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Saturn puts on a great show when it reaches opposition in late April. Observers on Earth can see many of the planet’s features, although not to the extent seen here by the Cassini spacecraft. © 2012 Kalmbach Publishing Co. This material may not be reproduced in any form without permission from the publisher. www.Astronomy.com

Martin Ratcliffe provides professional planetarium development for Sky-Skan, Inc., from his home in Wichita, Kansas. Richard Talcott is a senior editor of Astronomy.

A supplement to Astronomy magazine
Meteors battle the Moon in 2013

Every new year begins with a bang — at least if you’re a dedicated meteor observer. One of the most prolific annual showers ramps up to a sharp peak during the year’s initial week, bringing dozens if not 100 or more meteors per hour under good conditions. The 2013 Quadrantid meteor shower reaches its maximum the morning of January 3.

Unfortunately, a waning gibbous Moon shares the predawn sky with this display of “shooting stars.” Our satellite’s bright light will wash out fainter meteors and render the brighter ones less dramatic. Not all is lost, however. The Quadrantids typically produce anywhere from 60 to 200 meteors per hour. Even if the Moon cuts the number in half, a reasonable estimate because the shower generates a high percentage of bright streaks, this shower should still rank among 2013’s best.

You can improve your meteor viewing with a couple of simple tricks. First, observe from a dark site — you don’t want city sky glow or a neighbor’s bright security light to add to the Moon’s glare. Next, try to position yourself where a tree or building blocks the Moon and reduces its glare.

Many of 2013’s other major meteor showers also fight bright moonlight. A waxing gibbous Moon remains in the sky almost until twilight begins at the April 22 peak of the Lyrid shower. The Orionids in October and the Leonids in November fare even worse, with a nearly Full Moon in the sky all night for both showers. And the Geminids, which peak December 14, have a single hour of darkness between moonset and the beginning of twilight. On a happier note, the waning crescent Moon won’t interfere with the Eta Aquarid peak the night of May 5/6.

But the year’s best meteor display promises to come during the Perseid shower. A waxing crescent Moon sets by 11 p.m. local daylight time August 11, leaving the prime viewing hours after midnight free from its illumination. See page 9 for more on this great summer shower.
Spend evenings with Mercury

You can catch your first glimpse of Mercury this year shortly after the Sun sets in February. The innermost planet pulls away from our star during the month’s first week. On the 1st, Mercury shines brightly (magnitude –1.1) and sets nearly an hour after the Sun.

If you watch during twilight the next two weeks, you’ll see the planet climb progressively higher. On February 8, Mercury passes just 0.3° north of Mars. The inner planet then shines at magnitude –1.0 — eight times brighter than its ruddy companion. You’ll likely need binoculars to catch Mars’ dim glow against the bright twilight. Three nights later, a slender crescent Moon appears some 5° to Mercury’s upper right.

The planet reaches the peak of this evening apparition at greatest elongation February 16. It then lies 18° east of the Sun and stands 11° above the western horizon 30 minutes after sunset for observers at mid-northern latitudes. Afterward, Mercury sinks into the solar glare as quickly as it rose, disappearing from view by month’s close.

Getting a clear look at the innermost planet depends on several factors. Because it never strays far from the Sun, Mercury appears only low in the west after sunset or in the east before sunrise. It climbs highest around the times of greatest elongation, but not all such configurations are created equal. Your local setting also plays a role — buildings, trees, or hills can obstruct your view.

Mercury makes five other appearances during 2013. It puts on a similarly good evening show in late May and early June, although the company it keeps then far outshines the glow Mars offers in February. From May 24 to 28, Mercury, Venus, and Jupiter lie within 4° of one another. (Venus is the brightest of this trio and Mercury the faintest.) After Mercury reaches greatest elongation June 12, it heads back toward the Sun and passes just 2° from Venus on the 20th.

The innermost planet’s best morning appearance of 2013 for Northern Hemisphere observers occurs around the time of its November 17 greatest western elongation. It then lies 12° high in the east-southeast 30 minutes before sunrise. It appears nearly as high before dawn in late July.

For viewers who live at mid-northern latitudes, Mercury’s worst appearances come around greatest elongation March 31 (morning sky) and October 9 (evening sky). Solar system geometry then favors viewers south of the equator. For observers at 30° south latitude in late March, the planet appears some 20° above the eastern horizon 30 minutes before sunrise. At October’s greatest elongation, Mercury climbs equally high in the west a half-hour after sunset.

Mercury’s pockmarked surface displays circular craters, deep basins, bright rays, and maybe water ice to the sharp eyes of NASA’s MESSENGER spacecraft. NASA/JHUAPL/CIW

Mercury puts on a nice show in February’s evening sky. On the 11th, the innermost planet lies between the Moon and Mars.
A bright comet in evening twilight

A dazzling comet can ignite a viewer’s passion better than almost any other celestial object. Those flames could burn bright this month for seasoned observers and novices alike — astronomers forecast Comet C/2011 L4 (PanSTARRS) will glow brighter than any comet in the past six years. And for those in the Northern Hemisphere, this could be the brightest easy-to-view comet since the 1990s.

Researchers discovered this comet June 6, 2011, on images taken through the 1.8-meter Panoramic Survey Telescope and Rapid Response System (PanSTARRS) on Haleakala in Hawaii. At the time, the object glowed dimly at 19th magnitude. But its time as an inconspicuous visitor from the distant Oort Cloud will soon be over.

If predictions hold true — never a sure thing when it comes to comets making their first trip through the inner solar system — C/2011 L4 will become a superb object when viewed through binoculars and probably an impressive naked-eye sight. It could peak as bright as magnitude 0 during the first half of March.

Southern Hemisphere observers will have the best views during January and February. In 2013’s first month, the comet should reach 7th magnitude as it crosses Scorpius and Corona Australis and appears low in the east before dawn. It brightens considerably — perhaps to 2nd magnitude — and tracks more rapidly eastward during February. Early morning observers south of the equator will find it passing through southern Sagittarius, Corona Australis, Microscopium, Grus, and Piscis Austrinus.

The comet pushes northward during March, when it becomes visible in the evening sky for Northern Hemisphere observers. The earliest views should come around March 6 or 7, when it appears a degree above the western horizon 30 minutes after sunset. Each following day, the comet climbs 1º to 2º higher, which dramatically improves its visibility. By the time it reaches perihelion (its closest approach to the Sun) March 9/10, C/2011 L4 lies 7º high in the west 30 minutes after sunset and should shine at magnitude 0. As dusk soaks up the Sun’s rays and the sky darkens, the comet’s ethereal tail should come into view.

From perihelion to the end of March, the comet moves almost due north through Pisces and Andromeda while its brightness drops by about a magnitude every five days. The tail of PanSTARRS swings through 90º, turning from east to north. Depending on how much dust the comet produces, this could create a nice broad dust tail to go along with a finer, straighter gas tail.

The comet should fade to 4th magnitude by early April, which would make the extended object visible only through binoculars or a telescope. It passes 2.5º west of the Andromeda Galaxy (M31) on the 3rd, then crosses into Cassiopeia on the 9th.

As good as C/2011 L4 could be, it might be only the second-best comet of 2013. As this issue was going to press, astronomers were predicting that C/2012 S1 (ISON) could peak as bright as magnitude –12 in late November. To learn more about this potentially great comet, see the article in the January 2013 Astronomy.
Running rings around Saturn

Saturn appears magnificent from January through September, but it reaches its peak when it lies opposite the Sun in our sky in late April. At opposition, any outer planet rises near sunset and remains visible all night. But more importantly, the planet then lies closest to Earth, so it shines brighter and appears larger when viewed through a telescope than at any other time of the year.

Saturn begins the year among the relatively faint background stars of Libra. This region rises around 2:30 a.m. local time and lies high in the southeast as twilight begins. But Saturn pokes above the horizon a few minutes earlier every day. By mid-February, you can find it low in the eastern sky at midnight.

Saturn continues to rise earlier and grow more prominent as it approaches its April 28 opposition. The planet then shines at magnitude 0.1 and easily surpasses its stellar neighbors. When viewed through a telescope, Saturn’s disk spans 19” across its equator and 17” through the poles — a difference that’s easy to see through any size instrument.

This assumes, of course, that you aren’t totally enthralled with the planet’s gorgeous ring system. At opposition, the rings span 43” and tilt 18° to our line of sight. They haven’t appeared this open since 2006, which makes this a great year to explore their structure. You easily will see the 2,900-mile-wide Cassini Division that separates the outer A ring from the brighter B ring. On nights with steady viewing conditions, you should be able to spot the semitransparent C ring that lies closest to Saturn as well.

After opposition, the ringed planet remains prominent throughout the spring and summer. Unlike other bright planets, Saturn doesn’t change its appearance much as it moves away from peak visibility. Its brightness varies by just 0.6 magnitude during 2013, and the rings look beautiful at almost any scale.

Saturn’s westward motion relative to the background stars carries it into Virgo in mid-May. The planet spends most of June and July in the company of 4th-magnitude Kappa (κ) Virginis before it loops back eastward. It returns to Libra in early September.

As Saturn dips toward the western horizon in September, it passes 4° from brilliant Venus on the 19th. Three weeks later (October 10), the ringed planet appears 5° from Mercury, although the pair will be low enough in evening twilight to prevent good views. These two have a better conjunction after they move into the morning sky. On November 26, Mercury passes 0.3° from Saturn in the predawn twilight. Saturn closes out the year shining conspicuously in the southeast before dawn.
When the Sun and Moon align

Some of the most beautiful sky events involve shadow play — either when the Moon casts its shadow onto Earth or our planet blocks sunlight from reaching the Moon. Five such eclipses occur in 2013, although the solar variety (when our satellite lies between the Sun and Earth) perform significantly better than the lunar type (when our world plays the central role).

On May 9/10, an impressive solar eclipse will cover a similar stretch of land as last November's eclipse. This time, however, the Moon lies farther from Earth than average, so it doesn't completely cover the Sun. This leaves a ring of sunlight visible to people situated along the central track, creating an annular eclipse as opposed to the total one six months earlier.

The path of annularity begins at sunrise May 10 in Western Australia, crosses the Northern Territory, and then cuts across Queensland northwest of Cairns. People on the center line in Queensland will witness more than four minutes of annularity. Although November’s eclipse immersed Cairns in totality, some of the same regions northwest of there lie within both tracks.

After the Moon’s shadow leaves Australia, it crosses the southeastern tip of Papua New Guinea and some of the Solomon Islands before heading across the Pacific. Although the annular eclipse makes no other significant landfall, many islands experience a partial eclipse. People on the southern coast of Hawai‘i’s Big Island will see the Moon cover 50 percent of the Sun at 3:48 p.m. HST May 9. Those in Honolulu will witness 44 percent of the Sun disappear at 3:48 p.m. HST. Because the Moon never completely covers the Sun during this eclipse, viewers will need to use safe solar filters. Nearly six months later, 2013’s second solar eclipse promises to be even more spectacular. On November 3, the Moon fully blocks the Sun for people along a narrow path that cuts across central Africa. For details on this total eclipse, see page 12.

This year’s three eclipses of the Moon pale in comparison to its solar eclipses. On April 25, residents of Europe, Asia, Africa, and Australia can see a slim partial lunar eclipse. The Full Moon’s northern limb dips into Earth’s dark umbral shadow for 27 minutes. At maximum (20h07m UT), just 1.5 percent of the Moon’s diameter lies in the shadow.

And this stands as the year’s best lunar eclipse. On May 24/25 and October 18/19, the Moon slides through Earth’s lighter penumbral shadow. The first of these will be essentially undetectable, with only 2 percent of our satellite entering the shadow’s fringe.

North American observers might glimpse the second penumbral eclipse the evening of October 18. The Moon slides into the shadow starting at 5:51 p.m. EDT. By 7:50 p.m., about three-quarters of our satellite lies in the shadow. Sharp-eyed observers should see the Moon’s southern limb darken slightly around the peak.
An active Sun means observing fun

If predictions hold true, our star will reach its highest level of activity in a decade sometime this spring or summer. Observers saw little activity from 2008 into 2010, and several months went by without any sunspots. But sunspot numbers on our local star have been rising these past couple of years and seem poised to peak in 2013. (Solar scientists won’t know when maximum occurs until after the number of sunspots starts to fall.)

Observing the Sun can be exciting, but you have to be cautious. Sunlight can quickly and painlessly injure your retinas, possibly leading to blindness, particularly if you view through a telescope. (The intense light can damage optics, too.) If you want a direct view of the Sun, you must use a safe solar filter that fits over your scope’s front end. The most common are white-light and specialized Hydrogen-alpha filters.

Alternatively, you can project the Sun’s image. Drawing a circle a few inches in diameter on a card lets you plot the positions of sunspots and forms a nice record of your observations. Use a telescope no larger than 4 inches in aperture to reduce heat buildup and a basic eyepiece that has few optical elements — the adhesives in some modern eyepieces can melt with prolonged solar viewing.

If you record sunspot positions every day, you’ll soon discover that the Sun rotates. Observe long enough and you’ll discern our star’s period of rotation. Although the equatorial regions take about 25 days to spin around the Sun’s axis, you’ll record a period about two days longer because Earth’s orbital motion changes our perspective. Our star’s gaseous nature causes higher latitude regions to rotate more slowly.

During the approximately 11-year solar cycle, sunspots migrate from relatively high to lower latitudes. With their numbers now peaking, don’t be surprised to see two nearly parallel belts of these dark blemishes standing astride the solar equator. Sunspots appear dark because they are some 2000°F Fahrenheit cooler than the rest of the Sun’s surface.

Other signs of solar activity to look for include white-light flares and, if you view through a Hydrogen-alpha filter, bright prominences along the solar limb and dark filaments projected against the solar disk. Although scientists predict the number of spots in this cycle will be significantly lower than normal, don’t let that discourage you — astronomer Richard Carrington observed the largest white-light flare ever recorded in 1859 during a similar level of solar activity.

Solar activity also can have effects closer to home. Strong flares and coronal mass ejections can expel enough high-energy particles to damage orbiting spacecraft and power-line transmissions. And for observers, these particles pump energy into Earth’s magnetosphere, creating stunning auroral displays. So, even if you prefer your observing at night, this year’s solar maximum holds great promise.

The Sun will display many sunspots and other activity as our star reaches the peak of its 11-year cycle. Jim Lafferty

Northern skywatchers should look for aurorae this year as the Sun bombards Earth’s magnetosphere with charged particles. Marvin Nauman
Under a changing light

Astronomy offers several enticing deep-sky pursuits. Some observers prefer viewing splashy star clusters, many appreciate glowing nebulae, and still others hunt down faraway galaxies. Although they usually don’t get the attention heaped on their flashier cousins, variable stars also excite lots of sky gazers. It’s easy to identify many of these stars and estimate their brightnesses, and in some cases it takes only a minute or two.

The summer sky has a few bright ones to get you started. Two famous long-period variable stars — Mira (Omicron [ο] Ceti) and Chi (χ) Cygni — reach their peak this season. And Delta (δ) Cephei, a star important for its historic role in measuring cosmic distances, is on view every clear evening.

Let’s begin with Mira, which should reach maximum light in late July. It then lies one-third of the way to the zenith in the southeastern sky in the hour before dawn. Mira typically ranges from 3rd to 10th magnitude over a 332-day period, though it occasionally grows even brighter. As it nears maximum this summer, it changes the appearance of Cetus the Whale. You can find the variable approximately 10° southwest of a conspicuous circle of stars that forms the Whale’s head.

Summer evenings feature two other bright variables. Chi Cygni, a pulsating variable similar to Mira, lies nearly overhead around midnight. Its brightness ranges from 5th to 13th magnitude over a 407-day period. Near its maximum, Chi changes the appearance of Cygnus the Swan by adding a star to the bird’s neck. It should glow brightest in early June and remain visible to naked eyes in July and August.

Our final star, Delta Cephei, lies near the southeastern corner of Cepheus the King. Delta sits at the eastern apex of a small triangle it forms with Zeta (ζ) and Epsilon (ε) Cep, a pair of stars separated by two Full Moon-widths.

Delta varies between magnitudes 3.5 and 4.4 over a 5.4-day period. This makes it ideal for a quick estimate every clear night, and you can witness its entire cycle within a week. Zeta and Epsilon Cep nearly span Delta’s brightness range, with Zeta shining at magnitude 3.6 and its neighbor at magnitude 4.2. Variables like Delta pulsate with regular periods, and their luminosities correlate with their periods. This behavior makes such stars ideal for measuring distances throughout the local universe.

Mira varies from 3rd to 10th magnitude during a 332-day period. It should reach its peak in late July. Astronomy: Roen Kelly

Delta (δ) Cephei changes brightness by 0.9 magnitude every 5.4 days. (Numbers are magnitudes with decimal points left out.) Astronomy: Roen Kelly
**Perseids receive a Hero’s welcome**

Although this is a down year for meteor showers overall, the Perseids are a notable exception. While the other major showers share the sky with the Moon, the Perseids peak under Moon-free conditions the morning of August 12. From mid-northern latitudes, the five-day-old crescent Moon sets shortly after 10 p.m. local daylight time on the 11th. As always, you’ll see more meteors at a viewing site far from artificial lights.

It actually takes a few weeks for our planet to cross the broad trail of debris ejected over millennia by Comet 109P/Swift-Tuttle. Each time the comet enters the inner solar system (a feat it performs every 133 years), the Sun’s heat evaporates some of the ices in the nucleus, which liberates plenty of dust. This debris eventually spreads along the comet’s entire orbit. Perseid meteors result when Earth plows through this debris and friction with the atmosphere vaporizes the dust particles.

Our planet encounters the leading edge of this trail in mid-July. The number of meteors gradually rises until the peak night, when rates top out at up to 100 meteors per hour. These high rates can last 10 hours, providing excellent views for observers across a wide range of longitudes. That helps North Americans this year because the peak should occur around noon August 12, leaving the predawn hours of the 12th a little better than the following morning. The number of meteors visible on succeeding nights falls until Earth exits the debris stream around August 24.

Throughout this period, the Milky Way arches nearly overhead during the predawn hours. This is a favorite backdrop for viewers to scan for meteors and photographers to capture the bright streaks. Many Perseids leave a persistent train — a glowing tunnel of ionized gas in the atmosphere created by a particularly bright meteor.

The Perseids get their name from the constellation Perseus. All of the meteors appear to emanate from a region near the border between this constellation and its neighbor, Cassiopeia. This is purely a perspective effect — the meteors travel on parallel paths, but our location on Earth creates the illusion of diverging trails.

Although observers will see more meteors in the hour before twilight begins, keep watching as the sky starts to brighten. By this time, the radiant lies nearly overhead and you’re on the part of the planet heading straight into the dusty debris stream. The meteors then hit the atmosphere at top speed — some 37 miles per second — and consequently appear especially bright.

**This bright Perseid meteor highlighted the 2012 shower. A waxing crescent Moon sets well before midnight at this year’s peak, leaving a dark predawn sky.**

**The Moon sets before the 2013 Perseid meteor shower peaks, allowing viewers under a clear, dark sky to see up to 100 meteors per hour.**

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A bright year for asteroids

More than 100,000 asteroids lurk between the orbits of Mars and Jupiter. Because of Jupiter’s gravitational influence, these objects failed to coalesce into a full-fledged planet during the solar system’s earliest days. A few of the largest of these protoplanets now orbit the Sun in the company of a vast number of smaller bodies created by subsequent collisions.

Although this so-called asteroid belt holds many tempting targets, backyard observers tend to concentrate on four — Ceres, Pallas, Juno, and Vesta — that were the first ones discovered. But 2013 holds a surprise: The two brightest asteroids to reach opposition and peak visibility rarely appear on viewers’ radar screens. Bamberga is at its best September 13 and remains a nice sight well into September. Johann Parisa first detected 324 Bamberga in February 1892, one of 122 asteroids the Austrian astronomer discovered. The space rock begins September glowing at magnitude 8.3 inside the familiar Circlet asterism in western Pisces, just below the Great Square of Pegasus. By opposition, Bamberga brightens to magnitude 8.1 and lies even closer to Pisces’ northwestern corner. The asteroid shines brightly enough to show up through binoculars, though a telescope makes it somewhat easier to track down.

Englishman John Russell Hind discovered 7 Iris in August 1847. At opposition this year, the asteroid glows at magnitude 7.9 and appears within 1° of the magnitude 2.9 star Beta (β) Aquarii. By September, Iris has faded slightly and lies among the background stars of western Aquarius. Although Bamberga and Iris are the brightest asteroids that reach opposition in 2013, 1 Ceres and 4 Vesta are worth targeting early in the year. Both reached opposition in December 2012 and remain 7th-magnitude objects in Taurus during January. To find them, see the map on page 43 of Astronomy’s January 2013 issue. Ceres passes 2° south of magnitude 1.7 Beta Tauri early in the month. It then heads a few degrees west before loop ing back and coming even closer to the star in early March. Vesta lies in a more crowded region — near the striking V-shaped Hyades star cluster — some 10° to 15° southwest of Ceres. During January’s final week, Vesta remains nearly stationary just 3° north of 1st-magnitude Aldebaran and 1° east of magnitude 3.5 Epsilon (ε) Tauri, the star that marks the Hyades’ northeastern tip.

Ceres and Vesta continue to be newsmakers for more than their visibility. NASA’s Dawn spacecraft orbited Vesta from July 2011 to September 2012. The probe discovered a series of equatorial grooves, analyzed the asteroid’s diverse composition, and mapped a giant crater and mountain peak at the object’s south pole. Dawn is now making its way to Ceres, which it should reach in early 2015. Observations from Earth show Ceres to be icier than rocky Vesta. In a few years, planetary scientists should know for sure.
Icy giants for chilly autumn nights

The outermost major planets come to opposition within several weeks of each other in 2013. Uranus reaches its peak October 3, less than six weeks after its more distant sister planet, Neptune. Both will be easy to find and fascinating to observe these fall evenings. Simply seeing the light from these worlds at the solar system’s edge evokes mystery and wonder.

Although planetary scientists now use the term ice giant to describe these outer worlds, don’t think of them as massive balls of frozen ice. The description caught on as a way to differentiate Uranus and Neptune from their larger cousins, the gas giants Jupiter and Saturn. By “ice,” scientists mean Uranus and Neptune have relatively high abundances of substances such as water and methane while both Jupiter and Saturn consist almost entirely of hydrogen and helium. The large number of exoplanets with masses similar to Uranus and Neptune discovered in the past several years shows the importance of this class of planet.

Uranus is easier to locate. It spends 2013 wandering in a sparse region near the border between Pisces and Cetus. The planet shines at magnitude 5.7 at opposition, bright enough to show up to naked eyes from a dark site. It’s much easier to view through binoculars, however. Uranus lies in the same binocular field as the magnitude 4.4 star Delta (δ) Piscium. At opposition, the planet lies 5° south-southwest of the star. On October 14, Uranus moves within 7’ of a magnitude 6.4 sun. Crank up the magnification, and you’ll see the planet’s 3.7”-diameter blue-green disk.

You’ll need a bit more perseverance to track down Neptune. Although this distant world reaches opposition August 26, it lies so far from Earth (some 2.7 billion miles) that its appearance hardly changes during the next several months. It remains at its peak magnitude of 7.8 until mid-October and doesn’t fade below magnitude 7.9 until 2014. It also stands higher in the evening sky during autumn than in late summer.

You’ll need binoculars or a telescope to spot Neptune. It resides among the background stars of Aquarius, roughly midway between Sigma (σ) Aquarii (magnitude 4.8) and 38 Aqr (magnitude 5.4) throughout the summer and fall. These two stars lie 5° apart and will appear in the same binocular field. Turn a telescope on Neptune and boost the magnification to see its tiny blue-gray disk, which measures just over 2” across.
The year’s preeminent eclipse arrives November 3, when the Moon passes between the Sun and Earth and casts its shadow on our planet. This solar eclipse is special because it belongs to the rarest class. Only about 5 percent of all eclipses are hybrids — annular along part of the central track and total along the rest.

The Sun and Moon appear nearly the same size in our sky, about 0.5° in diameter. But neither the Moon’s orbit around Earth nor ours around the Sun is perfectly circular, so their dimensions change slightly during the course of the month and year. When the three objects line up precisely and the Moon appears a hair smaller than the Sun, as it does May 9/10, we see an annular eclipse. If the Moon looks a bit bigger than our star, observers see a total eclipse.

On November 3, the Moon and Sun are exactly the same apparent size for a brief second. At the start of the central eclipse, the Sun looms a tiny fraction larger and observers on the center line see the ring of fire of an annular eclipse.

But during the next couple of hours, the Moon moves about 300 miles closer to Earth and the shadow falls on a point more directly beneath the Moon and — voilà — totality! The central path begins in the Atlantic Ocean about 600 miles due east of Jacksonville, Florida. Although few, if any, people will travel there to witness annularity (which lasts just four seconds on a path 2.5 miles wide), residents along North America’s East Coast can see a partial eclipse at sunrise. From Boston, for example, the Moon will cover slightly less than two-thirds of the Sun as the pair rises around 6:20 a.m. EST. The eclipse ends about 50 minutes later. People farther south and west will see less of our star blocked. (Remember to use a safe solar filter to view any partial eclipse.)

Less than 300 miles east-southeast of where the annular phase starts, the eclipse turns total and remains that way along the rest of the path. Maximum eclipse occurs in the Atlantic some 200 miles southeast of Liberia, where totality lasts 1 minute and 39 seconds.

The Moon’s shadow makes no landfall until it reaches the African coast in Gabon north of Port-Gentil. On the center line there, totality lasts 1 minute and 8 seconds. The Moon’s shadow continues east and slightly north, rushing across narrow sections of Gabon, Congo, the Democratic Republic of the Congo, northern Uganda and Kenya, and southern Ethiopia before ending at sunset in Somalia. The duration of totality falls as the eclipse sweeps across equatorial Africa, dropping to less than 25 seconds by the time it reaches Uganda.
Venus’ brilliant evening return

Although Venus reaches its greatest elongation from the Sun on November 1, it appears significantly higher in the evening sky in early December. The extra altitude makes it even more conspicuous when it shines brightest (magnitude –4.9) December 6.

Venus’ upward trend arises through solar system geometry. The ecliptic — the Sun’s apparent path across the sky that the planets follow closely — makes a shallow angle to the western horizon during early autumn from mid-northern latitudes. So, Venus’ elongation from our star translates more into distance along the horizon and less into elevation. But during November and December, the ecliptic’s angle steepens sharply, more than offsetting the planet’s smaller solar elongation. On November 1, Venus appears 11° high in the southwest an hour after sunset; by December’s first week, it stands 15° high.

Venus first emerges into the evening sky during May. Although the planet lies low in bright twilight, make an effort to view it during the month’s final week. On the 28th, it passes 1° north of Jupiter. Venus then shines at magnitude –3.9, two full magnitudes brighter than Jupiter. As a bonus, Mercury lies 3° from the pair.

Venus has several close encounters with bright stars during the summer and fall. It cruises 1.2° north of Regulus in Leo on July 21, 1.8° north of Spica in Virgo on September 5, and 1.6° north of Antares in Scorpius on October 16.

By the time it reaches greatest elongation November 1, Venus lies against the backdrop of the Milky Way just 2° north of the galaxy’s center. The second planet from the Sun then shines at magnitude –4.5 and appears 47° east of our star. As Venus continues its trek across Sagittarius, it slides 3° south of the Lagoon Nebula (M8) on November 5 and 6. The 6th likely offers the finest view because a slim crescent Moon stands nearby. Use binoculars to see the Moon 7° north of Venus, with the Lagoon and Trifid (M20) nebulae midway between. The group lies low in the southwest as darkness falls, so view from a dark site with an unobstructed horizon and hope for clear skies.

A telescope reveals dramatic changes on Venus during the year’s final two months. On November 1, the inner planet displays a 25”-diameter disk that appears half-lit. At the time of greatest brilliancy December 6, Venus shows a disk 41” across and one-quarter lit. By New Year’s Eve, the planet has swelled to 60” in diameter while its phase has waned to a thin sliver just 4 percent lit. It then appears less than 10° above the horizon 30 minutes after sunset; it will succumb to the Sun’s glare by the end of January’s first week.
Jupiter gleams high in the sky

Jupiter dominates the night sky in early 2014. It reaches opposition and peak visibility January 5, when it shines at magnitude –2.7 and appears 47" across through a telescope. Even better for Northern Hemisphere observers, the giant planet resides among the stars of Gemini, so it passes nearly overhead around midnight local time. This is as high as it’s been for northern observers in 12 years.

Jupiter doesn’t reach opposition in 2013. This omission does not happen often for the solar system’s largest planet. The period between oppositions runs 399 days, or about 13 months. A simple calculation shows that if Jupiter lies opposite the Sun in our sky in December (as it did December 2, 2012), it rules out an opposition the following year. The next year void of a Jupiter opposition is 2025.

Despite the lack of peak viewing conditions, Jupiter is a stunning object for much of 2013. As January begins, its vital stats — a magnitude of –2.7 and an equatorial diameter of 47" — match those in January 2014. The planet graces the constellation Taurus in early 2013, lying between the Hyades and Pleiades star clusters. After nearly all-night visibility during the winter and evening views during spring, Jupiter sets soon after twilight in May. It has a fine conjunction with Venus May 28, when the two brightest planets appear 1° apart with Mercury 3° away.

Jupiter reappears in the morning sky during July. It meets Mars on July 22, when the two lie less than 1° apart against the backdrop of Gemini. The giant planet rises earlier each night through late summer and autumn, coming up around midnight in early October as it ushers in a return to the late-evening sky.

The gas giant moves eastward relative to the starry background until November 7, when it becomes stationary and then starts traveling westward. As it loops through central Gemini, Jupiter twice passes close to magnitude 3.5 Delta (δ) Geminorum. On October 3/4, the planet skims 7' north of the star; on December 10/11, 15' separate the pair.

When viewed through a telescope, Jupiter offers a stunning array of atmospheric features and four bright moons. The best views come during moments of good seeing, when Earth’s image-distorting atmosphere steadies and the planet’s disk sharpens. These moments happen most often when Jupiter lies high in the sky, so observers throughout the Northern Hemisphere should have spectacular views in late 2013 and early 2014.
No one has seen a total eclipse of the Moon since December 2011, but the long drought ends with a veritable flood in 2014. On the night of April 14/15, the Full Moon dips deeply into Earth’s shadow. People throughout North America will have ringside seats for the entire show. The eclipse’s partial phases begin at 1:58 a.m. EDT. For the next hour or so, the Moon darkens as totality approaches. This peak stage lasts from 3:06 a.m. to 4:25 a.m. Our satellite should appear orange-red during totality as sunlight filters through Earth’s atmosphere. The partial phases wrap up at 5:33 a.m.

As if one encounter with totality isn’t enough, the Moon returns to Earth’s shadow the morning of October 8. This event’s partial phases commence at 5:14 a.m. EDT with totality following at 6:24 a.m. After 60 minutes immersed completely in our planet’s shadow, the Moon re-emerges at 7:24 a.m. Residents of western North America will have the best view of this eclipse, although even those on the East Coast will see at least some of totality.

No total solar eclipses grace our skies in 2014, but a partial eclipse takes place across most of North America the afternoon of October 23. People in most of the United States will see the Moon block more than 40 percent of the Sun’s disk while those in the country’s northern states and in Canada will see more than 60 percent coverage. Maximum eclipse occurs in northern Canada, where 81 percent of the Sun will be hidden from view.

Planet-watchers can look forward to a dramatic appearance of Mars in the spring. The Red Planet reaches opposition April 8, when it shines at magnitude –1.3 and spans 15” when viewed through a telescope. It hasn’t appeared this big and bright since 2007. Meanwhile, Saturn looks gorgeous for a few months on either side of its May 10 opposition, and Jupiter reigns supreme around its early January peak. Watch for brilliant Venus to put on an impressive show before dawn in late winter and spring.

After a down year in 2013, meteor observers have better prospects in 2014. Although August’s Perseids must battle a nearly Full Moon, January’s Quadrantids have no lunar competition. And no other major meteor shower faces worse than a half-lit Moon. All in all, 2014 is shaping up as a stellar year for backyard skygazers.
Since its launch in March 2009, NASA’s Kepler probe has been staring at more than 100,000 stars in the constellations Cygnus and Lyra. As of October 2012, it had discovered some 2,300 planet candidates orbiting other stars and confirmed 77 of them. For scientists to verify a discovery, the spacecraft must observe a candidate transit its parent star three times—which means finding an Earth-like planet in an Earth-like orbit around another star requires three to four years of observations. So, 2013 could mark astronomers’ first detection of a planet with earthly characteristics elsewhere in the cosmos.

Such a discovery undoubtedly would be one of the top science stories of 2013, but NASA and the European Space Agency (ESA) have dozens of other missions pushing back the frontiers of science. The venerable Hubble Space Telescope and Chandra X-ray Observatory report new discoveries every month. And newer instruments such as the Fermi Gamma-ray Space Telescope, NuStar (the first detector designed to focus X-rays), and Planck (ESA’s mission to explore the cosmic microwave background) continue to study the universe in great detail.

Although deep space holds great allure for most astronomers, planetary scientists get just as excited about missions closer to home. The biggest discoveries in 2013 likely will come from NASA’s Curiosity rover, which landed on Mars in August 2012. The mobile science lab has started exploring its home in Gale Crater and soon will venture into the layered deposits of Mount Sharp. Mission scientists hope Curiosity will find evidence that Mars once had habitats with the potential to support life. Curiosity has plenty of company at Mars. As of late 2012, the Opportunity rover, Mars Express, Mars Odyssey, and Mars Reconnaissance Orbiter all were still operating on or above the Red Planet.

The other planets don’t tend to make as much news as Mars, but they remain under close scrutiny. Venus Express continues to explore our neighbor’s thick atmosphere while MESSENGER studies innermost Mercury. Farther from the Sun, Cassini keeps returning stunning images of Saturn, its rings, and its moons.

Other planetary probes are set for future stardom. The Juno spacecraft will fly past Earth in October 2013 to get a gravity assist as it heads toward a 2016 rendezvous with Jupiter. Dawn has started its trek from the asteroid Vesta to dwarf planet Ceres, where it will arrive in 2015. That year also will witness New Horizons’ arrival at Pluto for the first close-up observations of this intriguing world at the solar system’s edge.