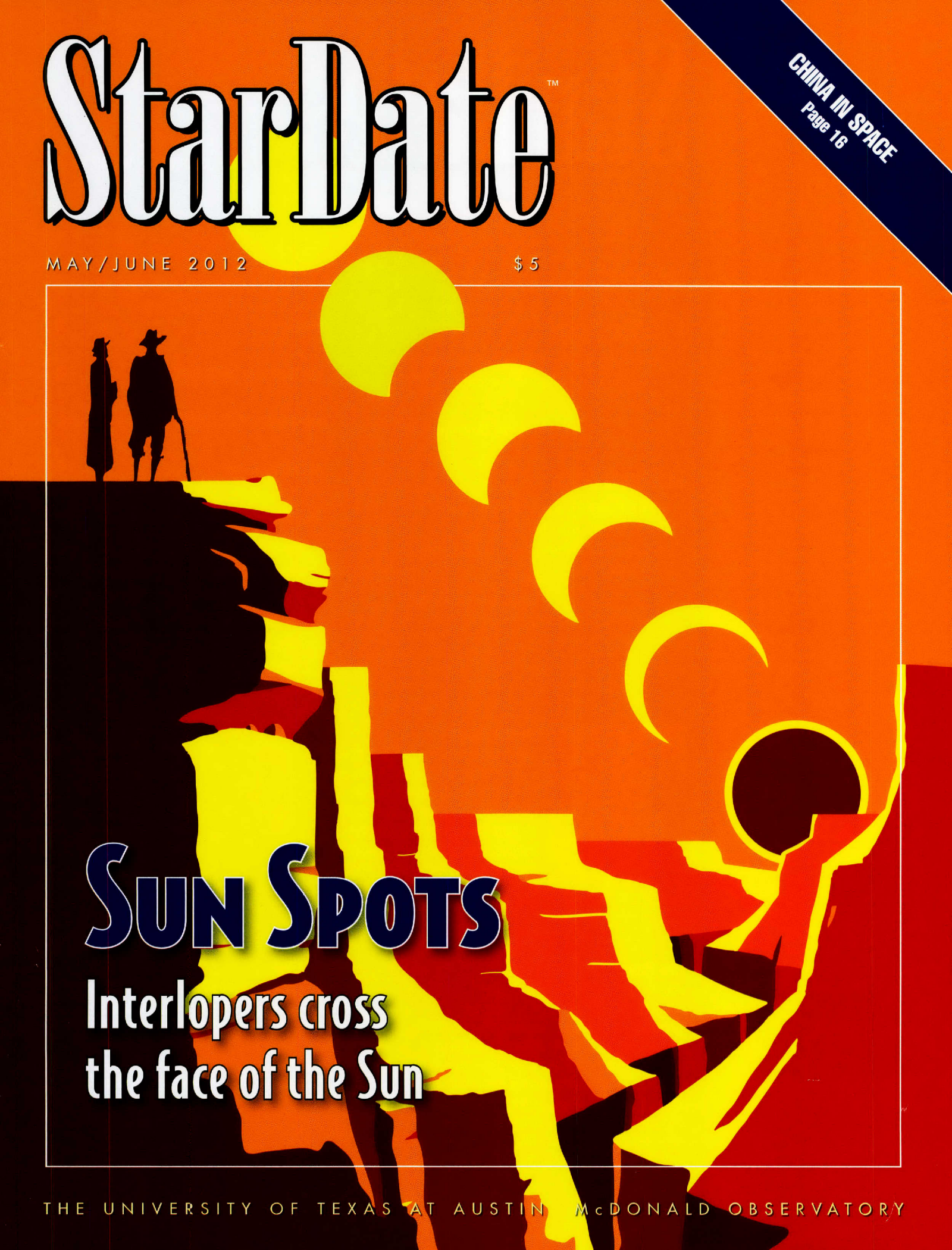
StarDate™

CHINA IN SPACE
Page 16

MAY/JUNE 2012 $5



Sun Spots

Interlopers cross the face of the Sun

THE UNIVERSITY OF TEXAS AT AUSTIN McDONALD OBSERVATORY

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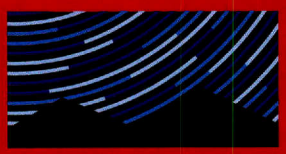

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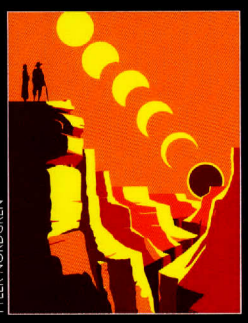
MAY/JUNE 2012 • Vol. 40, No. 3

Features

Departments



TYLER NORDGREN

On The Cover

The annular eclipse of May 20 is shown dropping toward the Grand Canyon in this illustration. For details on the eclipse, see Page 6. To order a copy of this or other eclipse illustrations, visit newton.uor.edu/facultyfolder/tyler_nordgren/eclipse/Eclipse.html.

This Page

Dwarf galaxy NGC 4449 (top center) is tearing apart an even smaller galaxy (faint pink streamer, bottom center), and will eventually swallow it. It's the first-known example of dwarf galaxies imitating their more massive relatives, which astronomers have long known interact gravitationally, pull each other apart, and merge. This pair was identified by David Martínez-Delgado of the Max Planck Institute for Astronomy and Michael Rich of UCLA.

Coming Up

July/August brings you StarDate's *Summmer Reading Issue. We'll share feature-length excerpts from several new books in astronomy and space to help you plan your summer reading, as well as the latest astronomy news, summer skywatching tips, and star charts.*

R. J. GABANY (RBGUD, MARTINEZ-DELGADO, IMPIA)

MERLIN

Dear Merlin,

How many extrasolar planets have been discovered so far?

Adriano Henrique de Oliveira
Caruaru, Brazil

The pace of planet discovery is so quick that even Merlin has a hard time keeping up with it. As of April 1, the total of confirmed planets was around 800, depending on whose tally you follow. The Kepler spacecraft has identified more than 2,000 other possible planets, while other observatories are following up on many more. The total will certainly pass 1,000 this year, and 1,500 isn't out of the question.

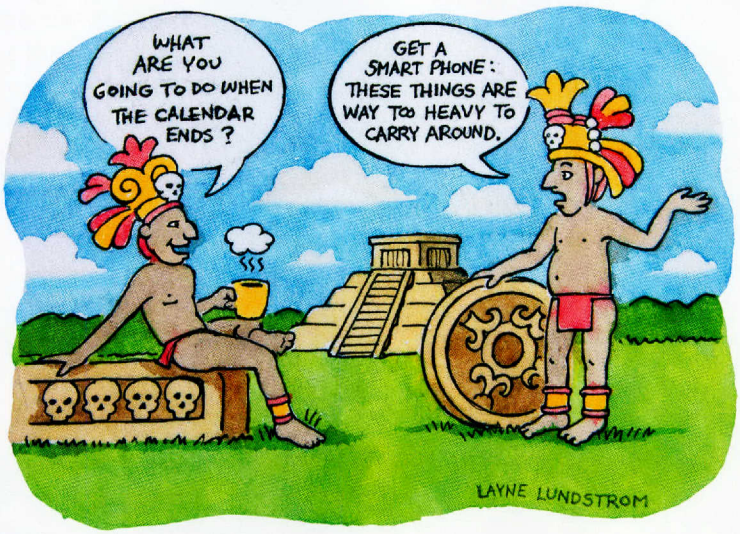
Perhaps the most astounding thing about all of these discoveries is the sheer variety of planets in the universe. They orbit small stars, giant stars, and even "dead" stars like white dwarfs and neutron stars. Some orbit one of the two stars in a binary system, and others orbit both stars. They range from the size of the Moon to several times the mass of Jupiter, the largest planet in the solar system.

The census even includes a few planets that are trending toward "Earth-like" — worlds with similar mass and temperature. There's no Earth twin on the list — so far.

Dear Merlin,

In the January/February issue of StarDate, *I thought the author of the Featured Myth article on page 27 was a little hard on the Maya. ... The Maya had amazing knowledge to develop a calendar (I should say calendars) which is as accurate as it is, and still in use in parts of the world. In any case, the Maya were an amazing people and deserve some credit.*

Richard L. Poor
Wolcottville, Indiana



Merlin certainly agrees that the ancient Maya were keen observers of the natural world, including the night sky. They developed an intricate knowledge of Venus, which allowed them to predict the position of Venus in the sky decades or centuries in advance.

However, the point of the earlier article (and this one) is that none of the Mayan calendars predicted that the world would end this year or any other. In fact, Merlin would argue that the Maya were much smarter about the ways of the universe than many of their modern-day "followers," who misinterpret — or deliberately misrepresent — Mayan cosmology, because the Maya understood that although each calendar cycle ends, it starts anew the next day.

Dear Merlin,

Why is it that, on some nights, the Moon is not visible until midnight?

Brooke Andrews
Dickerson Maryland

I saw recently that the Moon's perigee [closest point to Earth] was days away from the full Moon. I thought perigee always happened at full Moon. What was the difference?

Phillip B. Hausken
Monroe, Washington

Even though it's the biggest, brightest thing in the night sky, people seem to pay relatively little attention to the Moon. They notice it when it's around, but don't really think about it when it's not. That leads to some misunderstanding.

Many people expect the Moon to be visible every night, for example, but it's not. As the Moon orbits Earth, it rises an average of about 48 minutes later each day, so it is visible at different times of day and night. When the Moon is new it passes between Earth and the Sun, so it rises and sets with the Sun and hence is not visible. About 15 days later, at full Moon, it rises as the Sun sets, so it is visible all night. And when it's at last quarter, it rises around midnight (Standard Time; an hour later under Daylight Saving Time) and is highest in the sky around sunrise. So the Moon is actually in the daytime sky as much as the nighttime sky, but it looks pale in the bright sunlight, so it's less noticeable.

Another misunderstanding concerns the link between the Moon's phases and its distance from Earth. Since the Moon is brightest when it is full, many people assume it is closest to Earth then, but that's not necessarily the case. The Moon actually takes 27.3 days to orbit Earth, so it is closest to Earth every 27.3 days. During that period, however, Earth and the Moon move quite a distance in their combined orbit around the Sun, so it takes about two days longer for the Moon to return to any given phase (such as new or full). Sometimes, then, the Moon is closest to Earth when it is full, but other times it is actually farthest from Earth when it's full.

Merlin hopes this sheds a little light on the brightest object in the night sky.

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

stardate.org/astro-guide

SEND QUESTIONS TO
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merlinknows@austin.rr.com
stardate.org/magazine

DAMOND BENNINGFIELD

May 20
Annular Eclipse

The Moon crosses in front of the Sun, obscuring almost all of the solar disk. The Moon is farther than its average distance, so it doesn't completely cover the Sun, leaving a bright 'ring of fire' around the dark lunar disk.

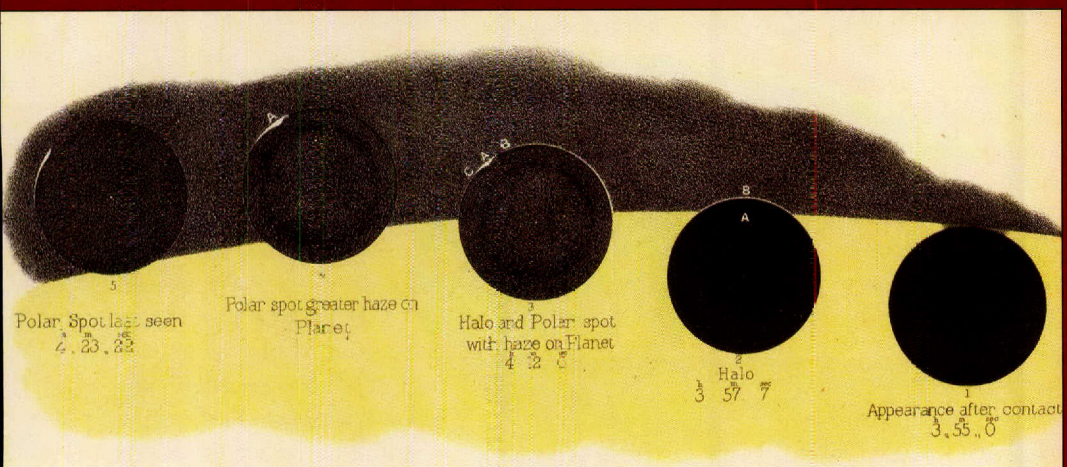
- Annular eclipse visible in late afternoon from California-Oregon border to western Texas
- Partial solar eclipse visible from the rest of the country
- One way to view the eclipse: Watch the ground beneath a leafy tree; gaps between leaves act as lenses, projecting small images of the eclipse on the ground (left).

June 4
Partial Lunar Eclipse

The Moon 'dips its toe' into Earth's dark inner shadow, darkening part of the Moon's southern hemisphere, as though some celestial beast were taking a bite. (At right: A view of a partial eclipse from the International Space Station.)

- Visible before sunrise from most of the United States
- A greater portion of the eclipse is visible from the west than the east
- Next good lunar eclipse visible from the United States: April 15, 2014 (total eclipse)

NASA



Transit of Venus 1874
Sydney N.S.W.
Mr Russell's Observations at Egress

June 5
Transit of Venus

The planet Venus crosses the face of the Sun, producing a small, dark spot on the Sun's northern hemisphere. The crossing will take almost seven hours.

- At least parts of the transit are visible from the entire United States, beginning in mid- to late afternoon. For most of the country, the Sun will set while the transit is in progress.
- Second of a pair of transits; the first was in 2004
- Final transit until December 2117

SUBLIME SYZYGY

Precise solar system alignments will provide three shadowy events in 17 days

A series of three solar system encounters over a 17-day period in May and June is a neat freak's dream: precise alignments of Earth and the Sun with the Moon (twice) and the planet Venus. The first two will produce eclipses that will be visible across most of the United States, while the third will produce a transit of Venus across the face of the Sun that the entire country can catch.

An alignment of three astronomical objects is known as syzygy, from an ancient Greek word meaning "yoked together." Examples include new Moon, when the Moon lines up between Earth and the Sun, and full Moon, when it is in the opposite direction from the Sun.

Most months this alignment is slightly bent, with the Moon passing a little above or below the plane of Earth's orbit around the Sun. On May 20 and June 4, however, the Moon slices through the plane at just the right time, producing solar and lunar eclipses.

The May event is the most precise alignment, with the Moon covering most of the Sun's disk. The Moon will be a few thousand miles farther from Earth than average, though, so it won't completely block the Sun from view. Instead, seen from a narrow path across the western United States, it will be encircled by a brilliant ring of sunshine, known as an annular eclipse. Most of the rest of the country will see a partial eclipse.

As the Moon circles around to the other side of Earth a fortnight later, it will dip into Earth's shadow, producing a partial lunar eclipse, at least parts of which will be visible from all but the West Coast, Alaska, and Hawaii. Earth's dark inner shadow first touches the lunar disk at 5 a.m. CDT on June 4 and completes its journey across the Moon a bit more than three hours later. The shadow won't completely cover the Moon, but instead will appear to take a dark "bite" out of its southern hemisphere.

The third alignment, which is the rarest of all, takes place on the afternoon of June 5, when Venus transits the Sun, forming a small, dark silhouette against the Sun's northern limb. It's a syzygy that won't repeat until 2117.

– Damond Benningfield

NOTE

View the solar eclipse and Venus transit with care. Looking directly at the Sun without proper protection can damage your eyes. For safe viewing, look through a dark welder's glass (at least No. 14) or special eclipse glasses. You can also poke a pinhole in the side of a cardboard box and watch the events as the light projects onto the bottom or back of the box. We will have details on our website, stardate.org.

RING OF FIRE
PAGE 6

DANGEROUS TRANSITS
PAGE 8

RING OF FIRE

From northern California to western Texas, the sky will grow dusky on the afternoon of May 20. The air will cool noticeably, and leafy trees will cast odd ring-shaped shadows. The strange effects are the result of an imperfect game of hide-and-seek between the Moon and Sun known as an annular solar eclipse. The Moon will pass directly in front of the Sun, blocking most of its light. But like a child who tries to hide behind a too-small tree, some of the Sun's disk will peek around the Moon, leaving a thin but bright ring of fire in the sky.

"The Moon is farther away from Earth, so it doesn't completely cover the Sun like it does during a total eclipse," says Tom Heisey, president of the South Plains Astronomy Club in Lubbock, Texas, which is hosting a public eclipse-watching party. "It leaves a silhouette of the Moon surrounded by a ring of sunshine. Kids say it it looks like Cookie Monster is eating the Sun."

The annular eclipse begins in eastern China, wraps across the northern Pacific Ocean, then enters the United States at the Oregon-California border in late afternoon. It ends at sunset in western Texas. At most, the Moon will cover about 94 percent of the Sun's disk, and for American viewers it will remain immersed in the disk for less than five minutes. Areas outside the path of annularity, including all but the Eastern Seaboard of the United States, will see a partial eclipse.

While the eclipse is a great event for casual skywatchers, it will attract little scientific attention from professional astronomers. Sun-watching satellites, which monitor our star 24 hours a day, can create artificial eclipses by blocking out the Sun's disk, providing clear views of the Sun's hot but faint outer atmosphere, the corona, which is impossible to see from the ground.

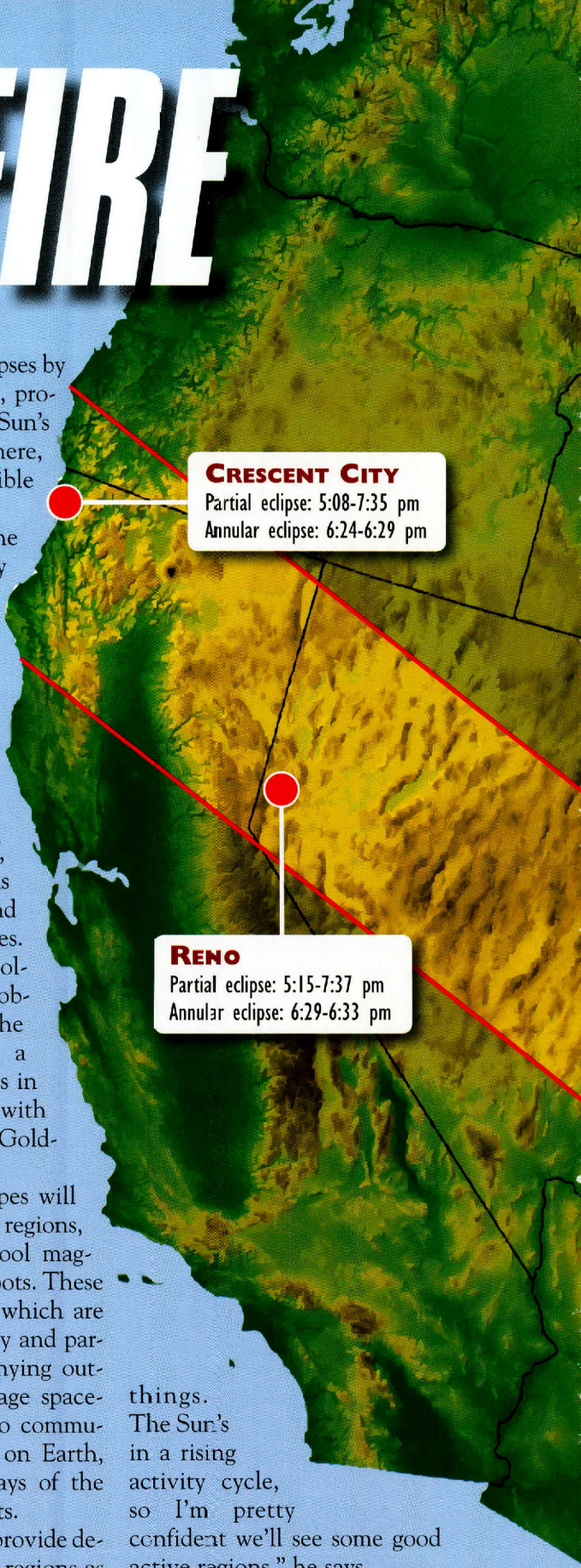
Yet one astronomer says the eclipse offers an opportunity to study some solar phenomena in far greater detail than space telescopes can provide.

"We can use the Moon as an occulting disk to get high-resolution observations of the solar atmosphere with radio telescopes," says Jay Pasachoff, an astronomer at Williams College in Massachusetts and veteran of 54 solar eclipses. Pasachoff and a group of colleagues and students will observe the eclipse with the Jansky Very Large Array, a collection of 27 radio dishes in western New Mexico, and with a NASA tracking dish at Goldstone, California.

In particular, the telescopes will target the Sun's "active" regions, which include the dark, cool magnetic storms known as sunspots. These regions trigger solar flares, which are powerful eruptions of energy and particles. Flares and accompanying outbursts of hot gas can damage spacecraft, knock out some radio communications and power grids on Earth, and produce intense displays of the northern and southern lights.

The radio telescopes will provide detailed observations of these regions as the Moon covers and uncovers them, offering insights that can't be obtained with satellites or with an uneclipsed Sun, Pasachoff says. "When you go to higher resolution, you learn new things. The Sun's in a rising activity cycle, so I'm pretty confident we'll see some good active regions," he says.

"There are still some niches that can only be done during eclipses. One should always keep thinking of new opportunities, and I'm glad we have the chance to work with this one."



Helping Hands (and Eyes)

Many astronomy clubs, science museums, observatories, and other groups will host eclipse-watching events that will include viewing through solar telescopes, helpful information, and other perks.

Eureka, California
Kneeland Airport, 5 p.m.; hosted by Astronomers of Humboldt
www.astrohum.org/upcoming.html

Stockton, California
The Stockton Astronomical Society will host an event in the Shima parking lot of San Joaquin Delta College
www.stocktonastro.org/EclipsePage.html

Los Angeles, California
Griffith Observatory (partial eclipse only)
www.griffithobservatory.org/exhibits/special/Specail_Event_Partial_Eclipse_2012.html; 213-473-0800

Reno, Nevada
MacLean Observatory, Redfield Campus, Univ. of Nevada-Reno, 5-7 p.m.
www.eclipsereno.unr.edu

Great Basin National Park, Nevada
Ranger-guided viewing activities at park headquarters
www.nps.gov/grba/planyourvisit/great-basin-night-sky.htm

Pyramid Lake, Nevada
Beginning at 5:15 p.m.
blackrockdesert.org/friends/events/2012/may-20-630pm/annular-solar-eclipse-at-pyramid-lake

Bryce Canyon National Park, Utah
Eclipse viewing and video projections, 3 locations; free eclipse glasses for attendees; 6:30 p.m.; *www.nps.gov/brca/planyourvisit/astrofest.htm*

Glen Canyon National Recreational Area, Utah
Solar telescopes; 6:30 p.m.
www.nps.gov/glca/planyourvisit/2012-annular-eclipse.htm

Grand Canyon National Park, Arizona
Telescopes, box projectors, and other activities on both rims
www.nps.gov/grca/planyourvisit/annular201205.htm

Very Large Array, New Mexico
Tours of the giant radio telescope, 70 miles west of Socorro, followed by eclipse viewing beginning at 4 p.m.; *www.nrao.edu/VisitVLA*

Albuquerque, New Mexico
Several organizations are hosting eclipse events:
- New Mexico Museum of Natural History & Science
- Anderson-Abruzzo Albuquerque International Balloon Museum
- Petroglyph National Monument
- University of New Mexico

www.itsatrip.org/events/featured/spring/albuquerquesolarevents.aspx

White Rock, New Mexico
Overlook Park, Hosted by Parajitos Astronomers
www.unm.edu/~tbeach/pajarito.html

Chaco Culture National Historical Park, New Mexico
Pueblo Bonito Plaza, 6 p.m.
www.nps.gov/chcu/index.htm; 505-786-7014

Lubbock, Texas
The South Plains Astronomy Club will host an event at Lubbock Lake Landmark; *www.southplainsastronomyclub.org*

Midland, Texas
Marion Blakemore Planetarium, hosted by West Texas Astronomers
432-683-2882

Albuquerque
Partial eclipse: 6:28-8:08 pm
Annular eclipse: 7:34-7:38 pm

Page (Grand Canyon)
Partial eclipse: 5:24-7:31 pm
Annular eclipse: 6:32-6:37 pm

Lubbock
Partial eclipse: 7:31-8:45 pm
Annular eclipse: 8:34-8:38 pm

Midland
Partial eclipse: 7:33-8:43 pm
Annular eclipse: 8:36-8:39 pm

SANCHO_PANZA/WIKIPEDIA

DANGEROUS TRAN

In June 1761, the world's great superpowers were at war, their mighty fleets battling across much of the globe. Yet scientists from both countries sailed into unfriendly waters in search of a scientific treasure: a passage of Venus across the Sun, known as a transit. By triangulating Venus' position on the face of the Sun from several widely spaced locations, astronomers hoped to measure the planet's distance, and from that measure the distance to the Sun — a key yardstick that would help them measure all astronomical distances.

Venus transits have lost much of their scientific value since then, yet they retain their esthetic appeal in part because they are quite rare. Transits occur in pairs, with the two separated by eight years. Pairs, in turn, are separated by either 105.5 or 121.5 years, so for most of us a transit is at best a twice-in-a-lifetime event.

The second half of one of these pairs takes place on June 5. The transit begins around 5:04 p.m. CDT when Venus first touches the edge of the solar disk. Venus will be completely immersed inside the Sun by about 18 minutes later, and remain in transit for more than six hours. Skywatchers in the eastern U.S. will see the first stages of the transit, those in the west will see most of the event, and those in Alaska and Hawaii will see the whole thing (weather permitting, of course).

The first recorded Venus transit took place in 1639. British astronomer Jeremiah Horrocks predicted it, but he didn't complete his calculations in time to alert other astronomers, so Horrocks and a friend were the only ones to see it.

A few decades later, Edmond Halley, for whom Halley's Comet is named, realized that astronomers could use future transits to calculate solar system distances.

The idea was to place teams of astronomers at widely spaced locations, where they would note the starting and ending times of the transit and measure Venus' track across the Sun. By comparing the angle and the timing from different locations and applying some trigonometry, they expected to measure the distance to Venus. Astronomers already knew the relative distances to the Sun and planets — they knew, for example, that Venus was only about seven-tenths as far from the Sun as Earth is — but they didn't have absolute distances; estimates of the Sun-Earth distance varied by tens of millions of miles. A precise distance to Venus would allow them to calculate the distances to the Sun and the other planets.

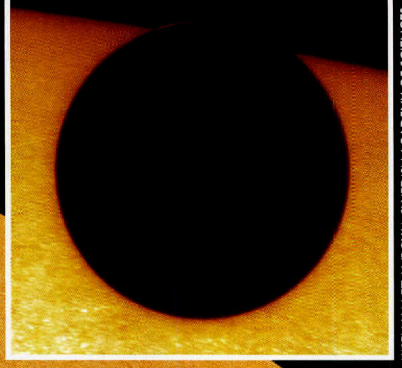
As the next transits — in 1761 and 1769 — approached, scientists from the two superpowers, Britain and France, worked together to arrange several expeditions. The two empires were at war, however, and combined with foul weather and other conditions, they were dangerous transits.

The British vessel HMS Seahorse, for example, left port in December 1760, bound for Sumatra, where it would observe the transit six months later. Seahorse was attacked by a French warship just hours after leaving home, however, so it limped back to port with 11 dead, more than 30 wounded, and two passengers who were ready to pack it in: Charles Mason,

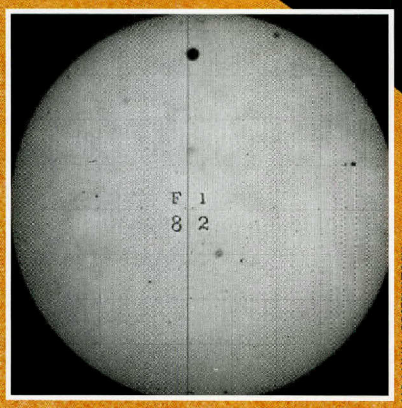
Sizing Up the Sun

Astronomers have also used transits to measure the Sun's diameter, and a team led by the University of Hawaii's Marcelo Emilio will be using this Venus transit to do just that. Current measurements of the Sun's diameter vary by hundreds of miles. But by precisely timing the transit with a Sun-watching satellite, the astronomers can measure the exact length of Venus's track across the Sun. Earlier this year, the team reported a measurement made with transits of Mercury in 2003 and 2006: 865,375 miles (1,392,684 km), with an uncertainty of just 80 miles.

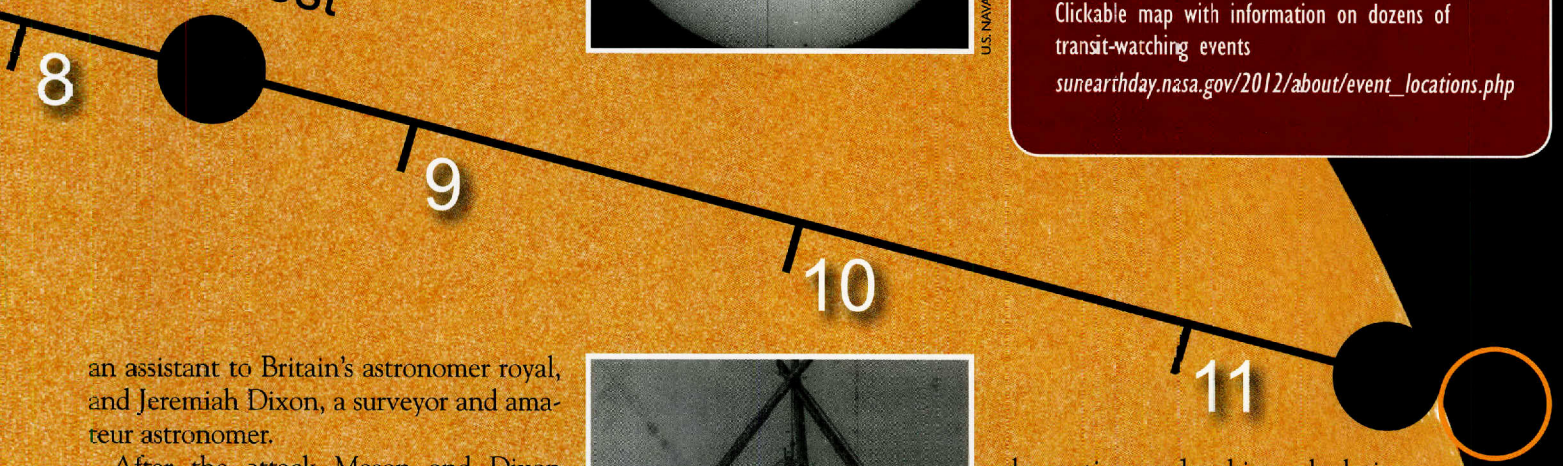
SITS



KISELMAN ET AL/ROYAL SWEDISH ACADEMY OF SCIENCES



U.S. NAVAL OBSERVATORY



Resources

Live Transit Webcast
sunearthday.nasa.gov/2012/transit/webcast.php

McDonald Observatory
Special transit-watching events at the Observatory, near Fort Davis, Texas
mcdonaldobservatory.org

Transit of Venus.org
Information on the current transit, viewing tips, and the history of transit science
www.transitofvenus.org

NASA Transit Page
Viewing times for more than 100 American cities
eclipse.gsfc.nasa.gov/transit/venus/city12-2.html

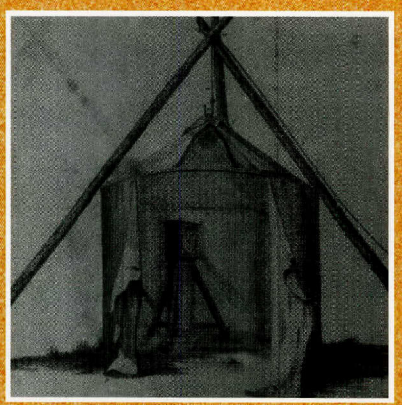
Transit Event Locations
Clickable map with information on dozens of transit-watching events
sunearthday.nasa.gov/2012/about/event_locations.php

an assistant to Britain's astronomer royal, and Jeremiah Dixon, a surveyor and amateur astronomer.

After the attack Mason and Dixon tried to abandon their expedition. But the Royal Society, which chartered and funded the trip, threatened both men with lawsuits and financial ruin if they didn't complete their mission. So they quickly reconsidered, and headed back out to sea in early 1761.

Mason and Dixon never made it to Sumatra, though, because France had captured their intended destination. Instead, they watched the transit from Cape Town, South Africa. And despite the tribulations, their observations were superb. In fact, just a couple of years later, their work earned them a new assignment: surveying a dividing line between American colonies — the Mason-Dixon Line.

Transits in 1761 and 1769 provided some data, but observers encountered several problems. Venus appeared to cling to the edge of the Sun's disk for a few moments, for example, making it impossible to obtain highly precise timings. Teams of astronomers spent years reducing the observations and making calculations, but came up with conflicting numbers. The next pair of transits, in the 19th century, helped with astronomers coming close to the correct value of about 93 million miles (150 million km) from Earth to the Sun. That distance forms one of the most important measuring sticks in modern astronomy, known as the Astronomical Unit.



From top: *A view of the 2004 transit, with the Venus limb outside the Sun enhanced; an image of the 1882 transit; a portable observatory built for the 1769 transit.* ***Background:*** *Venus' path against the Sun; the numbers indicate the time (p.m., CDT).*

No risky transit expeditions are on tap for this year. Instead, astronomers have found a new use for transits: as a way to discover planets orbiting other stars. A transit blocks a tiny bit of the star's light, producing a slight dip in its brightness. The technique has yielded dozens of new planet discoveries, and the Kepler space observatory, which is looking for planets around 150,000 stars, has a list of about 1,800 additional candidates that astronomers are trying to confirm.

So while transit observations are no longer life threatening, they still play a role in the effort to gain a better understanding of how the universe is laid out.

SOHO/MDI/NASA/FRED ESPENAK

SKY CALENDAR

by Alan MacRobert

May and June are packed with skywatching treasures this year. In addition to May's lunar eclipse and June's transit of Venus across the Sun, planet-and-star groupings abound. Be sure and make some time to watch these cosmic events unfold.

MAY 1 - 15

Brilliant Venus, still shining in the western twilight, has a climactic month in May.

Venus starts the month close to the much fainter (but still nearly first-magnitude) star Beta Tauri, or El Nath. On May 6, they pass just 0.8 degree apart, about a pencil width at arm's length. This is close enough that you may need binoculars to pick the star out of the planet's dazzling glare. During the next week or two they separate only gradually.

But Venus won't stay around for long. It has dominated the clear twilights all winter and spring, but May will be its month of vanishing. Watch it drop lower after sunset each day, at an accelerating pace. By month's end it's gone.

This is also the dramatic time in Venus' cycle when the planet wanes to a thin crescent while enlarging in diameter as it swings near Earth. You can watch its changing phase and size in a telescope or even in solidly mounted high-quality binoculars. On May 1, Venus is 38 arcseconds wide and still a thickish crescent, 26 percent sunlit. By the 10th it has enlarged to 44 arcseconds wide and waned to 18 percent sunlit. On the 20th the numbers are 51 arcseconds wide and 8 percent sunlit as the planet wanes to almost nothing. Venus is on its way to an even more remarkable event: transiting the face of the Sun on the afternoon of June 5.

Other things are happening in the twilight sky. Look for Capella shining to Venus' upper right (by about two fist-widths at arm's length) in the first half of May. Look twice as far to Venus' upper left for Pollux and Castor, the heads of Gemini, lined up roughly horizontally. Pollux is the brighter of the two, on the left.

Look to the lower left of Pollux and Castor for Procyon. Each spring Capella, Castor, Pollux, and Procyon form a great arch in the western twilight sky, with Venus now only a temporary intruder.

Betelgeuse — the last, highest corner of Orion — sparkles far below this arch, and a little to the left of its center. Can you still catch it? Orion is a winter constellation, and Betelgeuse is getting lower and more difficult every day.

MAY 16 - 31

On the afternoon of May 20, the Moon transits the Sun's face for a partial or annular solar eclipse for most of North America except the East. The event happens in late afternoon or around sunset, depending on where you are. For complete details on how and where to safely view the event, see page 6.

The other celestial highlight of May's second half is Venus' increasingly rapid drop toward the sunset as its crescent enlarges but thins, as described above.

On the evening of May 22, Venus is joined by a hair-thin crescent Moon to its left; look just above the west-northwest horizon in twilight. And use binoculars to look for the third-magnitude star Zeta Tauri very close to the Moon as twilight fades. In fact, the Moon occults (covers) Zeta Tauri in late afternoon or twilight for much of the American west.

Turning elsewhere in the evening sky, Saturn and Mars are now high in the south and southwest at nightfall, respectively. They shine at the same height roughly an hour after dark, depending of your date and location.

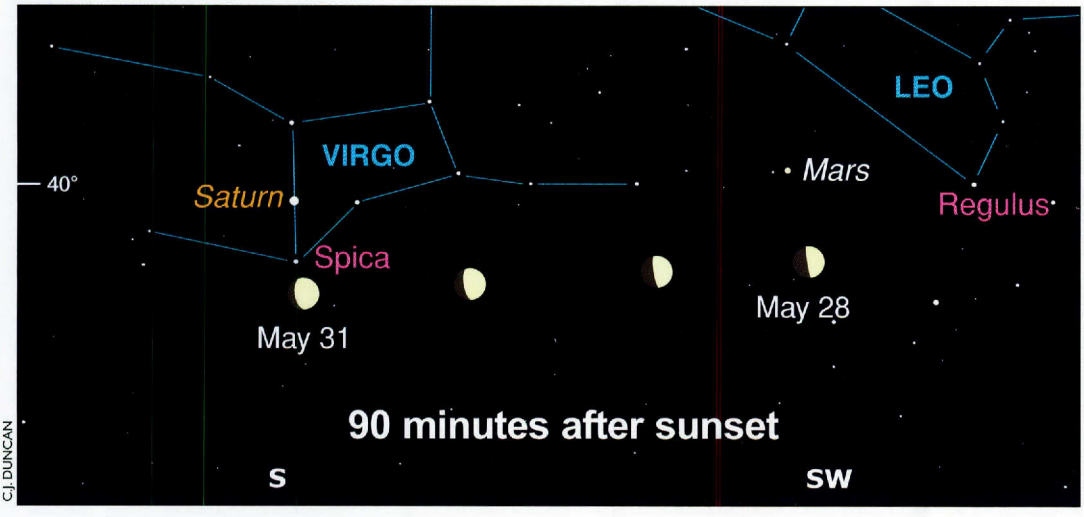
Bluish-white Spica glitters beneath yellow-white Saturn. Look for bluish Regulus a greater distance to the right of orange Mars. And the Moon poses under Regulus on May 27, Mars on the 28th, and the Saturn-Spica pair on the 31st.

With spring about two-thirds done now, the Big Dipper has flipped around high in the northwest to start hanging with its bowl more or less down. By about 11 p.m., the Dipper hangs straight down.

Stay out late enough to see the Dipper in that position, and you can turn completely around to face southeast and see the bright constellation Scorpius already well on the rise, bearing orange-red Antares as its heart.

JUNE 1 - 15

On the afternoon of Tuesday, June 5, the dark silhouette of Venus will cross the face of the Sun. This is the first transit of Venus since 2004 and the last until 2117. Much of the event will be visible from across all of the United States and Canada.



C.J. DUNCAN

Details on how to view it safely are available on page 8.

As summer gets under way, a big, temporary triangle of a star and two planets shines high across the southern sky at nightfall. One of the triangle's corners has another star dangling just off it.

Arcturus is the triangle's brightest and highest corner. It's nearly overhead toward the southeast to south in late twilight and early night.

The planet Saturn glows far below Arcturus, and perhaps somewhat to the right. Look just below Saturn for Spica, a bit less bright. Can you see the subtle color difference between them? They're currently 5 degrees apart (about three finger-widths at arm's length).

The third corner is Mars, far off to the right of Saturn (by 35 degrees). The two planets are now about the same brightness; Mars continues to dim following its brilliant pass by Earth last March. Earth is leaving Mars ever farther behind as we pull ahead in our faster orbit around the Sun.

Follow the line from Saturn to Mars and extend it on by another 15 or 20 degrees, and you'll hit Regulus, distinctly dimmer.

Turning elsewhere: Across the east to northeast sky, lower down, look for the Summer Triangle. Vega is its bright apex on top, the brightest star in the eastern sky. Deneb is to Vega's lower left by two or three fist-widths at arm's length. Altair is to Vega's lower right by three or four fists.

The Summer Triangle is almost as large as the Arcturus-Saturn-Mars triangular interloper on the other side of the sky. And like no pattern made with planets, it will be back again next year and for many millennia to come.

JUNE 16 - 30

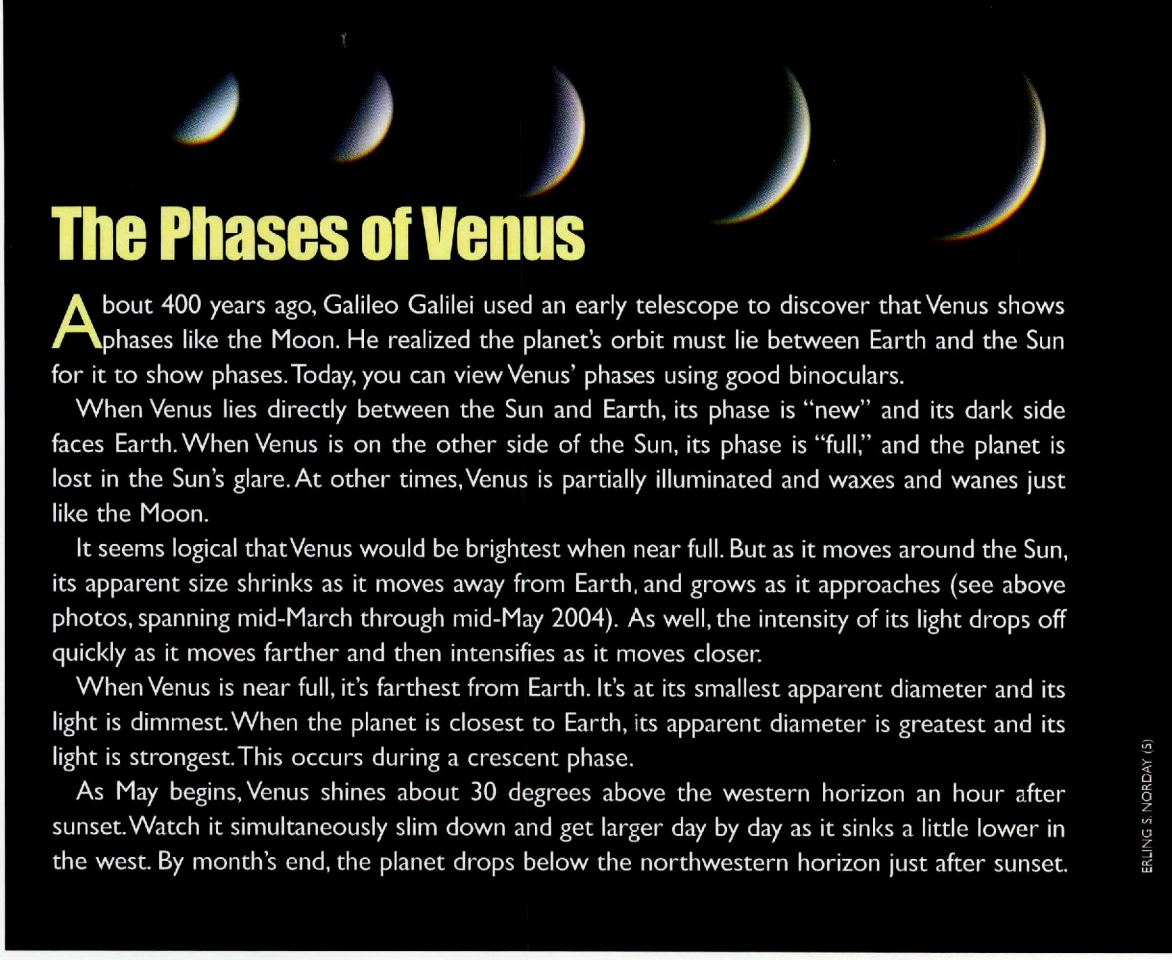
Now the Big Dipper hangs straight down by its handle as soon as the stars come out. This turn of events always signals the turn of spring into summer. The solstice happens on June 20 this year: the longest day, followed by the shortest night.

Around the June solstice, the dim Little Dipper floats straight upward from the end star of its handle, second-magnitude Polaris, after dark. In this pose, the Little Dipper looks to me like a helium balloon floating up into the night, perhaps escaped from some evening graduation party.

In the eastern sky, bright Vega continues its ascendancy. Arcturus is shifting to the high southwest after dark. Look almost straight below Arcturus now for the Saturn-Spica pair. And Mars, still dimming, is moving lower over to the west.

Catch Scorpius at its highest in the south around 11 p.m. or midnight. And following along behind it, the teapot pattern of Sagittarius is now moving up to tip and pour across the south all summer.

Alan MacRobert is a senior editor of Sky & Telescope *in Cambridge, Massachusetts.*



The Phases of Venus

About 400 years ago, Galileo Galilei used an early telescope to discover that Venus shows phases like the Moon. He realized the planet's orbit must lie between Earth and the Sun for it to show phases. Today, you can view Venus' phases using good binoculars.

When Venus lies directly between the Sun and Earth, its phase is "new" and its dark side faces Earth. When Venus is on the other side of the Sun, its phase is "full," and the planet is lost in the Sun's glare. At other times, Venus is partially illuminated and waxes and wanes just like the Moon.

It seems logical that Venus would be brightest when near full. But as it moves around the Sun, its apparent size shrinks as it moves away from Earth, and grows as it approaches (see above photos, spanning mid-March through mid-May 2004). As well, the intensity of its light drops off quickly as it moves farther and then intensifies as it moves closer.

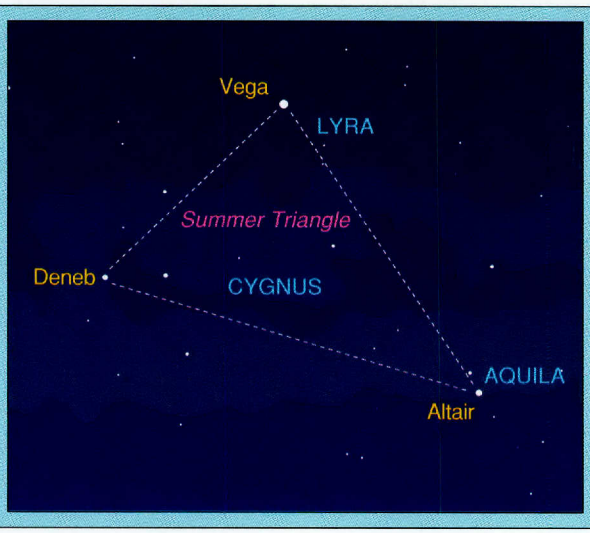
When Venus is near full, it's farthest from Earth. It's at its smallest apparent diameter and its light is dimmest. When the planet is closest to Earth, its apparent diameter is greatest and its light is strongest. This occurs during a crescent phase.

As May begins, Venus shines about 30 degrees above the western horizon an hour after sunset. Watch it simultaneously slim down and get larger day by day as it sinks a little lower in the west. By month's end, the planet drops below the northwestern horizon just after sunset.

ERLING S. NORDAY (5)

THE SUMMER TRIANGLE

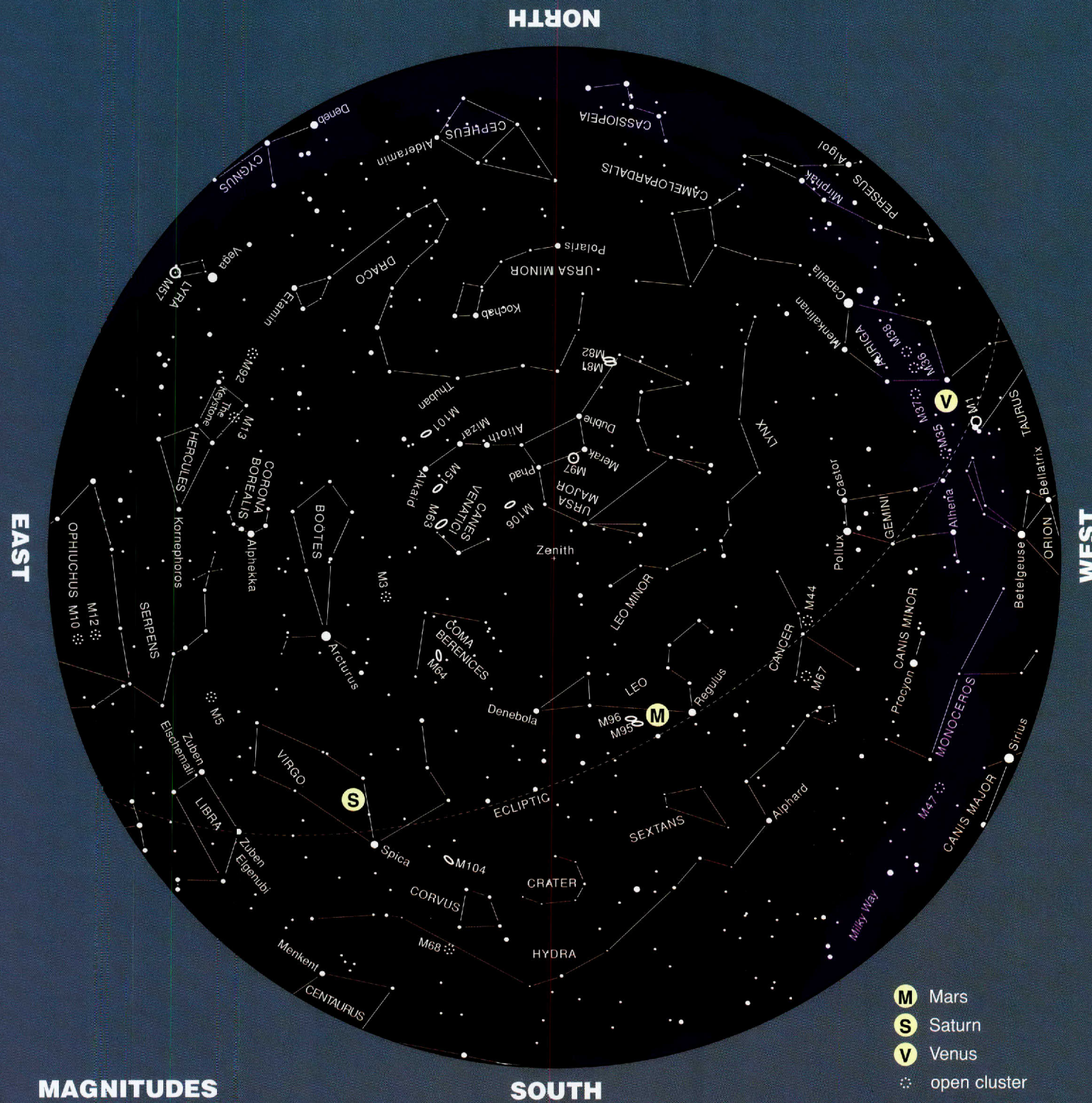
The Summer Triangle dominates summer's eastern sky. In May, it rises high overhead by midnight. But by mid-June, it's in good view by 10 p.m. To find it, look for the brightest star in the east. That's Vega, the triangle's top star, in Lyra, the harp. Its other points are Deneb, in Cygnus, the swan, and Altair, in Aquila, the eagle. Vega and Altair are relatively nearby, at 25 and 17 light-years, respectively. Deneb, however, is about 1,500 light-years distant.



MAY

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

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



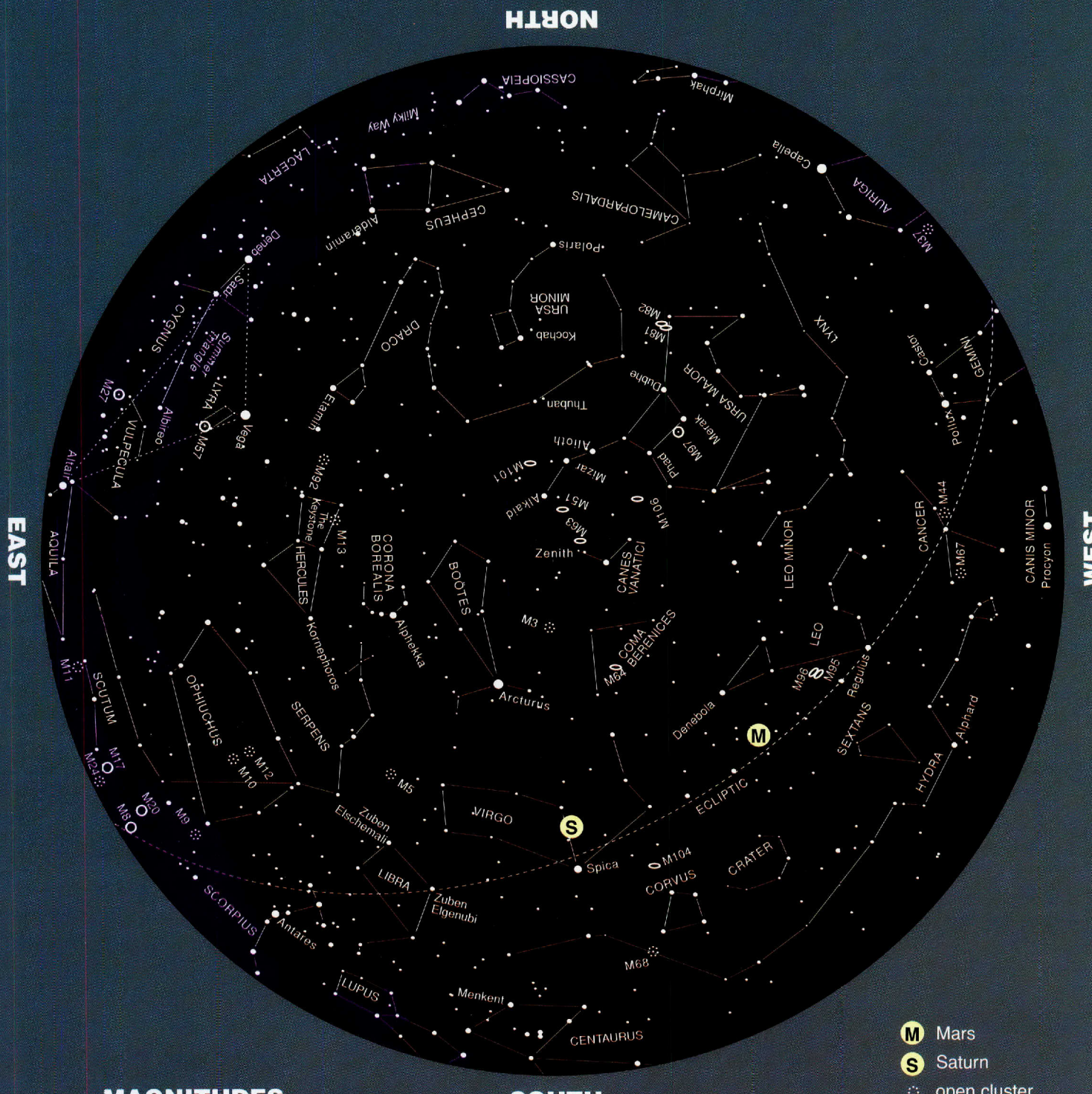
MAGNITUDES
- 0 and brighter
- 1
- 2
- 3
- 4 and fainter

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

JUNE

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

May 20	**11 p.m.**
June 5	**10 p.m.**
June 20	**9 p.m.**



MAGNITUDES

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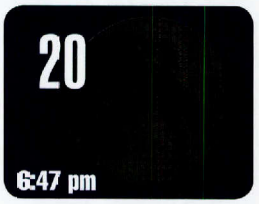
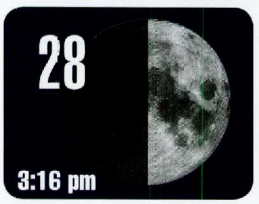
Sky Highlights

by Damond Benningfield





Moon phase times are for the Central Time Zone.

MAY

1 Mars looms far to the upper right of the Moon at nightfall, with the star Regulus to the right of Mars.

3/4 The Moon slips past Spica and Saturn. The pair is to the lower left of the Moon at nightfall on the 3rd, and above the Moon on the 4th. Saturn is the star-like point to the left, Spica to the right.

7 Antares, the orange "heart" of the scorpion, is to the left of the Moon at dawn.

13 Jupiter is in conjunction, passing behind the Sun and out of sight. It will return to view in the dawn sky by early June.

20 An annular eclipse of the Sun is visible from western North America (see page 6).

22 Evening-star Venus is to the upper right of the Moon, quite low in the west at sunset. Both are near the tips of the horns of Taurus, the bull, with the star at the tip of left horn, Zeta Tauri, quite close to the Moon, and the right horn, El Nath, to the right of Venus.

27 Mercury is in superior conjunction, passing behind the Sun as seen from Earth. The tiny planet will return to view in the western sky in early June, and put in a decent showing from the middle of the month into early July.

Su	M	T	W	Th	F	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

28 Orange Mars is above the Moon at nightfall, with the star Regulus farther to the upper right of the Moon.

31 Spica huddles close to the Moon this evening, with the planet Saturn a little farther from the Moon, along the same line.

JUNE

3 Mars and Regulus snuggle close. They are in the west at nightfall. Mars looks like a bright orange star. Regulus is to the lower left of Mars on the 6th, and directly below it on the 7th. They are separated by about the width of a finger held at arm's length.

4 A slight lunar eclipse is visible before sunrise today from most of the United States. Earth's dark inner shadow will take a small "bite" from the bottom of the Moon.

5 Venus will transit the face of the Sun late today (see page 8).

Su	M	T	W	Th	F	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

16/17 The brilliant planet Jupiter is to the lower left of the Moon at dawn on the 16th, and just a degree or so to the right of the Moon on the 17th. They are quite low in the sky, so you need a clear horizon to spot them.

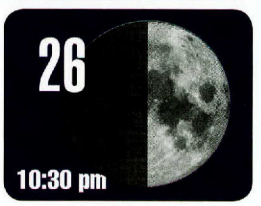
20 Summer arrives in the northern hemisphere at 6:09 p.m. CDT, which is the summer solstice.

21 The planet Mercury and the twin stars of Gemini, Pollux and Castor, line up to the upper right of the Moon shortly after sunset. Mercury is the brightest of the three.

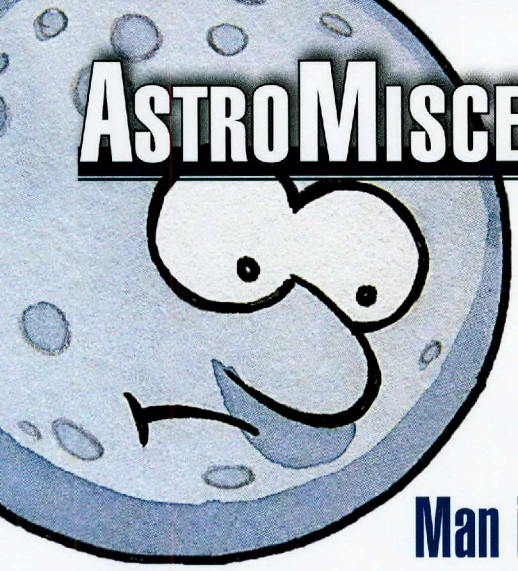
25 Orange Mars is above the Moon at nightfall.

26 Mars stands to the upper right of the Moon at nightfall, with Spica and Saturn to the upper left of the Moon.

27 The star Spica is close to the upper left of the Moon this evening, with Saturn above Spica. Saturn has a slightly golden color, while Spica is blue-white.



AstroMiscellany



Seeing Eye to Eye with the Man in the Moon

Like a parent talking to a snarky child, Earth may have turned the Moon so that its "face" — the familiar Man in the Moon — is always turned in our direction.

The Moon is gravitationally locked so that it takes the same amount of time for it to rotate on its axis and to return to the same position relative to the Sun — about 29.5 days — so the same hemisphere always faces us.

AstroPrimer

The hidden farside consists of mountainous terrain, with a thicker crust than on the nearside, which is distinguished by dark volcanic plains that form the pattern of the Man in the Moon.

Early this year, a team of astronomers suggested the face with the dark markings faces our way because of Earth's gravitational grip.

The Moon probably was born from the debris from a giant collision between Earth and another planet as big as Mars. The young Moon was much closer to Earth and spun much faster, so the entire surface would have been visible from Earth. Tides on both Earth and the Moon caused the Moon to slow down and move farther away.

Computer simulations by Oded Aharonson of Caltech and two colleagues suggested that the rate at which the Moon's rotation slowed favored the current configuration. The Moon is slightly elongated, with the "points" on the nearside and farside, and the simulations showed that Earth's gravity pulled on the nearside a little more strongly than the farside, locking it in position.

BEN HAMILTON

Big Bend National Park Honored for Dark Skies

The International Dark Sky Association has designated Big Bend National Park an "International Dark Sky Park." Located in West Texas about 150 miles south of McDonald Observatory, the park's 800,000 acres have the darkest measured night skies in the continental United States.

Big Bend was recognized not only for its dark skies, but its stewardship of the sky. The park has measured the light in its skies since 2003. A joint project with a commercial vendor to replace all outdoor park lighting led to a 98 percent reduction in light pointed skyward.

In addition to regular tours and hikes, the park hosts stargazing events year-round, night hikes, occasional telescope viewings, and public events on preserving the night sky.

The International Dark Sky Association started the IDS Places Program in 2001. So far, just 10 parks and four towns have been designated IDS Places. Big Bend National Park is the largest of the parks so honored.

For more information: darksky.org/IDSPlaces

Background: A part of the SETILive search area, taken from a Kepler image.

NASA

Eavesdropping on ET

setilive.org

A new website offers users a chance to eavesdrop on ET. With SETILive, participants monitor signals from the Allen Telescope Array in California. The telescope scans dozens of stars for which the Kepler space telescope has discovered planets. Computers sift through the radio signals, but SETILive organizers say the human eye is better at detecting some patterns. The website offers pictures of the radio waves, and trains users to eliminate signals from orbiting satellites, cell phones, and other terrestrial sources. If enough users report an interesting signal in a target star's radio waves, the Allen array will slew back to the star (if in view) to conduct additional observations.

Clockwise from top left: Shenzhou 5 blasts off on China's first human spaceflight in 2003; Shenzhou 5 re-entry module on display; artist's concept of unmanned Shenzhou 8 docking with Tiangong-1 station in November; mission controllers at the Jiuquan Launch Center.

CHINA IN SPACE

The People's Republic has sent taikonauts into Earth orbit, visited the Moon, and has its sights on Mars

By Rebecca Johnson

Even with the world's largest population and oldest continuous civilization, China has been a latecomer to the space arena. That hasn't stopped the emerging superpower from creating a wide-reaching program in the last few decades that has launched dozens of Earth-orbiting satellites, sent unmanned probes to the Moon, and carried out three successful manned spaceflights. It has plans for much more.

Many in the West have mixed feelings about China's ascent into space. The United States and other Western nations' relationships with communist China are complex and color their view of China's space ambitions. Yet with or without collaboration with other nations, China is likely to continue its climb to space.

China's early forays into space have ties to the United States. Chinese rocket engineer Qian Xuesen was a graduate of MIT and Caltech. In the 1940s, he helped to create what eventually became NASA's Jet Propulsion Laboratory. In the 1950s, the FBI and the Los Angeles police accused him of being a Communist (which he denied), and he returned to China in 1955. A few years later, he presented plans to the Chinese government for a space program.

Within a decade and a half, China launched its first satellite, Dong Fang Hong 1. Orbiting Earth for 26 days, it broadcast the song "The East is Red." By the mid-1980s, China offered its launch services to other nations as a competitor to the U.S., Russia, and Europe.

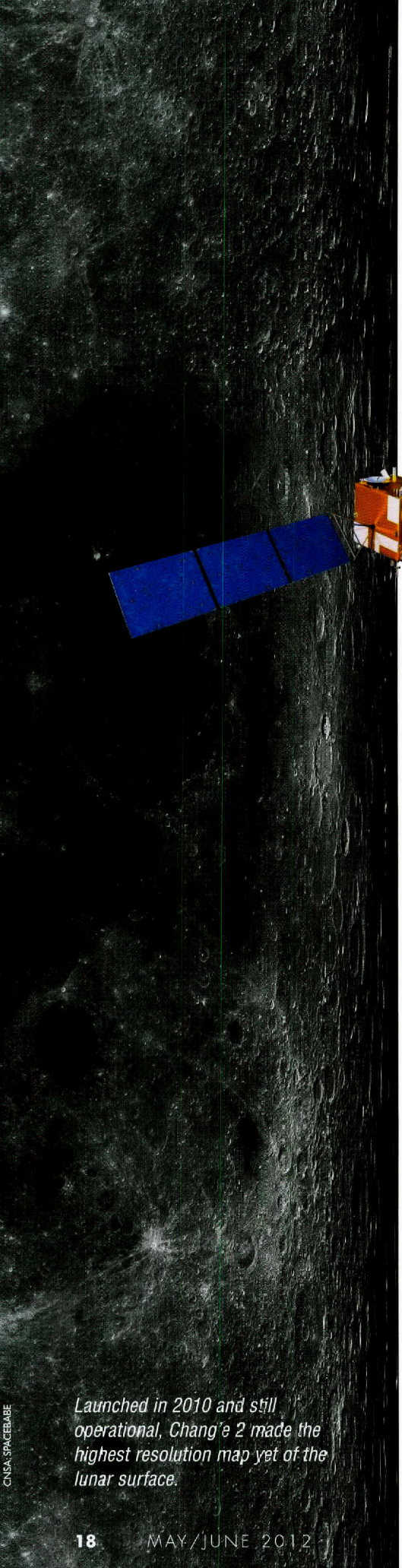
Some American companies looked to China to launch their satellites after the Challenger accident grounded the space shuttle fleet in 1986. As more and more U.S. commercial satellites were launched from China, questions about prohibited technology transfer led to a Congressional investigation in the mid-1990s. The resulting report led to stricter government controls on how American aerospace companies do business with China.

In addition to commercial space endeavors, in the 1980s China began training some astronaut candidates. The program was abandoned for several years, but picked up steam again in the late 1990s.

Today, the heart of China's manned space program is the Shenzhou capsule, or "Divine Ship." Similar to Russian Soyuz spacecraft, but larger, Shenzhous are launched from the Jiuquan launch center in the Gobi desert. From 1999 to 2002, China launched four unmanned Shenzhou test flights.

Lt. Colonel Yang Liwei became China's first "taikonaut" on October 15, 2003, aboard Shenzhou 5. He performed 200 scripted tasks during the 14-orbit, 21.5-hour flight, while the craft was tracked by nine stations across China as well as four ships at sea.

Though its launch was not televised, Chinese President Hu Jintao and other Communist Party leaders were on hand. The English-language *People's Daily* reported that Jintao described the flight as "an honor for our great motherland, an indicator for the initial victory of the country's first manned space flight and for a historic step taken by the Chinese people in their endeavor to surmount the peak



Launched in 2010 and still operational, Chang'e 2 made the highest resolution map yet of the lunar surface.

CNSA, SPACEBABE

of the world's science and technology."

The craft parachuted to a landing in Inner Mongolia, where Yang received a congratulatory phone call from Prime Minister Wen Jiabao. Like Yuri Gagarin, Alan Shepard, and John Glenn before him, Yang became a national hero.

Shenzhou 5 made China the third nation to send people into space, albeit many decades after Soviet and American landmark flights.

"They are where we were in 1962," says former NASA Deputy Administrator Hans Mark, now a professor of aerospace engineering at The University of Texas at Austin. "We are way ahead of the Chinese in the exploration of the Moon, the planets, and everything else. And I also believe that the Chinese, if they put their mind to it, could equal or beat us if we falter. But they're not there."

China is not necessarily out to best the rest of the world in space, however, says Frank Morring, senior editor of *Aviation Week & Space Technology*. "Their real audience is domestic. They're doing it to show their own people," he says.

Two years after Yang's flight, Shenzhou 6 carried two other taikonauts aloft in 2005 for a five-day mission. Shenzhou 7, the most recent manned effort, launched three taikonauts on a three-day mission on September 25, 2008. The mission included China's first spacewalk, and tested a new spacesuit, dubbed Feitian after a flying goddess.

China also has been developing plans for a space station. In late September, it launched a small test module, Tiangong 1 ("heavenly palace"), from Jiuquan. The automated Shenzhou 8 docked with Tiangong 1 on November 2, forming an orbiting structure 60 feet long. These maneuvers may be practice for future flights to a larger space station, which reports say could be completed by 2020.

China's manned space program is run by the People's Liberation Army (PLA), and historically has been shrouded in secrecy, with launches announced only hours in advance.

There are signs, however, that the Chinese may be opening up a bit.

Morring was the first Western journalist to see and touch a Shenzhou spacecraft. "Two or three years ago I went to their launch site at Jiuquan," he says. "They let us climb all over the Shenzhous. ... It was the red carpet treatment all the way — no pun intended."

The Chinese engineers "really wanted to talk to U.S. astronauts," he said, and *Aviation Week's* publisher at the time (and Morring's traveling companion) was former astronaut Tom Henricks, who had commanded two space shuttle missions and piloted two others.

"There were private talks about manned cooperation in space. It seemed like there was going to be some cooperation," Morring says. "Then Congress enacted very strict prohibitions on cooperation with China in space." The 2011 Congressional appropriations act forbids NASA to spend any money on activities leading to space collaboration with China, including allowing official Chinese visitors at NASA facilities.

Lawmakers likely were spurred on to such a tough stance, at least in part, by a 2010 anti-satellite test, in which the PLA shot down one of the country's own defunct weather satellites with an ICBM. The test was widely condemned by other nations. "That's a very scary capability," Morring says. "So much of our economy and military depends on satellites now."

Many in China's space sector want to be more transparent to enable international collaboration, Morring says. "NASA and ESA [the European Space Agency] are very open," says Morring, who covers civil space agencies around the world. "The Indian Space Agency is relatively open; the Japanese, same thing. China is just opening up; they really are making overtures to the U.S."

Developing separately from its manned space program, China's lunar program is run by its civil National Space Agency. Currently in the first stage of a three-stage lunar plan, China has launched two lunar probes. The probes were named after the mythical Chinese goddess Chang'e, who flew to the Moon.

Launched from the Xichang launch center in Sichuan Province on October 24, 2007, Chang'e 1 carried eight instruments. After entering lunar orbit on November 5, the craft began mapping the entire lunar surface in three dimensions and studying its chemistry. Its planned one-year mission was extended until mission directors steered it into a controlled crash on the Moon on March 1, 2009.

Chang'e 2 launched October 1, 2010. Similar in design to Chang'e 1, it carried a higher-resolution camera which enabled it to make an improved Moon map, particularly scouting out a landing site for a future Chinese lander and rover.

After a successful lunar mapping mission, Chang'e 2 was sent to orbit the L2 point, a spot one million miles (1.5 million km) beyond the Moon where the gravity of Earth and Sun balance each other. It's an important vantage for spacecraft, and the planned location for the future James Webb Space Telescope. In sending Chang'e 2 there, China was testing possibilities for future missions.

Construction on the Chang'e 3 lander and rover is under way. The planned launch in 2013 will kick off the second stage of China's lunar program. The craft is scheduled to touch down in the Bay of Rainbows, an ancient volcanic plain. Should it succeed, it would be the first soft landing on the Moon since the Soviet Luna 24 sample-return mission in 1976. A rover would collect and analyze soil and rock samples.

The third stage of China's lunar program is slated to begin with a lunar sample-return mission planned for 2017. Mission designers say it would carry a drill that could reach 2 meters (6 feet) below the lunar surface.

Chinese lunar program engineers and scientists have expressed interest in manned missions to the Moon, but stress that their government has not approved such a mission.

China also has looked beyond the Moon. On November 8, its Yinghou-1 ("firefly") probe launched piggy-back on Russia's Phobos-Grunt mission to Mars. Phobos-Grunt was scheduled to land on Phobos, one of Mars' two small moons, while Yinghou-1 was to remain in Mars orbit to study the planet's space environment, atmosphere, and gravity.

Though the combined craft reached Earth orbit, the rocket's upper stage did not perform its scheduled engine burn to take it toward the Red Planet. Instead, the assemblage fell to Earth in January, breaking up over the Pacific Ocean.

Despite its wide-ranging space programs, and a distinguished history of studying the stars since antiquity, China has yet to launch any purely astronomical missions. Its science-centric craft are mostly Earth-observation satellites that study weather, land use, and the oceans, and provide early warnings of natural disasters.

China has collaborated on Earth-environment research with ESA. In 2003 and 2004, for example, China launched Double Star 1 and 2, which worked with a network of four European satellites to study storms in Earth's magnetosphere, the aurorae, and other space weather phenomena.

China says it expects to launch its first orbiting astronomical telescope in 2015. The 1 billion Yuan ($150 million) Hard X-ray Modulation Telescope (HXMT) has been delayed for several years due to cost concerns. It is slated for a four-year mission, during which it will map the X-ray sky and study supermassive black holes in galaxies.

With its many aspects, China's space program is going strong. The nation has an ambitious lunar program, space station plans, and is just venturing into space-based astronomy, and there are some indications that its historical secrecy may be softening.

Chinese space technology lags behind the U.S., but its large space industry is making rapid strides. And some in the American government worry that any collaboration on civil space projects will lead to technology transfer that China could use for military purposes.

"China has replaced Russia as the existential threat to the United States," says Hans Mark, who also headed the National Reconnaissance Office and served as Secretary of the Air Force. "They've got nuclear weapons, they've got Intercontinental Ballistic Missiles — just like the Russians, they could destroy us. But I don't think they will. I think the Chinese are *much* less dangerous than the Russians were. And the reason for that is that they do not have an ideology which is that, 'We've got to spread X ideology around the world.' Whereas the Russians did."

Though NASA is prohibited from collaborating with China, that doesn't mean things can't change in the future. "We're collaborating with the Russians now," Mark says. "The Russians are the only people that can get us to *our* space station. If somebody had told me that 20 years ago, I would have said, 'you're crazy.' So sure, things could happen that way" with China, he says.

"Now do I believe collaboration in space will make peace? Hell, no! These collaborations are done by a very small number of people for mutual advantage. There's nothing ideological or moral about it."

Rebecca Johnson is editor of StarDate *magazine.*

Resources

Books

The New Space Race: China vs. USA, by Eric Seedhouse, 2010

China's Space Program: from Conception to Manned Spaceflight, by Brian Harvey, 2004

Articles

"Spending Bill Prohibits U.S.-China Collaborations," by Jeffrey Mervis, *Science*, April 21, 2011

"Qian Xuesen dies at 98; rocket scientist helped establish Jet Propulsion Laboratory," by Claire Noland, *The Los Angeles Times*, Nov. 1, 2009

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www.apsco.int

by Rebecca Johnson and Damond Benningfield

NASA/ESA/S. FARRELL (UNIVERSITY OF SYDNEY)

Black Hole Survivor Gnaws Away Giant Star

A circle shows the location of HLX-1 in the halo of the spiral galaxy ESO 243-49, which is seen edge-on.

One of the last remnants of a dead galaxy — a medium-sized black hole — may be devouring a star, taking a bite when the star comes close every year or so. As the black hole swallows the gas it flares brightly, producing X-rays.

The possible black hole, ESO 243-49 HLX-1 (the first "hyperluminous X-ray object" in the large spiral galaxy ESO 243-49) is 290 million light-years away. It was discovered by an X-ray telescope in space. The X-rays suggested the object was a disk of superhot gas around a black hole. Follow-up observations allowed astronomers to measure the mass of the black hole at about 20,000 times the mass of the Sun, making it one of only a handful of possible intermediate-mass black holes discovered so far.

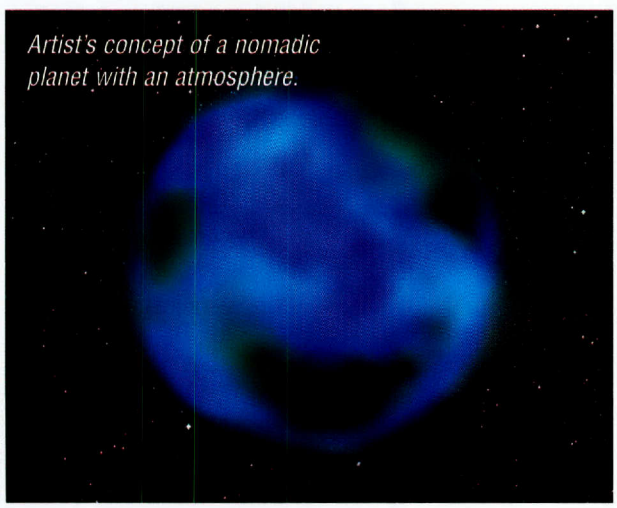
HLX-1 brightens and fades roughly once a year, indicating that the disk is fed by a star that periodically passes close to the black hole, says Sean Farrell of the University of Sydney, who led the discovery team.

"HLX-1 might have trapped a very massive star which is orbiting the black hole in a highly elliptical orbit, feeding the black hole roughly every 367 days, when it passes close to it," he says. "During this phase gas would flow from the star to fill up the disk around the black hole. When it moves farther away from the black hole, accretion would slow and maybe even stop, so the disk would shrink and mostly fade away."

The black hole appears to be surrounded by a cluster of hot, blue stars, suggesting that the whole group is the remnant core of a dwarf galaxy. The large galaxy it orbits today stripped away the smaller galaxy's outer regions about 200 million years ago and compressed the remaining gas in the core to trigger new star formation.

Supermassive black holes at the hearts of large galaxies, which can grow to billions of times the mass of the Sun, may have grown from the mergers of intermediate-mass black holes in dwarf galaxies. Finding such a black hole at the center of a likely dwarf galaxy strengthens that scenario, Farrell says. **DB**

Nomadic Planets Might Spread Life Around the Milky Way



Artist's concept of a nomadic planet with an atmosphere.

GREG STEWART/SLAC

Researchers led by Louis Strigari at the Kavli Institute for Particle Astrophysics say that there may be 100,000 times more free-floating planets in the Milky Way galaxy than stars. They call these "nomad" planets.

Their figure is based on extrapolations from a recent planet search in which astronomers studied the effects of a nearby star passing in front of a distant star and bending the distant star's light – an event called gravitational microlensing. That study found that for every typical star in the Milky Way, there are roughly two nomad planets.

The Kavli team coupled that with other factors, including how much planet-building material is available within the galaxy and the different ways in which planets might form. The number is a guess that needs to be backed up by observations. The astronomers say that those must wait for the next generation of telescopes coming on line in the next decade.

The researchers speculate that if some nomad planets generate their own internal heat and possess thick atmospheres, they might generate bacterial life and carry it from one part of the galaxy to another. **RJ**

Is Earth a Single Parent?

New study casts doubt on giant-impact hypothesis

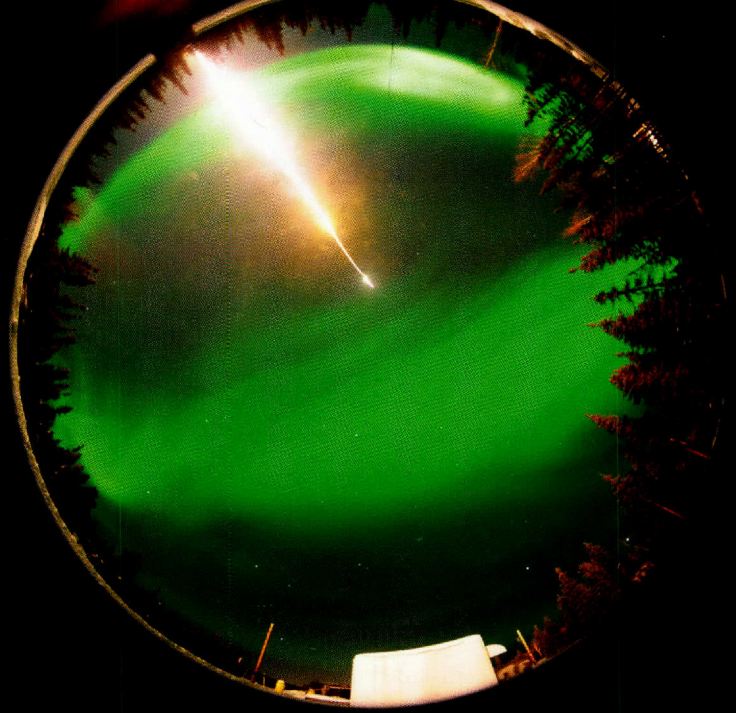
A new study appears to contradict the leading theory of how the Moon was born, suggesting that the Moon formed from Earth alone and not from a collision between Earth and another planet.

The study, led by Junjun Zhang, a graduate student at the University of Chicago, found that the ratio of different forms of titanium in Apollo lunar samples matches that found on Earth. Objects born in different parts of the solar system, such as Earth and the body with which it supposedly collided, were born from slightly different mixes of raw ingredients, so they should have different ratios of titanium.

The giant-impact hypothesis says that a Mars-size body hit the young Earth, blasting a ring of debris into orbit, some of which quickly coalesced to form the Moon. The hypothesis explains the motions of the Earth-Moon system and matches some other chemical studies, but it does not match others.

No other explanation for the Moon's birth has yet emerged, however. An old theory suggested the Moon was born when a rapidly spinning Earth threw a large blob of its own material into space, but that theory doesn't accurately reproduce the dynamics of Earth and Moon.

The study team cautions that a collision between Earth and another planet could have vaporized the titanium in both worlds, resetting the titanium ratios. Such a scenario is unlikely, though, because temperatures probably would not have been high enough.



RYUHO KATAOKA/TOKYO INSTITUTE OF TECHNOLOGY

Blasting Into the Northern Lights

In February, physicists sent a 40-foot NASA rocket into the northern lights about 200 miles above the Poker Flat Research Range in Alaska. The rocket's instruments studied electric and magnetic fields and charged particles in the aurora. The project seeks to discover how 'Alfven waves' interact with Earth's ionosphere to create the spectacular auroral displays, and, in general, better understand 'how the energy of the solar wind gets coupled to Earth's magnetic field and eventually gets dumped into the upper atmosphere,' said Marc Lessard of the University of New Hampshire's Space Science Center.

ESO MPE MARC SCHARTMANN

Artist's concept of the GRAIL twins in orbit; Inset: Earth rises above the Moon in a view from GRAIL.

The Quest for the Lunar Grail

Just three months after beginning work, two NASA spacecraft are set to end their mission of mapping the gravitational field of the Moon in late May. Their efforts will help scientists understand the way the Moon is put together, from its blotchy skin to its heavy core.

The probes form a mission known as GRAIL (Gravity Recovery and Interior Laboratory), which began its observations in early March after arriving at the Moon at the start of the year. The two craft follow the same orbital path, with one trailing the other. Instruments aboard the twin craft measure their distance from each other to within a few millionths of an inch. Such tiny changes in distance reveal variations in the Moon's pull, yielding detailed maps of its gravitational field.

Scientists will use those maps to study the composition of the lunar surface, which has blotches of dense volcanic rock that pull more strongly than the surrounding landscape. The GRAIL observations also will help scientists study the Moon's core, which may be at least partially molten.

GRAIL's mission will end in late May because the two craft will no longer be able to track each other.

Giant Cloud Zips Through Galactic Center

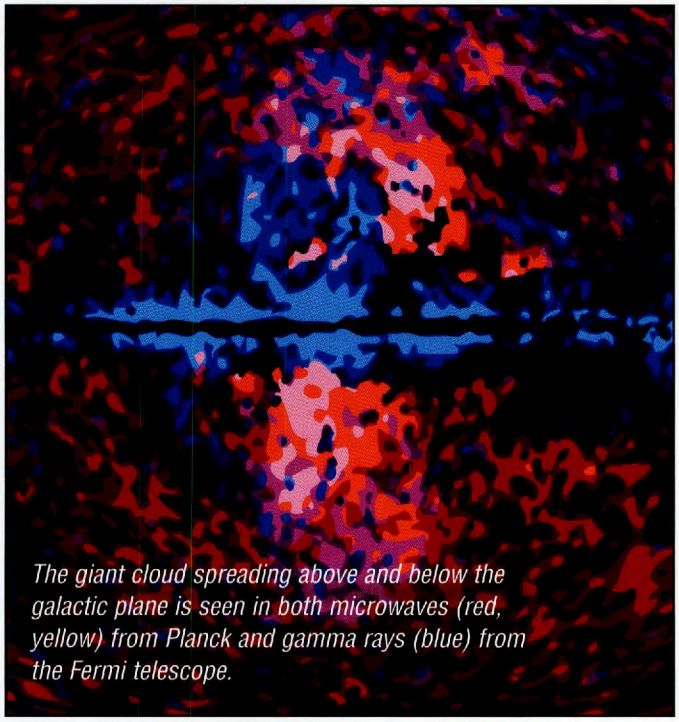
The European Planck telescope has revealed the clearest pictures yet of a cloud of electrons near the center of the Milky Way galaxy that spans 35,000 light-years and moves close to the speed of light.

"The images reveal two exciting aspects of the galaxy in which we live," said Krzysztof Gorski of NASA's Jet Propulsion Laboratory. "They show a haze around the center of the galaxy, and cold gas where we never saw it before." NASA is also a partner in the Planck telescope.

Astronomers are puzzled by the amount of high-energy particles in the cloud, which is greater than the amount that could be created by all the exploding stars in the galaxy. The origin of these high-energy particles remains a mystery.

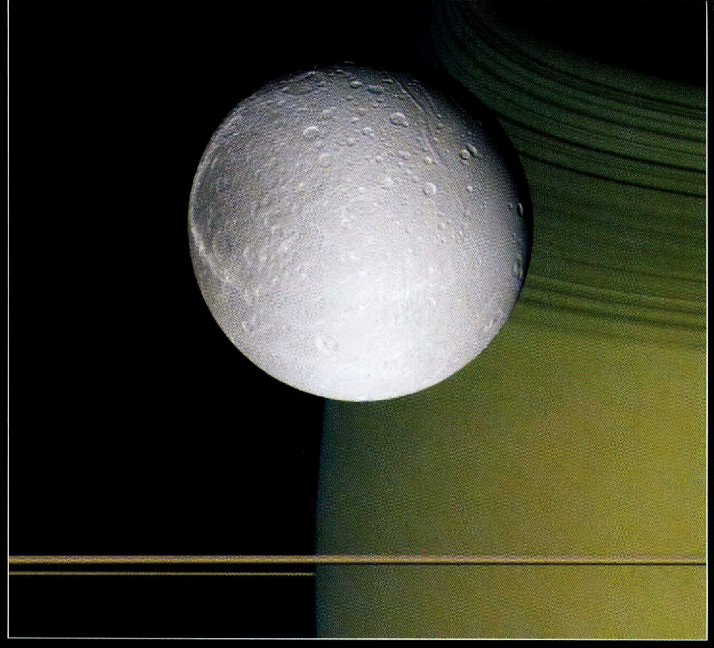
"There are many possibilities and theories," said UC Santa Barbara astronomer Gregory Dobler, "ranging from galactic winds to a jet generated by the black hole at the center of our galaxy to exotic physics related to dark matter. The problem is that the picture that has emerged with the Planck data, as well as the Fermi data, challenges all of the explanations. There is no Goldilocks theory yet. None of them fit the data just right."

Dobler previously saw hints of the cloud in images from the Wilkinson Microwave Anisotropy Probe, helped discover a gamma-ray counterpart with the Fermi telescope, and now is part of the Planck team. **RJ**



ESA/PLANCK COLLAB.; NASA/DOE/FERMI LAT/DOBLER ET AL./SU ET AL.

The giant cloud spreading above and below the galactic plane is seen in both microwaves (red, yellow) from Planck and gamma rays (blue) from the Fermi telescope.



NASA/JPL/SPACE SCIENCE INSTITUTE

A Breath of Thin Air

Faint wisps of atmosphere encircle Dione, a small moon of Saturn, according to recent observations by the Cassini spacecraft. The atmosphere consists of oxygen molecules that may have been knocked into space by solar radiation. It is about as dense as Earth's atmosphere at an altitude of 300 miles, so it is little more than a vacuum. This Cassini image shows Dione in true color against Saturn. Saturn's rings form a horizontal line beneath the moon, and their shadows form the dark bands behind Dione.

WIMPing Out

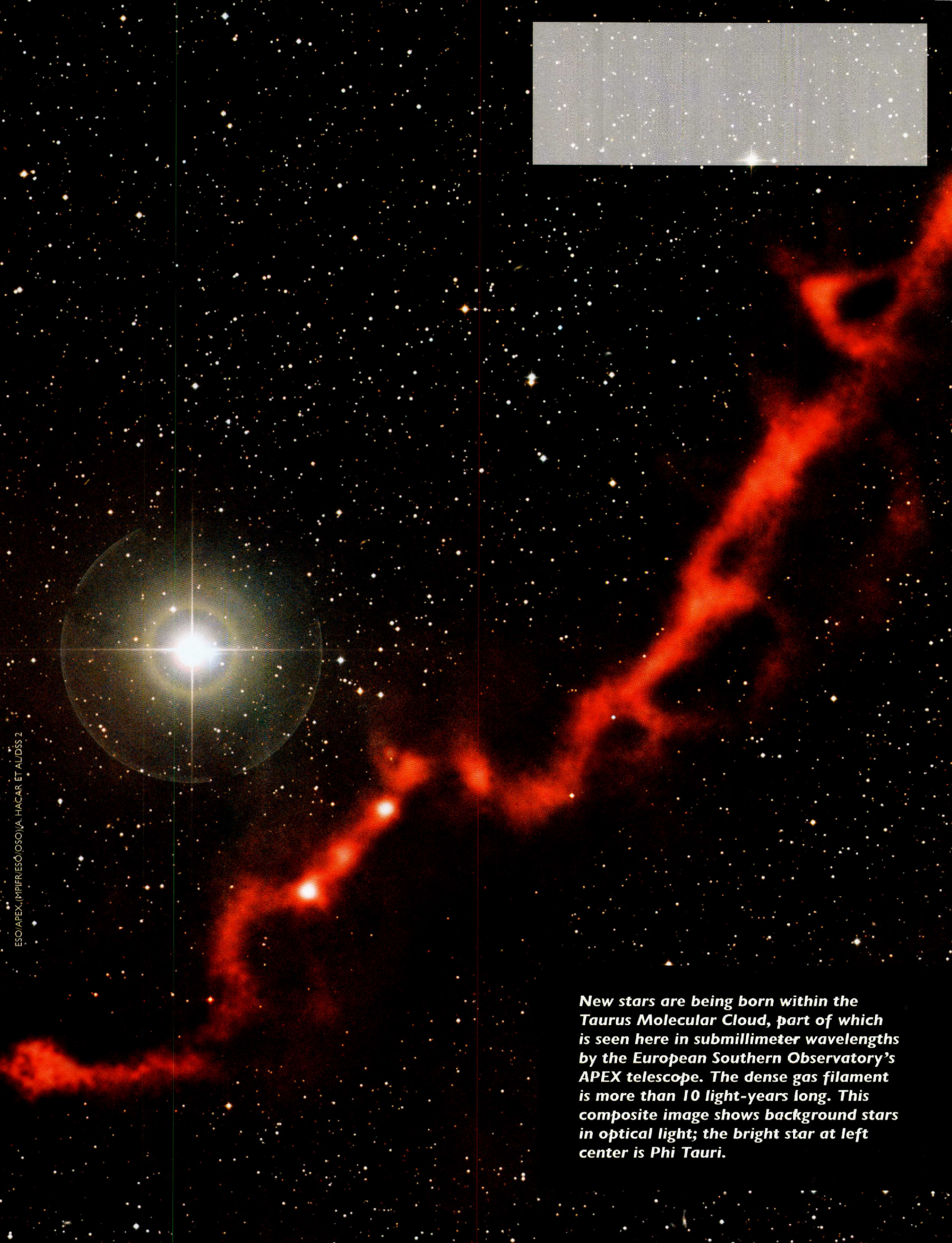
Like a superhero masked from prying eyes, dark matter continues to hide its identity. A two-year search for a possible signature of dark matter has turned up no hint of its identity.

Dark matter produces no detectable energy, but reveals its presence by exerting a gravitational tug on the visible galaxies around it. It appears to make up more than 80 percent of all the matter in the universe.

Leading theories suggest that dark matter comprises a type of subatomic particle, created in the Big Bang, known as a WIMP (weakly interacting massive particle), yet there is no agreement on the details. Some models suggest that certain types of WIMPs should collide and annihilate each other, producing outbursts of gamma rays, which are the most powerful form of energy.

Astronomers have used the space-based Fermi gamma-ray telescope to search for evidence of these interactions in 10 small galaxies that orbit the Milky Way. The galaxies are packed with dark matter. They have few stars, however, so any gamma rays at certain wavelengths must come from the destruction of dark matter.

The observations, however, have revealed no gamma rays at those frequencies, which the astronomers say eliminates some WIMP models. The astronomers plan additional observations of more small galaxies, at different wavelengths, to evaluate other WIMP models.



ESO/APEX/(MPIFR/ESO/OSO)/A. HACAR ET AL/DSS 2

New stars are being born within the Taurus Molecular Cloud, part of which is seen here in submillimeter wavelengths by the European Southern Observatory's APEX telescope. The dense gas filament is more than 10 light-years long. This composite image shows background stars in optical light; the bright star at left center is Phi Tauri.