. On March 22 the crescent Moon pairs up with the Pleiades for a beautiful evening decoration.

Bright Capella shines high above the Pleiades and a bit to the right in its wintry constellation Auriga, the charioteer. Gemini is higher above Orion, headed by Pollux and Castor at its top. Brilliant Sirius in Canis Major is to the left of Orion by two fists. Procyon in Canis Minor is a similar distance above Sirius.

All these winter groups are wheeling down toward the west. Watch them decline and set during the course of the night, and during the course of the spring.

Turn east after dusk to find a different celestial landscape coming into view.

The Big Dipper is standing on its handle high in the northeast, beginning its warm-weather tip-over to the left. Its handle curves around to point more or less toward bright Arcturus, shining low in the east a little more than a dipper-length away.

Saturn glows with a steady light high in the southeast, with lesser Regulus a little more than a fist to its lower left. Regulus is the forefoot of Leo, the lion, which marches across the sky all spring.

To the lower right of Leo is the front of dimmer Hydra, the sea serpent. Hydra's brightest star is Alphard, the creature's orange-red heart, about three fists to the lower right of Saturn and Regulus.

APRIL 1 - 15

How big and bright Venus has become! It shines a little higher in the western twilight every week, grabbing attention ever more insistently. It stays visible in the west for quite a while after darkness falls. On the evenings of April 10-12, Venus passes just to the left of a more delicate ornament of the western dusk: the Pleiades.

Saturn remains the other evening planet. It's now crossing high in the south after dark, with Regulus trailing to its left or lower left.

To spot any other planets, you must wait up until after midnight or 1 a.m. That's when Jupiter comes up in the southeast. It's second in brightness only to Venus (which by then has long since set). Jupiter is accompanied by fire-orange Antares twinkling to its right by a little more than a fist-width. By dawn, Jupiter is at its highest in the south, with Antares now to its lower right.

Back in the evening sky, Orion and company are rapidly tilting and descending in the west week by week. Arcturus is rapidly rising in the east. Each week advances the turning of the starry sky by the equivalent of about half an hour. In other words, the stars at 9:30 tonight look the same as they will at 9 a week from now. This is why the constellations change from season to season.

But early spring brings a strange twist to this steady progression. It seems to speed up. If you miss just a few weeks of skywatching, the whole scene looks different when you come back. The reason is that sunset and nightfall come later and later, making you do your star-watching at an ever-later hour. So, if you go out right after dusk, you're looking ever later by the clock, which makes the seasonal sky changes appear to happen oddly fast.

The payback, of course, comes on the other side of the year. In late summer and early fall, you see the stars come out sooner in the evening as the Sun sets at an earlier hour, so the seasonal turning of the constellations seems to slow almost to a standstill.

APRIL 16 - 30

Venus in the west and Arcturus in the east are both heading into their fullest glory. Venus is now nearly as high as it will get during and after twilight. Arcturus, on the opposite side of the sky, is climbing faster. It shines ever higher at nightfall and continues to ascend as the evening grows late.

Look three fists to the lower right of Arcturus for Spica, number two in brightness on this side of the sky. Closer to the right of Spica, look for the four-star pattern of the constellation Corvus, the crow.

High in the northeast, the Big Dipper is turning over now as if dumping water on the springtime world. Its upside-down bowl is to the left, and its bent handle is to the lower right. The star at the handle's bend is a famous skywatching curiosity. This is Mizar, accompanied by faint Alcor tucked right next to it. If you have normal or well-corrected distant vision you should be able to make out Alcor fairly easily. It's currently just under Mizar.

Keep an eye on the northeast horizon, very far below the Big Dipper. That's where the summer star Vega rises after dark. By late evening Vega is well up in good view, matching Arcturus for brightness once it gets up out of the thick layers of atmosphere near the horizon. Arcturus and Vega will shine as the two brightest stars of summer.

If your sky is reasonably free of light pollution, you can try for a special spring sight: the huge but dim star cluster forming the constellation Coma Berenices, the hair of Queen Berenice. As star clusters go, it would be unremarkable except for one thing: it is one of the nearest to Earth, only 300 light-years away. So it looks to the unaided eye the way many clusters look in a telescope.

The Coma Cluster's location is easy enough to find. It's at the point forming an equilateral triangle with Arcturus and the end star of the Big Dipper's handle, to their right. If your sky is good and dark you will see a hazy, speckled glow half as wide as your fist held at arm's length.

Two smallish star patterns that are not quite so dim line up along the route from Arcturus to Vega. The first of these, a third of the way along, is the constellation Corona Borealis, the northern crown. It's a tiara-like semicircle with one bright gem, called Alphecca or Gemma, near its middle. The open side of the semicircle is currently to the upper left.

Two-thirds of the way from Arcturus down to Vega is the four-star Keystone star pattern in Hercules. This marks the midsection of Hercules, a big constellation whose stars can be connected to form a kneeling strongman wielding a club. The Keystone is most famous for harboring the great globular star cluster M13 in its western (currently upper) edge. Binoculars show M13 as a tiny, dim fuzzball among the stellar pinpoints. A large amateur telescope begins to resolve it into a sugarpile of thousands of faint and distant stars. Summer will find it passing high overhead.

Alan MacRobert is a senior editor of Sky & Telescope *and* Night Sky *magazines.*

Binocular Vision

N.A.SHARP/REU PROGRAM/NOAO/AURA/NSF

M13, The Hercules Cluster

In mid-April, look about 30 degrees above the east-northeast horizon around 10 p.m. Hercules will be lying on his side far below the Big Dipper, whose handle is pointing down to him. Train your binoculars on Hercules' topmost star, Eta Herculis. Within your field of view, just to the right and somewhat below Eta's bright pinpoint, you will find the great globular star cluster M13. (Locate it using the maps on the next two pages.) It will look like a fuzzy ball. This cluster of more than 100,000 stars is about 150 light-years wide and 20,000 light-years away.

Meteor Watch

The Shower

Lyrids

Named for the constellation Lyra, the harp, which is notable for its brightest star, Vega, the third-brightest nighttime star visible from most of North America.

Peak

April 22

Notes

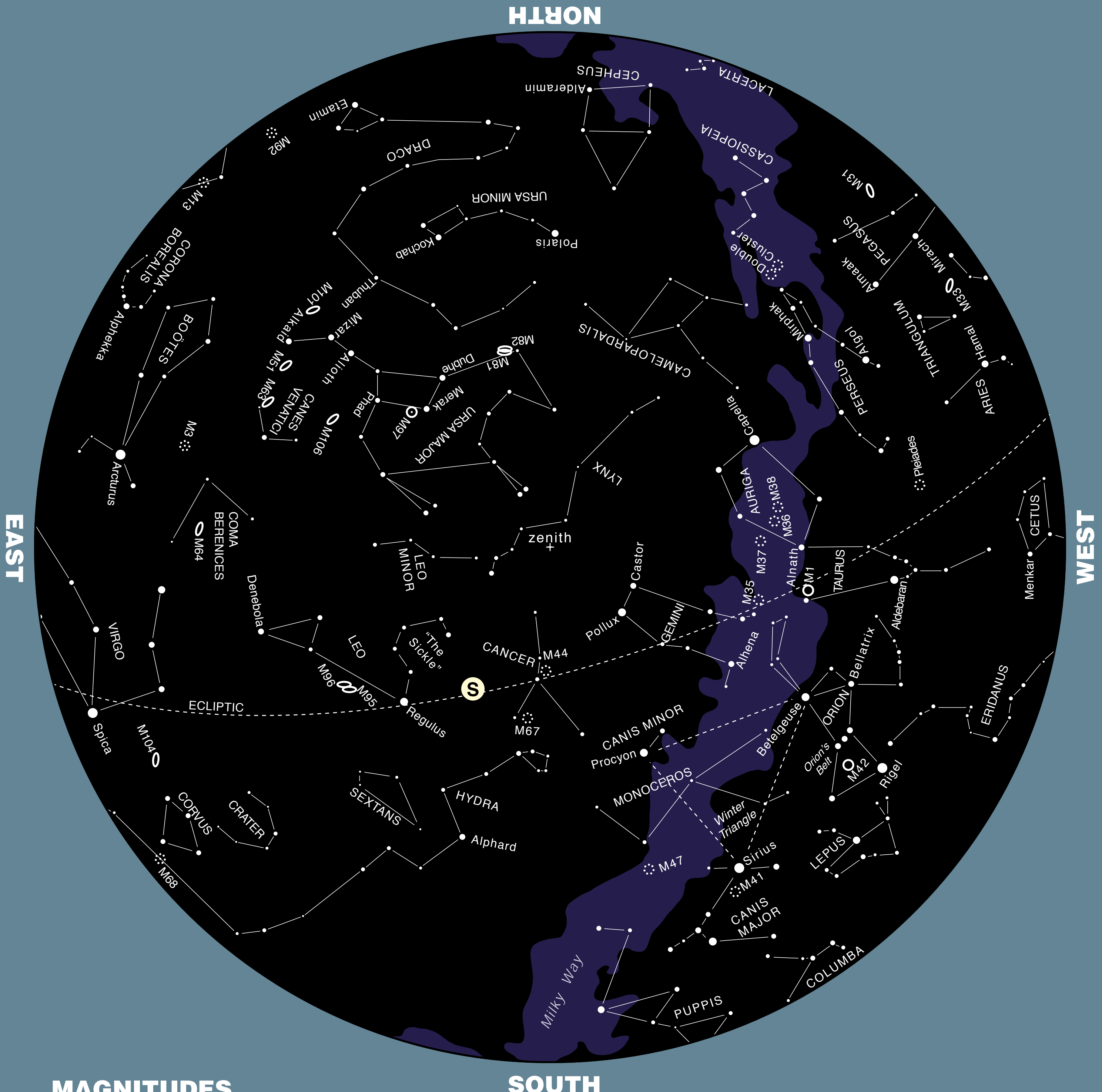
The first-quarter Moon sets by midnight or 1 a.m., leaving several hours of good meteor watching before dawn. This is an unpredictable shower, with peaks of a few to a few dozen meteors per hour.

MARCH

How to use these charts:
1. Determine the direction you are facing.
2. Turn the chart until that direction is at the bottom.

February 20	**11 p.m.**
March 5	**10 p.m.**
March 20	**10 p.m.***

*Daylight Saving Time



MAGNITUDES

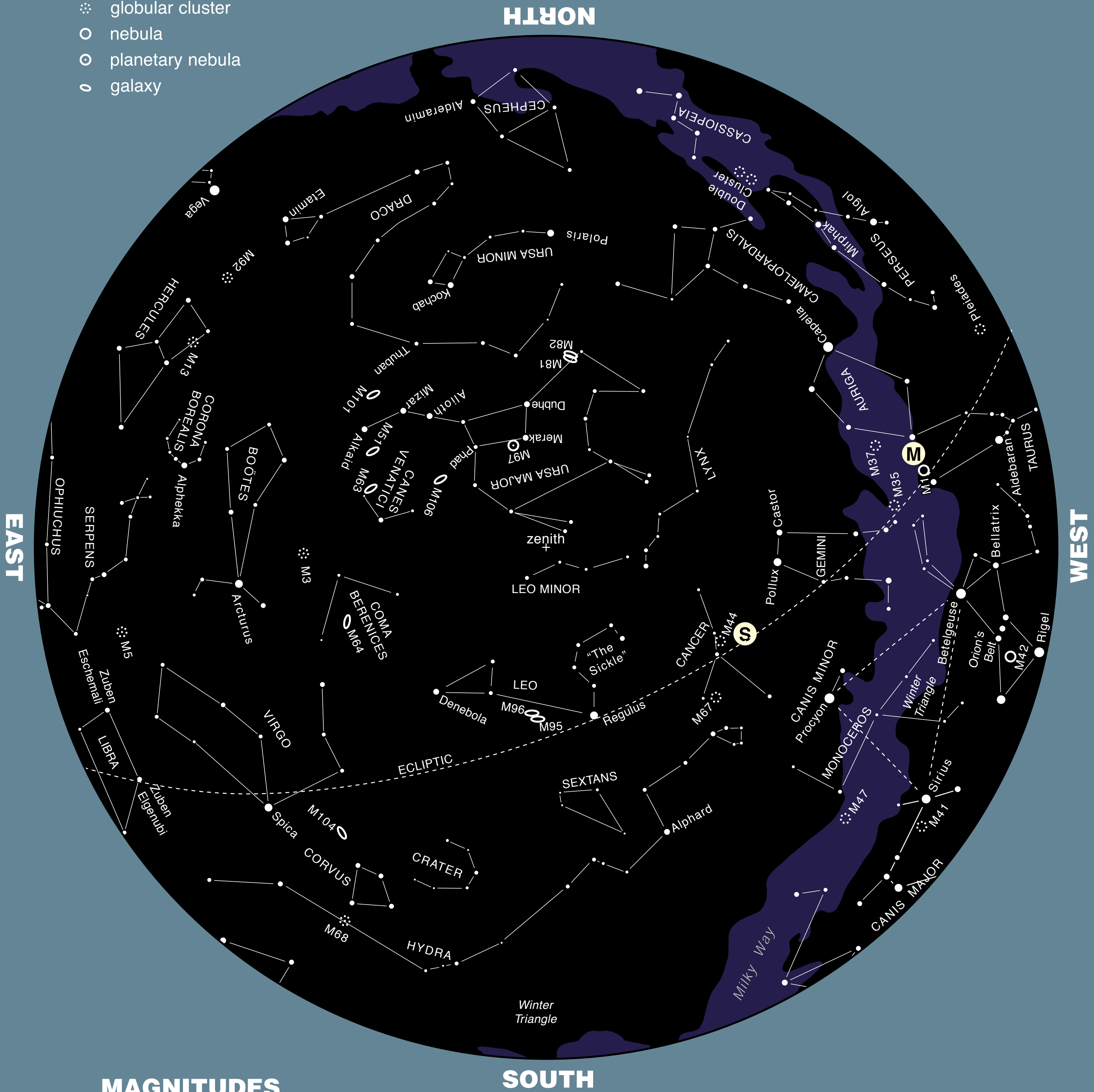
- 0 and brighter
- 1
- 2
- 3
- 4 and fainter

Charts produced with Voyager II software.

APRIL

March 20	**11 p.m.**
April 5	**10 p.m.**
April 20	**9 p.m.**

- M Mars
- S Saturn
- open cluster
- globular cluster
- nebula
- planetary nebula
- galaxy



MAGNITUDES

- 0 and brighter
- 1
- 2
- 3
- 4 and fainter

Sky Highlights

by Alan MacRobert

MARCH

1 Saturn shines close to the Moon tonight. Watch the separation between them change hourly as the Moon moves eastward.

2 Saturn shines above the bright Moon this evening. Regulus is much closer above the Moon.

3 Full Moon, called the Egg Moon.

There is a total eclipse of the Moon for eastern North America early this evening. The total eclipse begins at 4:44 p.m. and ends at 5:58 p.m. CST. The partial eclipse ends at 7:12 p.m.

6 Look for Spica close to the waning gibbous Moon late this evening.

The Moon is at apogee.

11 Daylight Saving Time begins at 2 a.m. except in Hawaii and most of Arizona. Clocks "spring forward" an hour. Starting this year, daylight time in the United States begins on the second Sunday in March and ends on the first Sunday in November.

12 Before and during dawn, Jupiter is to the upper right of the Moon in the south, and Antares to the lower right of Jupiter.

18 A partial eclipse of the Sun is visible from northwestern Alaska and from eastern and central Asia except most of Japan.

The Moon is at perigee. The Moon's orbit is elliptical, so the Moon's distance from Earth varies by about 30,000 miles (50,000 km).

20 The vernal equinox occurs at 7:07 p.m. CDT. This is when the Sun crosses the equator heading north for the year, marking the start of spring in the northern hemisphere.

Look west in twilight for Venus, the "evening star," shining to the upper left of the Moon.

21 Venus shines below the Moon in the west this evening.

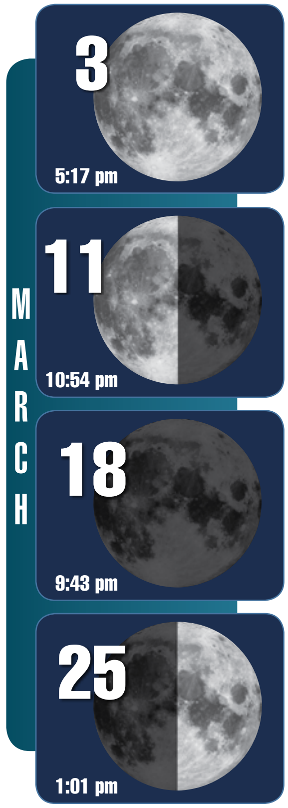
Mercury is at greatest elongation, 28 degrees west of the Sun in the dawn sky. Using binoculars, scan for it just above the east-southeast horizon 30 or 40 minutes before sunrise. Don't confuse it with Mars, which is to its upper right by more than a fist-width at arm's length.

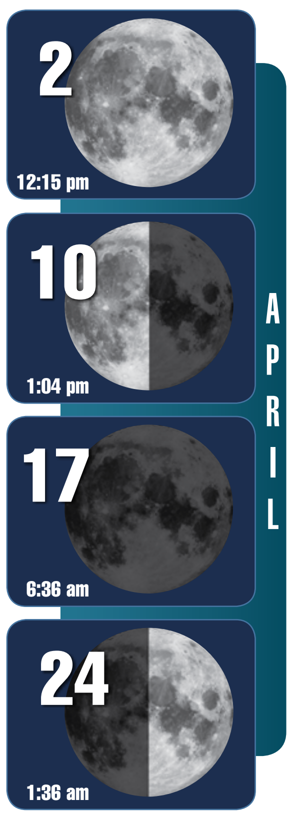
22 This evening Venus shines far below the Moon. The Pleiades is close above the Moon.

26 Look for Castor and Pollux near the Moon.

28 Saturn shines very close to the Moon. Regulus is to their lower left.

29 Regulus' shines close to the Moon. Saturn glows to the Moon's upper right.





APRIL

2 Full Moon, called the Milk Moon. Spica shines to its lower left. Bright Arcturus is much farther to their left.

3 This evening Spica shines above the Moon (which is at apogee, its farthest from Earth for the month).

7 As dawn begins, the Moon shines in the south with bright Jupiter to its upper left. Orange Antares much closer to the Moon.

8 Jupiter shines above the Moon before and during dawn.

10 Venus is passing just 2 degrees south (lower left) of the Pleiades this evening and tomorrow evening, forming a lovely sight.

13 Spot the waning crescent Moon in the southeast during early dawn. Then look for faint little Mars roughly a fist-width at arm's length to the Moon's left and a bit below. Mars looks so small and faint because it's on the far side of its orbit from us.

17 The Moon is at perigee, its closest to Earth for the month.

18 The thin waxing crescent Moon hangs low in the west-northwest in twilight, with bright Venus to its upper left. Between them, look for the Pleiades.

19 Mark your calendar for this one: Venus and the crescent Moon shine together in the west in twilight, with Aldebaran to their left and the Pleiades to their lower right. Capella shines higher to their upper right.

20 This evening Venus is below the Moon, and Capella is farther to the Moon's right or upper right. The fainter star just above the Moon is Beta Tauri, also known as El Nath. Aldebaran twinkles 7 degrees south (lower left) of Venus.

22 The Moon is in Gemini, below Pollux and Castor, high in the west.

24 Saturn glows yellow just to the Moon's left in twilight, and to its upper left later in the night. Look below them for the head of the constellation Hydra, the water snake — a dim loop of stars about as wide as two or three fingers at arm's length.

25 Saturn is to the right of the Moon this evening. Fainter Regulus is much closer to the left of the Moon.

30 The Moon (at apogee) shines below Spica this evening. Far to their upper left is brighter Arcturus, sometimes called the "spring star."

By Dr. Chris Sneden

The Sun, Our Just-Right Star

Our Sun is a massive, fiery cauldron of gas that is more than 10,000 degrees Fahrenheit (nearly 6,000 C) at its surface and millions of degrees at its center. Its light provides the energy that makes life possible on Earth. We would not exist without this central furnace in our solar system.

But the rest of the Milky Way hardly notices us. If we traveled just 100 light-years away from the Sun, we could not see it without a telescope. Our star is actually a dull, rather dim, middle-aged, middle-mass star. Stars can be about 10,000 times less luminous than our Sun, but also can be up to one million times brighter. And stars range in mass from about 1 percent as massive to 100 times more massive than the Sun.

The Sun, like all stars, shines by releasing energy generated via nuclear fusion deep in its interior. More-massive stars are much brighter than the Sun because they consume their hydrogen fuel at a much faster rate. So they live shorter lives — much shorter — than will the Sun.

The Sun is now about 4.5 billion years old, and we expect it to live another five billion years or so. But the bright, more-massive stars like Vega and Sirius burn their fuel so fast that they may survive only for a few hundred million years. On the other hand, the least massive stars could live trillions of years — but their light output is feeble.

Picture life struggling for survival around stars at the extremes of this mass range. What if Earth orbited a massive, bright, hot star? That star probably wouldn't live long enough for life as we know it to spring up and evolve. And if life *could* occur, our planet would have to stay much farther away from the powerful parent star's ultraviolet rays to avoid frying. Finally, in relatively short order, the massive star would blow itself up as a supernova. This is probably an unhappy environment for a civilization.

What if, on the other hand, Earth orbited a very low-mass star? Lifetime is not a problem here; such a star can live almost forever. But its light output is so feeble that our planet would need to be much closer to get enough life-giving radiation. It might be so close that its rotation would be tidally locked to its revolution around the star, just as the Moon is to Earth. One side of Earth would eternally face the star, leaving the other side in endless night.

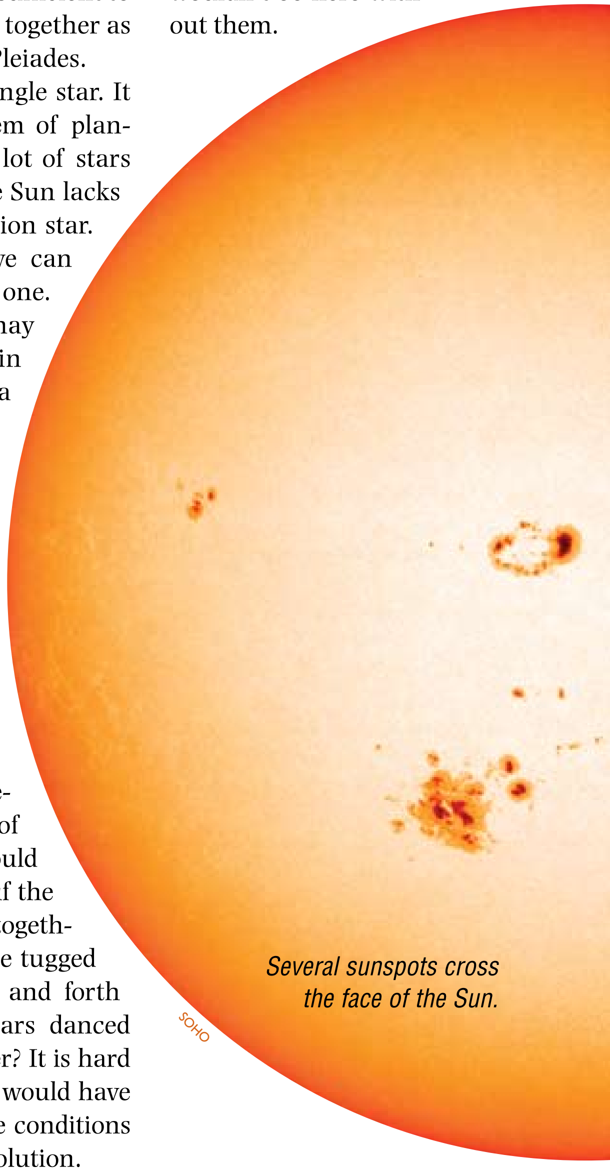
Stars apparently like to form in groups. Imagine the spectacular night sky we would enjoy if the Sun were still a member of a rich star cluster. But that is not what happened.

We don't know how many stellar births may have occurred in the Sun's birth cluster. We have little evidence today to link a particular group of nearby stars to each other and the Sun. So we guess that over time, these stars gradually drifted apart. Their mutual gravitational pull was insufficient to keep them bound together as a group like the Pleiades.

Our Sun is a single star. It has a large system of planets, but unlike a lot of stars in our galaxy, the Sun lacks a binary companion star. And as far as we can tell, it never had one. This situation may have worked in favor of creating a stable, life-giving planet Earth.

Our years and seasons would have been very different with a binary Sun. If the two stars were relatively far from each other, then Earth might simply "belong" to one of them and all would be well. But what if the stars were close together, and Earth were tugged in its orbit back and forth as the double stars danced around each other? It is hard to think that this would have fostered the stable conditions needed for our evolution.

Finally, if the Sun had been born in an earlier generation of stars in the Milky Way, we might not exist. The Sun contains trace amounts (about one percent of its atoms) of chemical elements heavier than helium. These elements that are so essential to life, like carbon, oxygen, nitrogen, iron, and others, were in short supply with the births of the first stars 10 billion to 13 billion years ago. We wouldn't be here without them.



Several sunspots cross the face of the Sun.

Dr. Chris Sneden is the Rex G. Baker, Jr. and McDonald Observatory Centennial Research Professor in Astronomy at The University of Texas at Austin.

This slice of the Johnstown meteorite, a rare achondrite, is shown magnified more than 10 times. The colors represent different minerals. Top right: The circles in this slice of the Marlinga meteorite, also magnified, show the presence of the round inclusions known as chondrules.

Running with Rockhounds

Quest to touch, own rocks from space spurs meteorite collectors the world over

By Rebecca Johnson

For billions of years, an asteroid has made its way around the Sun, orbiting in the belt between Mars and Jupiter. Until one fateful day — smash! — it careens into a neighbor, splintering into thousands of fragments. The kick of the blast sends some fragments out of the asteroid's normal orbit and toward the inner solar system. Some of these fragments will collide with Earth, and if they're hardy enough, survive their fiery descent to the ground.

Farther out, a comet orbits the Sun on its highly elliptical path. As the comet heads closer to the Sun, its nucleus of rock and ice heats up. Water and gasses escape, fanning out behind the celestial roadtripper, making multiple tails. Ice is the glue that holds the nucleus together. As it vaporizes, pieces of rock are liberated, leaving a trail of debris all along its orbit. When Earth passes through this trail, rocks fall through the atmosphere, burning brightly as "shooting stars." If the piece of leftover comet is big enough, it will survive the trip and hit the ground.

What do these fragments of asteroid and comet have in common? After their long ride to Earth, both are destined to end up on eBay for sale to the highest bidder — as meteorites.

Today, enthusiasts around the world vie for the most interesting, rare meteorites for their private collections. Clubs, magazines, and web sites abound for those rockhounds whose specimens of choice come from outer space.

It's only in the last two centuries that people realized the true nature of meteorites. According to Arthur Ehlmann, curator of the Oscar E. Monnig Meteorite Gallery at Texas Christian University in Fort Worth, "prior to 1800, people thought meteorites were Earth rocks."

A retired professor of mineralogy and geochemistry, Ehlmann has guided the collection from the time his longtime friend and Fort Worth businessman Oscar Monnig began donating his collection of about 3,000 meteorites, mostly from the southwestern United States, to TCU in the mid-1970s.

Ehlmann explains that it took "three important European falls" to convince eighteenth century scientists that space rocks could hit Earth. The first happened in 1790, near Barboton, France. The second came four years later near Siena, Italy. Finally, in 1803, a fall over Normandy dropped more than 3,000 stones from the sky. In all three cases, there were witnesses to the fall, and the stones were found on the ground afterward.

Additionally, German scientist Ernst Friedrich Chladni wrote a report in 1794 in which he examined the tales of "stones falling from heaven" from different cultures throughout history. Chladni is recognized today as the first scientist to uncover the true nature of meteorites.

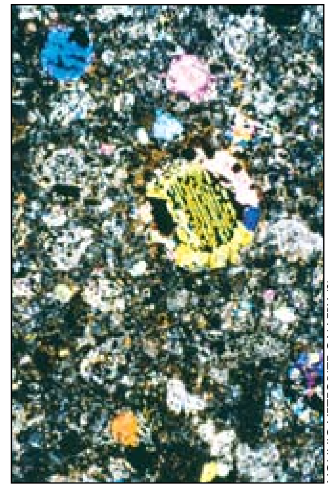
Not everyone was convinced, however. When a fireball exploded over Connecticut in 1807, and two scientists from Yale collected the fallen stones, Thomas Jefferson reportedly quipped, "I can more easily believe that two Yankee professors would lie than that stones would fall from heaven."

In the 200 years since, amateur astronomers and scientists have recorded dozens of meteor showers. Meteorite collectors are on the lookout constantly for the rocky fruits of these celestial lightshows.

A combination of astronomy, atmospheric science, chemistry, and geology have taught us why meteorites look the way they do, and where they come from.

A meteorite enters the atmosphere at tens of thousands of miles per hour. Friction quickly slows its descent, and erodes its outer layers. But as the rock sinks through the atmosphere, it soon hits thicker air and its molten surface freezes. "It's colder than sin up there," Ehlmann explains. This process of melting followed by freezing forms a black outer layer on a meteorite, called a fusion crust.

But to really know what kind of meteorite



MONNIG METEORITE GALLERY (2)

you've got, it must be sliced open to see beneath the fusion crust to study the composition within.

MONNIG METEORITE GALLERY, PHOTOGRAPHS BY GEOFFREY NOTKIN/AEROLITE.ORG (3)

The three types of meteorites. Top: Stony meteorite from New Mexico. Middle: Pieces of an iron meteorite from Russia. Bottom: Small piece of a two-ton stony-iron meteorite with peridot inclusions from Kansas.

Scientists classify meteorites into three main groups based on their composition: stony, iron, and stony iron. Ehlmann explains that the different types of meteorites come from different parts of an asteroid that has broken up due to a collision. "Asteroids have an iron-nickel core and silicates on top," he says.

Stony meteorites are pieces of the top layer of an asteroid. There are two types of stony meteorites, according to whether they contain the circular structures called chondrules. Stony meteorites with chondrules are the most common meteorites of all, and thus are called ordinary chondrites. But really, chondrites are anything but ordinary — at 4.5 billion years old, they are "one of the oldest things in the solar system," Ehlmann says.

Stony meteorites without chondrules are called achondrites, and are much more rare. In these, "the chondrules have been melted or metamorphosed in a squeezing or collision or something," Ehlmann explains.

The next major category, irons, come from the core of an asteroid that broke into pieces in a collision. These are the heaviest meteorites.

Finally, the stony irons are a mix — they are "core-mantle boundary materials," Ehlmann says, and are "the beauty queens of the meteorite world." They include crystals like the mineral olivine or the gemstone peridot.

Meteorites appeal to collectors not only because of their beauty, but also because they carry material left over from the formation of our solar system.

"For me, it's that you're touching history from billions and billions of years ago, part of the debris from when the planets were first forming," says Kevin Kilkenny, meteorite and fireball coordinator for the North American Meteor Network (NAMN). "The second thing is that this was out in space.... That is awesome."

Meteorite collecting is a worldwide hobby. Collectors can be found at gem and mineral shows, in amateur astronomy clubs, and online.

Kilkenny's organization has 660 members who watch meteor showers and record the numbers of meteors they see and other factors like brightness and direction of travel. The members come together online to discuss the hobby and to report their data. NAMN collects the data and submits them to the International Meteor Organization (IMO), which combines observations from meteor-watchers all over the world.

IMO uses the data to calculate the radiant — the point on the sky from which the meteors are coming — for a particular shower. Observations from amateur observers worldwide, Kilkenny says, were used several years ago to discover that November's Leonid meteor shower has two peaks. The observations also have been used to figure out which comets are responsible for meteor showers recorded in past centuries.

Meteor showers sometimes lead to meteorites falling to Earth — but not always. Many meteoroids burn up in Earth's atmosphere. The best chance of finding meteorites on the ground after a meteor shower is when large meteoroids streak across the sky, creating unusually bright meteors known as fireballs. As Ehlmann puts it, "Follow the fireball."

Searching for meteorites can be difficult, Kilkenny says. "You have to know where to look. In the western states, it's easier. When you come upon it, it's completely different from any other rock in the area. And in the Antarctic or northern Canada [the meteorites, which are] black and shiny stand right out against the snow."

If you think you have found a meteorite, there are some basic questions you should address. The non-profit International Meteorite Collectors Association (IMCA) suggests these three questions:

- *Does it have a glassy black crust?*
- *Does it stick to a magnet?*
- *Is it heavier than an Earth rock of the same size?*

"If the rock passes all the tests, there's a good chance it's real," Kilkenny says. But he says the only way to be certain is to send it in to a laboratory for testing. Links to laboratories that can do the test are available at the IMCA's web site, www.meteoritecollectors.org.

A lot of Earth rocks look like meteorites, Ehlmann says. People mistake them all the time. He estimates that over the past 20 years, people have sent him about 250 supposed meteorites for testing; only two proved to be real.

There is one guaranteed way to find tiny fragments of meteorites around your own home, Kilkenny says. Tiny particles from space are constantly raining down on Earth in what might be called "micro-meteor" showers. To test this yourself, put a bucket under the rain gutter outside your home. Then use a garden hose to flush out the gutter, catching the runoff in the bucket. Then, Kilkenny says "get a real good magnet, swirl it in the water, and granules will stick to it." The magnetic granules are tiny meteorites. Eighty to 85 percent of meteorites are magnetic, Kilkenny explains.

But for most folks on the hunt for meteorites, "it's a lot easier to buy them," Kilkenny says.

Meteorites are named for where they fall, and priced per gram. Prices vary widely. Specimens from Mars in the Monnig collection are worth $27,000 per gram. "It makes gold look like dirt," Ehlmann says.

But you need not spend quite that much. For most meteorites, prices run from $1,000 a gram down to 75 cents or $1 a gram, Kilkenny says. "Buy what you can afford. Look for favorites, things that appeal to you. My first one was from Canyon Diablo, from Meteor Crater in Arizona."

Irons are the least expensive meteorites, followed by stones. Ordinary chondrites are most common, and therefore fairly inexpensive. Meteorites that contain organic material (the so-called carbonaceous chondrites) are priced higher, as are the rare achondrites.

The motto when purchasing meteorites — especially online — is *caveat emptor*, Kilkenny says. "Either knowingly or unknowingly, they'll be selling you slag — hematite or magnetite." Hematite is a red iron oxide in mineral form. In other words, a rusty Earth rock. Magnetite is a different iron oxide mineral. It's black, glassy, and magnetic, so it can easily be mistaken for a meteorite. Among collectors, these Earth-rock imposters are known as "meteor-wrongs." Kilkenny advises potential buyers to review the IMCA website, which includes a page on meteorite scams.

"If you think a deal is too good to be true, it probably is," he says. "You're not going to get a lunar meteorite or a Martian meteorite for a dollar a gram or two dollars a gram."

But it's not only meteorite scams that new collectors need to watch out for. Some genuine meteorites present special problems of their own. "Meteorites don't like living on Earth," Ehlmann says. "They've been in space, without oxygen and in vacuum for 4.5 billion years." When they are exposed to oxygen and water on Earth, some iron-containing meteorites have a problem with rust. Kilkenny says collectors need to ask, "Is it stable enough to survive outside a museum environment, on your shelf?"

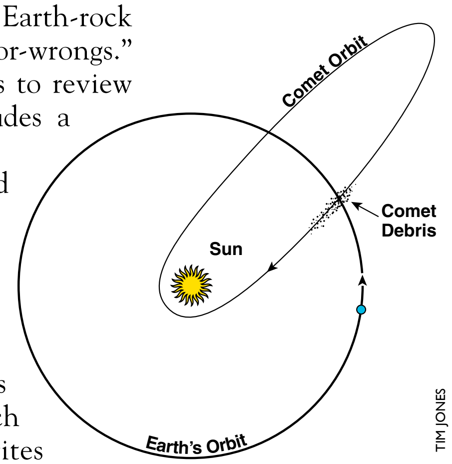
As one example, he describes the Nantan meteorites, which are named for the Chinese village near where they fell. New collectors may think they are getting a bargain at 15 to 25 cents per gram, he says, if they don't know that Nantan has been dubbed "the queen of rust" by collectors in the know. "No matter what you do, you cannot keep it from rusting to little tiny parts," Kilkenny says. A collector could buy "a piece the size of a baseball, and within a year, it falls into chips."

Ehlmann's advice on buying meteorites is much more succinct: "Have a lot of money."

If you don't want to spend a fortune, but would like to see some amazing rocks from space, he has some suggestions. In addition the Monnig in Fort Worth, he recommends the National Museum of Natural History in Washington, DC; the American Museum of Natural History in New York; and the Meteorite Museum at the University of New Mexico in Albuquerque.

So whether you decide to collect your own meteorites or visit some space rocks in a local museum, don't pass up the chance to reach out and touch these celestial messengers left over from the birth of our solar system.

Rebecca Johnson is editor of StarDate *magazine*.



TIM JONES

When our planet passes through the orbit of a comet, rocky debris along the comet's path may fall through Earth's atmosphere. The result is a meteor shower. In rare cases, meteorites fall to the ground.

RESOURCES

Internet

International Meteorite Collectors Association, Inc.
www.meteoritecollectors.org

North American Meteor Network
www.namnmeteors.org

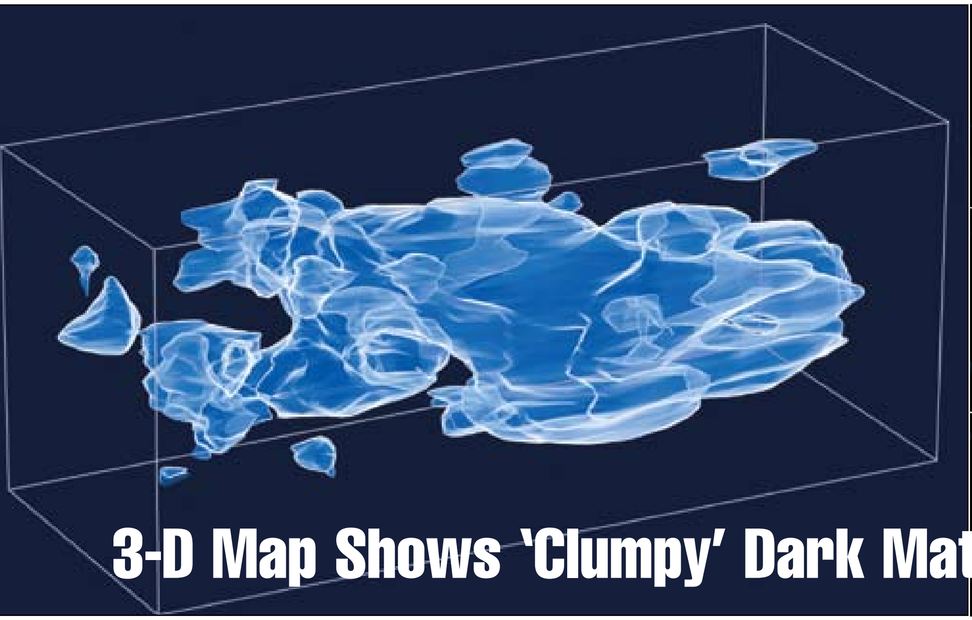
International Meteor Organization
imo.net

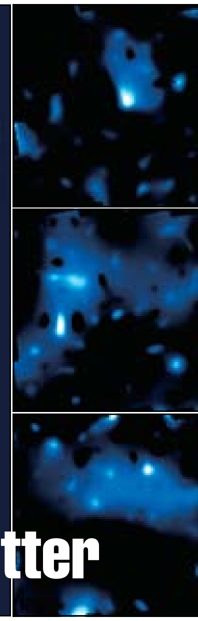
Monnig Meteorite Gallery
monnigmeteors.org

Books

Rocks from Space by O. Richard Norton, 1998.

by Rebecca Johnson and Damond Benningfield





NASA/ESA/ R.MASSEY (CALTECH)

3-D Map Shows 'Clumpy' Dark Matter

Dark matter is becoming clumpier as the universe ages, according to an international team led by Caltech astronomer Nick Scoville, which produced a three-dimensional map (above) of dark matter over the past several billion years. The map shows the more recent universe at left, with time (and therefore distance) increasing to the right.

The map shows that dark matter today forms more clumps than it did in the early universe, when it was more smoothly distributed. The gravity of the dark matter pulls it together to form the clumps.

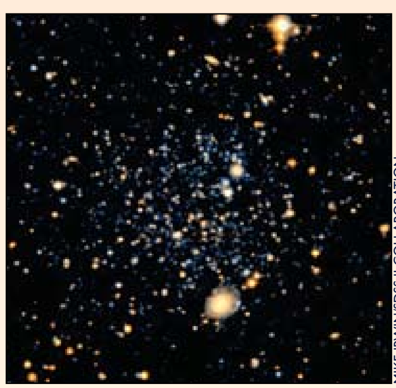
Dark matter produces no observable radiation, but astronomers detect its presence by measuring its gravitational pull on the visible stars and galaxies around it. Although most of the mass of the universe consists of dark matter, scientists have not yet determined what makes up dark matter.

The team that compiled the 3-D map photographed a large area of the sky with Hubble Space Telescope. Galaxies in the Hubble images (three samples at right) appear slightly distorted by the gravitational effects of dark matter between the galaxies and Earth.

The team measured the distances to many galaxies, which revealed how much dark matter was between Earth and each galaxy. Since distance equals time (if a galaxy is five billion light-years away, we see it as it looked five billion years ago), that allowed the team to compile a map of dark matter distribution through time. **DB**

New Neighbors for the Milky Way

A survey of a large swath of the northern sky has revealed at least seven, and possibly eight, new satellite galaxies of the Milky Way. They were discovered with the 2.5-meter telescope at Apache Point, New Mexico, which is probing the Milky Way and the space around it. Each of the new galaxies contains only a few million stars, and only one of them contains any young stars or enough gas to make more stars. The galaxies were not discovered earlier because they are small and faint, and they are hidden behind a veil of stars inside the Milky Way. The discovery gives the Milky Way more than 20 known satellites.



MIKE IRWIN/SDSS-II COLLABORATION

One of the newly discovered galaxies is a smudge of blue and orange stars. A larger spiral galaxy appears beyond it.

Gamma-Ray Oddball

Short-long or Long-short outburst may signal new way to make black holes

Black holes are the darkest objects in the universe because their gravity is so strong that not even light can escape from them. Yet the birth of a black hole may create one of the brightest objects in the universe, known as a gamma-ray burst.

An example is a burst that appeared last June 14. The flash of gamma rays, which are the most powerful form of electromagnetic energy, lasted just 1 minute, 42 seconds. In that short span, the gamma-ray burst emitted more energy than our Sun will produce in its 10-billion-year lifetime. This burst was an oddball, though, which has astronomers wondering if they witnessed a new mechanism for producing black holes.

Before the June burst, astronomers had identified two basic types of gamma-ray bursts. The first lasts less than two seconds and may occur when two neutron stars merge to form a black hole, or a neutron star and a black hole merge to form a bigger black hole. The other type of burst lasts from two seconds up to a few minutes, and probably occurs when the core of a massive star collapses, also forming a black hole.

The June outburst had some traits of each type. It lasted long enough to be a collapsing star, but it did not produce a supernova explosion, which accompanies other long-duration bursts. On the other hand, it resembled a merger event in some ways, although it lasted far too long. No matter the details, though, the outburst probably produced a black hole.

So astronomers are trying to decide what happened. Perhaps this was a collapsing star, but the star was different from others. Or perhaps the black hole swallowed the star's outer layers, preventing them from blasting into space. **DB**

Supernova Blast Illuminates Mystery of Expanding Universe

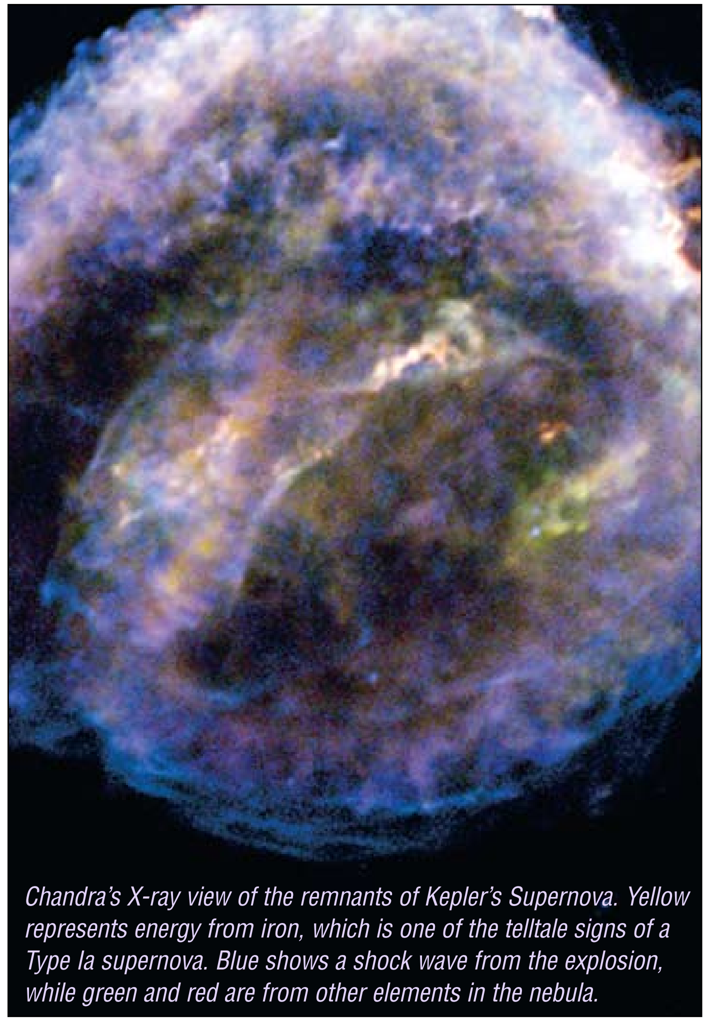
One of the great astronomical discoveries of the past decade is that the universe is expanding faster as it gets older. The discovery was based on measurements of a class of exploding stars known as Type Ia supernovae. Just how these stars work is not fully understood, though, and a recent discovery about one of the most famous Type Ia's only deepens the mystery.

The star is named Kepler's Supernova in honor of Johannes Kepler, who wrote about the star when it flared into view in 1604.

There are two basic classes of supernovae. One occurs when the core of a massive star collapses and its outer layers are blasted into space. The other occurs when a "dead" star, known as a white dwarf, steals gas from a companion star. When enough hot gas builds up on the white dwarf, it is blown to bits, creating a Type Ia.

Observations suggest that every Type Ia is the same brightness. By measuring how bright a Type Ia appears, astronomers can calculate its distance. Using distances to remote galaxies, astronomers found that the universe is expanding faster as it ages.

Recent observations with Chandra X-Ray Observatory confirmed that Kepler's Supernova is a Type Ia. But it has some of the characteristics of both types, which means that not all Type Ia's are alike. Astronomers must more fully explain how Type Ia's work to confirm that they are good yardsticks for measuring the expansion of the universe. **DB**



Chandra's X-ray view of the remnants of Kepler's Supernova. Yellow represents energy from iron, which is one of the telltale signs of a Type Ia supernova. Blue shows a shock wave from the explosion, while green and red are from other elements in the nebula.

NASA/CXC/NCSU/S.REYNOLDS ET AL.

New Satellite Launches, Hubble to Get Upgrade

The French national space agency launched the COROT satellite from the Baikonur Cosmodrome in Kazakhstan in late December. Set to search for extrasolar planets, COROT will also probe the interiors of stars by studying the sound waves their starquakes generate.

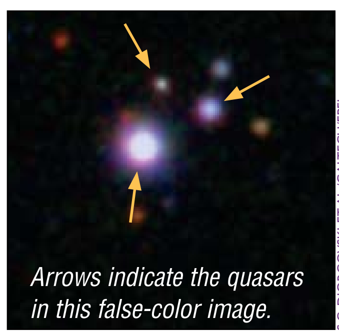
After years of debate following the Columbia accident, NASA has decided to send astronauts to upgrade Hubble Space Telescope a fourth and final time. The servicing mission, set for 2008, will install two new instruments and upgrade the telescope's pointing system. These changes should keep Hubble in business through 2013.

Triple-Quasar System Faces Scrambled Future

A trio of quasars is beginning a gravitational dance that should hasten the merger of two of their supermassive black holes and kick the third out on a high-speed journey through intergalactic space, according to two teams of astronomers.

The three quasars — supermassive black holes surrounded by disks of hot gas as big as the solar system — form a system known as QQQ 1432. They are about 10.5 billion light-years away, which means we see them as they existed three billion years after the Big Bang.

Astronomers discovered two of the quasars in 1989, but only recently found the third, which makes QQQ 1432 the first known triple-quasar system. Two of the three are inside galaxies, while the third also appears to have a host galaxy, said Caltech astronomer George Djorgovski, who led the team that studied the system. The quasars are about 100,000 light-years apart. One of the black holes is several billion times as massive as the Sun, while the other two are smaller.



Arrows indicate the quasars in this false-color image.

S.G. DJORGOVSKI ET AL./CALTECH/EPFL

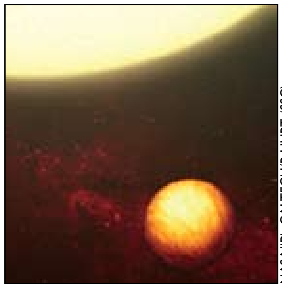
As the galaxies move closer to each other, their gas clouds will smash together, giving birth to new stars. At the same time, though, more gas will be funneled into the quasars, which will slow down or halt further star formation.

The black holes will conduct a complex gravitational dance, said Frederic Rosio of Northwestern University, a member of a team that simulated the interplay of three close supermassive black holes. Two of the black holes will form a tight binary. After many wild loops around each other, either the binary system or the single black hole will be ejected from their coalescing galaxies, while the other will settle into the center of the galaxies and eventually merge to form a larger black hole. **DB**

Extrasolar Planets Display Dazzling Array of Properties

Spitzer Spies Hot and Cold Planet

For the first time, astronomers have measured the temperature on the day and night sides of an extrasolar planet. Joe Harrington of the University of Central Florida used Spitzer Space Telescope to discover a giant hot spot on the side of the planet Upsilon Andromedae b that faces its parent star. The temperature difference between the planet's day and night sides is a scorching 2,550 degrees Fahrenheit (1,400 C). The gas giant planet orbits close to its star with a period of just 4.6 days, and is tidally locked with it so that one side is always hot, the other always cold.


NASA/JPL-CALTECH/R.HURT (SSC)

Small Scopes Find 'Planet Lite'

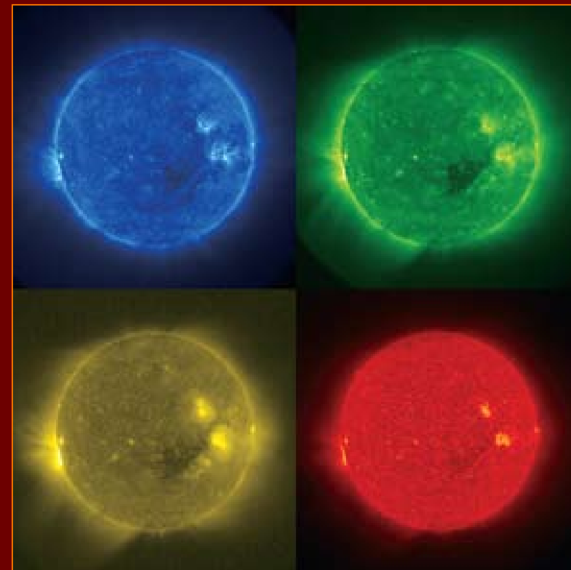
Using a network of small robotic telescopes, Smithsonian astronomers have to found an unexpectedly large extrasolar planet. The planet HAT-P-1 has a radius 1.38 times that of Jupiter, yet weighs only half as much. It circles one star of a binary pair every 4.5 days. Gasper Bakos of the Harvard-Smithsonian Center for Astrophysics designed the HAT telescope network, which searches for extrasolar planets by observing the dip in light output from stars when a planet passes in front of them. Bakos' group says that HAT-P-1 and another planet discovered by this "transit" method are larger than theory predicts, and may signal that something may be missing from today's planet-formation theories.


DAVID A. AGUILAR (CfA)

Snowstorms Could Spawn Super-Earths

Grant Kennedy of Australia's Mount Stromlo Observatory and a team of astronomers have calculated how a few "super-Earths" known to orbit dim red dwarf stars could have formed. A "super-Earth" is an extrasolar planet made of ice and rock with a mass five to 15 times Earth's. Kennedy's team says that in their early history, red dwarf stars grow dimmer as they evolve, and the inner region of their surrounding planet-forming disk starts to freeze. This makes water and other gasses condense into snowflakes and ice pellets. These ices help build up any planets already forming in the inner disk. Kennedy's group theorizes that such a "cosmic snowstorm" completely envelops the forming planet and lasts millions of years. **RJ**


DAVID A. AGUILAR (CfA)


NASA/NRL

Soaking up the Sun in STEREO

Following their October launch, the twin STEREO spacecraft sent back their first ultraviolet images of the Sun in December. These false-color images show the Sun's atmosphere at different temperatures. Clockwise from top left (in blue): 1.8 million degrees Fahrenheit, 2.7 million degrees, 100,000-140,000 degrees, 4.5 million degrees.

Stellar Neighbor Goes Quiet

Sun might have experienced similar snooze

Alpha Centauri A, the leading member of the closest star system, is undergoing a period of unprecedented calm and quiet, according to astronomers from Villanova University, who are monitoring Alpha Centauri A and other Sun-like stars.

Alpha Centauri is a triple-star system just 4.3 light-years away. Alpha Centauri A is the most massive member of the system. It is about the same mass, temperature, and composition as the Sun, although it is slightly older. Monitoring Alpha Centauri A and similar stars can help astronomers learn more about the Sun's behavior and lifecycle.

Observations by astronomy satellites revealed that the star's X-ray and ultraviolet energy output dropped dramatically from 2001 to 2006. It was the largest decline yet observed in a Sun-like star, the Villanova team reported at the American Astronomical Society meeting in January.

The Sun might have experienced a similarly "quiet" phase from around 1645 to 1715, a time known as the Maunder Minimum. The Sun produced almost no sunspots during that time, suggesting that its total energy output dropped. Earth's temperature dropped by about one degree, showing a possible link between climate and solar energy.

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Solar Viewing in our Indoor Theater (weather permitting)

Expanded Star Party Schedule

Saturday, March 10, 7:30 pm
Monday, March 12, 9 pm
Tuesday, March 13, 9 pm
Wednesday, March 14, 9 pm
Friday, March 16, 9 pm
Saturday, March 17, 9 pm

For complete details

877-984-7827 (toll-free)
http://mcdonaldobservatory.org/visitor

FRANK CIANCIOLO PHOTOS

Layers of ice, rock, and sand intertwine in this image of the north polar region of Mars. The top layers are mainly ice mixed with orange Martian dust. Lower layers, which form part of a canyon known as Chasma Boreale, are rock that may have started as sand dunes. Small, rippling dunes form dark stripes in several places. Mars Reconnaissance Orbiter snapped this false-color image, which shows details as small as a few feet across.

NASA/JPL/UNIVERSITY OF ARIZONA