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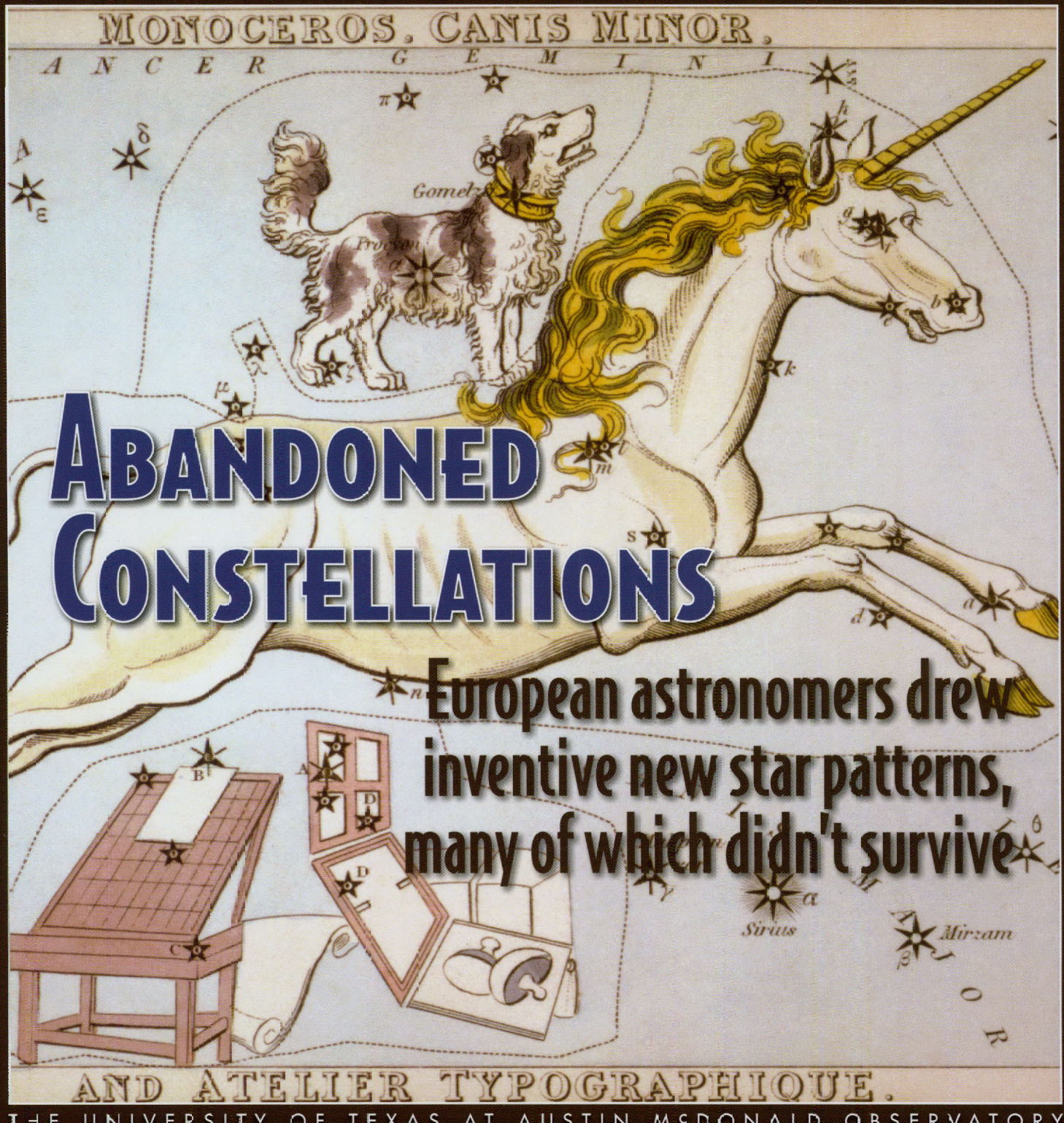

ABANDONED CONSTELLATIONS

European astronomers drew inventive new star patterns, many of which didn't survive

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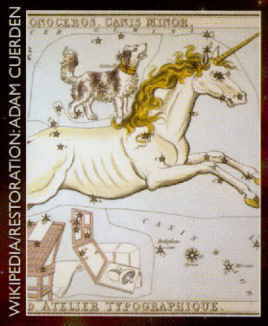

WIKIPEDIA/RESTORATION:ADAM CUERDEN

On The Cover

Over a period of two centuries, European astronomers created dozens of new constellations. Some, such as the unicorn, depicted on this 1825 diagram, are still around today. Others, such as the printing office (bottom), have vanished. Story, page 4.

This Page

This map depicts the positions of 525 brown dwarfs near our own solar system. A brown dwarf, often described as a 'failed star,' is more massive than a planet but not massive enough to shine as a true star. All of the brown dwarfs in the image, which is projected against a photograph of the Milky Way, are within 65 light-years of Earth.

Coming Up

Our annual books issue sets you up for summer reading, whether you're able to hit the road or just stay at home under the air conditioner.

NOIRLAB/NSF/AURA/J. DA SILVA

MERLIN

Dear Merlin,

As I understand it, we can use the Doppler effect (extension or compression of light waves) to determine if an object is moving toward or away from us and at what speed. Astronomers have observed that all distant objects have a redshift, indicating they are all moving away from our point of reference. If everything is receding, how can there be any relative directional/rate assumptions?

Owen Daniel
Fort Worth

The Doppler effect is one of astronomy's most valuable tools. As you say, the light from astronomical objects is shifted to redder wavelengths if they are moving away from the observer, and to bluer wavelengths if they are moving toward the observer. The greater the shift, the faster the relative motion.

And let Merlin correct you on one point: Not everything is moving away from Earth. Many stars in the Milky Way Galaxy, as well as quite a few nearby galaxies, are moving toward it. On a cosmic scale, however, you are correct: Distant galaxies are moving away from Earth because the universe itself is expanding as a result of the Big Bang. And note that Earth isn't special; no matter where you are in the universe, all the distant galaxies appear to be moving away from you.

That said, however, it's still easy to measure "relative" motions. Just use Earth as the starting point, then apply some simple math (okay, some complicated math) to determine the positions and motions of galaxies relative to each other.

Dear Merlin,

Does the Moon ever come to the zenith? I noticed today that the Moon was almost directly overhead.

Jim Antenucci
Dunwoody, Georgia

The Moon does indeed come to the zenith (the point in the sky directly overhead) but only within a limited geographical range. That range is defined by Earth's tilt on its axis and the Moon's tilted orbit.

Earth is tilted at an angle of about 23 degrees. As Earth orbits the Sun, that causes first one pole, then the other, to dip toward the Sun, so the Sun appears to move north and south across the sky. As the Sun rocks back and forth, it can pass directly overhead for viewers between 23 degrees north latitude and 23 degrees south.

The Moon follows roughly the same path as the Sun across Earth's sky. However, its orbit is tilted at an angle of roughly five degrees relative to that path, so the Moon can reach about five degrees north or south of the Sun's extremes. As a result, it can reach the zenith for anyone at latitudes between 28 degrees north and 28 degrees south.

From your town, the Moon can't quite reach the zenith, but it can come close—within about six degrees. So to the eye alone, it certainly looks like the Moon is standing straight overhead.

Dear Merlin,

Can you describe an activity that one could share that would explain retrograde motion of planets?

Ronald Schirmer
Viroqua, Wisconsin

Merlin called on his friends who handle the McDonald Observatory teacher programs for help with this one, and they obliged with this excellent reply:

"Retrograde" is what we call the apparent backward motion of a planet that orbits the Sun along the same plane as Earth. An easy way to think about retrograde motion is to imagine that you're driving on a highway with your cruise control set to 70 miles per hour. You catch up with a vehicle that's driving in a lane to your right with its cruise control set at 67 miles per hour. As you pass this vehicle, it appears to move backwards relative to you and to the landscape beyond it.

Now let's talk about Earth and Mars. Earth takes a year to make one complete orbit around the Sun. Mars is farther from the Sun so it takes longer to orbit—almost two years. That means Earth passes Mars every two years. For most of its orbit, Mars appears to move against the background of stars from west to east. However, as Earth catches up and passes Mars, the planet appears to reverse direction for a few months. This continues until Earth passes Mars, so it once again appears to travel in the "right" direction.

To learn more about planetary motion, the StarDate web site has a great K-12 activity, Modeling 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

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Merlin
StarDate
University of Texas at Austin
2515 Speedway, Stop C1402
Austin, TX 78712
stardatemerlin@gmail.com
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Forgotten Stars

By DAMOND BENNINGFIELD

This illustration from a 1776 atlas depicts the constellations of the southern hemisphere, most of which had been created over the previous two centuries. Most of the constellations are still in use today, but a few are extinct.

Over a couple of centuries, European astronomers drafted dozens of new constellations; some of their creations survived, but many others are extinct

King George III may be the only monarch in history to lose not only a sizeable chunk of land, but a planet and a constellation as well. He lost the 13 American colonies in 1781 after the Siege of Yorktown, the final battle of the American Revolution. At the time, though, he might have consoled himself with the seventh planet from the Sun. William Herschel discovered the planet in that same year. He called it Georgium Sidus—George's Star—in the king's honor. Flattered by the name, George appointed Herschel as King's Astronomer and supported his research. Alas, though, not all astronomers agreed with the gesture. Those outside Great Britain—especially in France—called the new planet Uranus, after a Greek sky god. Britain stuck with George's Star until 1850, when it, too, accepted the name that has caused schoolboys and podcast hosts alike to snicker ever since.

George's Harp

Hungarian abbot Maximilian Hell, a Jesuit monk and director of Vienna Observatory, also tried to honor George III for his patronage of astronomy. In 1789, he created three new constellations from some faint stars near the existing constellations Auriga, Gemini, Taurus, and Orion. Two of the new star patterns honored Herschel's telescopes, which were some of the finest in the world. The third was Psalterium Georgianum—George's Harp (the Latin name was later changed to Harpa Georgii). Hell selected a musical instrument as the constellation figure because Herschel was a professional musician as well as an astronomer and telescope-maker.

A few other astronomers went along with Hell's new constellations, especially Johann Bode, who compiled a beautifully illustrated star atlas in 1801 (and who had first suggested the name Uranus). Not long into the 19th century, though, all three of the constellations had disappeared from atlases and starcharts. The efforts to commemorate George III in the stars had failed.

George wasn't the only monarch to lose a constellation, though. So did Frederick the Great of Prussia, whom Bode had added to the stars in 1787, and several others. Less august constellations have faded away as well: the cat, the hot-air balloon, the electric generator, the reindeer, an arrow, a triangle, and many others. They were drawn by well-known and accomplished astronomers. Some of the new sky pictures persisted for decades, while others disappeared not long after their creation. They were driven to extinction when astronomers established a formal set of 88 constellations in 1930, leaving the heavens a little more organized but perhaps a little less entertaining.

For roughly 15 centuries, almost every western starchart depicted only the constellations compiled by Ptolemy, a Greek astronomer who lived in Alexandria, Egypt, almost 2,000 years ago. His publication the *Almagest* listed 48 constellations that dated from centuries or millennia earlier, including such classical figures as Leo, Scorpius, Gemini, Aquarius, Taurus, and Hercules. All except one of those constellations remains intact today, and the exception, Argo Navis, was split to form three others.

Each of Ptolemy's constellations consisted of a classical outline—bright stars linked to make a picture—plus a few outliers. There were no boundaries between constellations, though, so stars were assigned to different constellations by different astronomers. And many of the stars between the pictures had no constellation at all—they simply perched by themselves, unattached and frequently unnamed.

Starting in the late 1500s, though, European astronomers went on a constellation binge. Armed with a new invention, the telescope, they probed the universe for fainter and fainter stars. Assigning a star to a particular constellation helped them organize their discoveries.

Easier access to high-quality printing allowed them to produce detailed charts, many of which featured beautifully rendered illustrations of the people, animals, or objects portrayed in the constellations. Since many areas of the sky were bereft of such figures, astronomers created new ones to fill the gaps.

At the same time, European sailors journeyed into the southern hemisphere, where they saw regions of the sky that remained below the horizon of continental astronomers. The astronomers themselves soon followed, plotting the positions of thousands of southern stars and drafting new constellations to contain them.

The first big outburst of constellation creation, in fact, followed a Dutch expedition that set sail in 1595. Its four ships were bound for the East Indies, a large region of southeast Asia along the intersection between the Indian and Pacific oceans.

Pieter Dirkszoon Keyser, the chief navigator, had been trained in astronomy and mathematics by Petrus Plancius, a Dutch clergyman and cartographer. Plancius had already created two new constellations, which appeared on a world map he drafted in 1592: Columba, the dove, and Polophylax, a man who watched the southern celestial pole. (Columba survived the winnowing process, but Polophylax did not.) As an adviser to the expedition, Plancius asked Keyser to map the southern sky.

Keyser plotted about 135 stars (including some that were listed in the *Almagest*). Although he didn't survive the trip, his notes did, and they were delivered to Plancius in 1597.

WIKIPEDIA (4); LIBRARY OF CONGRESS; SMITHSONIAN LIBRARIES

THE CREATORS: *From left: Ptolemy, Johannes Hevelius, Gottfried Kirch, Nicolas Louis de Lacaille, Joseph Jérôme Lalande, Johann Bode*

Plancius and a collaborator published a celestial globe the following year that featured 12 new southern constellations based on Keyser's observations. Some of the constellations were patterned after exotic animals the sailors encountered south of the equator, such as the colorful toucan and peacock, the bird of paradise, the chamaeleon, and the flying fish. Others were based on creatures from mythology (Phoenix, the bird that rose from the ashes), outlined simple geometric figures (the southern triangle), or depicted other objects.

In 1603, another expedition navigator, Frederick de Houtman, published a catalog of more than 300 southern stars, based on his own observations and those of Keyser. The catalog included the 12 new constellations. Today, historians generally credit both navigators, along with Plancius, as creators of the constellations.

Bitten by the constellation bug, Plancius kept on drawing. Around 1612, he produced an 11-inch celestial globe that included seven new northern constellations, two of which survive today: the faint figures Monoceros, the unicorn, which is to the east of Orion, and Camelopardalis, the giraffe, which spins high across the north, near the Pole Star, Polaris.

His other northern contributions, however, have vanished from the sky. They depicted bees, the Tigris and Jordan rivers, a rooster, and a small crab, which was next door to the zodiacal constellation Cancer. At another time, Plancius also created a reindeer in the far-northern sky. Other astronomers incorporated some of these creations into their own sky atlases, while others imposed different pictures on the faint stars. Apes, the bees, for example, was transformed into a fly by some astronomers, and into a lily by French astronomer Augustin Royer to represent the fleur-de-lis and honor his patron, King Louis XIV (another monarch loses a celestial tribute!).

Charts of the southern hemisphere remained sparsely populated for more than a century, though, until the efforts of the most prolific constellation-maker in history, Frenchman Nicolas Louis de Lacaille. Although he studied theology, Lacaille decided on a career in science. One of his first tasks was to precisely plot the longitude line running through the Paris Observatory. The line served as the starting point for French maps, and it helped scientists measure the shape of Earth. The project earned Lacaille membership in the Royal Academy of Sciences and a professorship in mathematics at the University of Paris.

In 1751, Lacaille arrived at the Cape of Good Hope in South Africa to map the southern sky. Using a one-half-inch telescope, he plotted the positions of almost 10,000 stars. (He also measured the positions of the Sun, Moon, and the bright planets, which improved estimates of their distances.) From these observations, Lacaille drafted his own charts of southern skies.

Lacaille first demolished the largest and most famous of all extinct constellations: Argo Navis, the ship Argo.

The Greeks may have adapted the constellation thousands of years ago from an Egyptian star pattern that depicted a boat carrying Osiris, god of the dead, on his nightly journey through the underworld. The Greeks, however, associated its stars with the tale of Jason, a mythological character whose throne was stolen by his uncle. The uncle promised to give it back if Jason would bring him the fleece of a magical ram. So Jason had the shipbuilder Argus craft a sturdy boat, which he manned with 50 heroes, including Hercules and the twins of Gemini. The boat, known as the Argo, carried them safely through many harrowing adventures.

Lacaille, however, thought the constellation depicting the ship was too unwieldy—it covered a large part of the sky and it contained hundreds of stars visible to the unaided eye and thousands more visible through his telescope. That made Argo Navis difficult to catalog. So Lacaille split it into three new star pictures, although he preserved their heritage by naming them for parts of the Argo: Puppis, the poop deck (the raised deck at the back of the ship); Vela, the sail; and Carina, the keel. As seen from the United States, all three constellations sail low across the southern evening sky in late winter and early spring, although they are so far south that some of their stars remain below the horizon.

While he was at it, Lacaille did away with a constellation Edmond Halley had created in 1678 from a patch of "mist" that had been drawn at the bow of the ship. Robur Carolinum, Charles's Oak, depicted an oak tree in which England's King Charles II hid during the British civil war. Lacaille added the tree's stars to Carina, giving the ship a prominent front end. (For those keeping score, that's constellation-deprived monarch number four.)

Lacaille died in 1762, but his catalog of the southern sky was published the following year. It featured the severed parts of Argo Navis plus 14 new constellations. Because the 18th century was a time of great scientific, technological, and artistic achievement, Lacaille named 13 of his new figures for objects from those fields. (The 14th, Mensa, was named for a mesa in South Africa—the only modern constellation named for a real geographic feature). Among other wonders, they depicted a clock, telescope, microscope, and painter's and sculptor's studios. Although two of them have been whittled down, all still adorn the night sky.

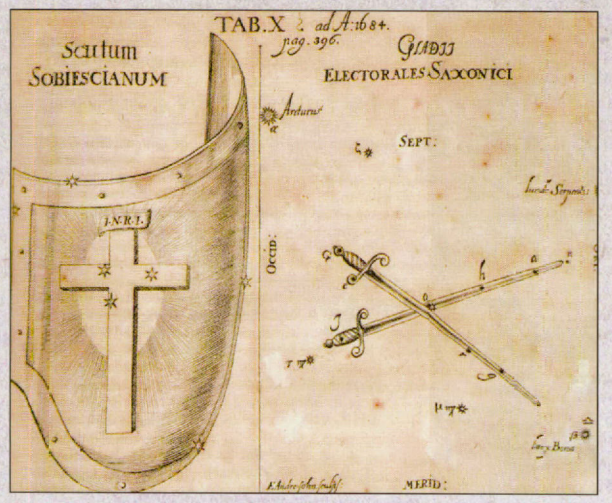
The southern hemisphere represented the low-hanging fruit for European astronomers wanting to create new constellations because many of its stars had never been charted before. It was a different matter for northern skies, though, which had been studied and mapped since antiquity. All of the bright stars had been assigned to ancient constellations, leaving only some small patches of sky to play with.

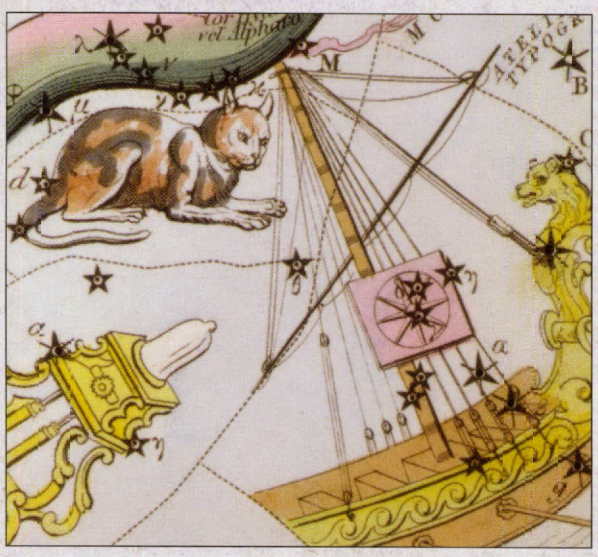
Several astronomers rose to the task. They picked a few faint stars here and there—sometimes nabbing a minor member of an existing constellation—and linked them up to make pictures. As with many of the ancient constellations, though, most stargazers need a vivid imagination to "see" these pictures.

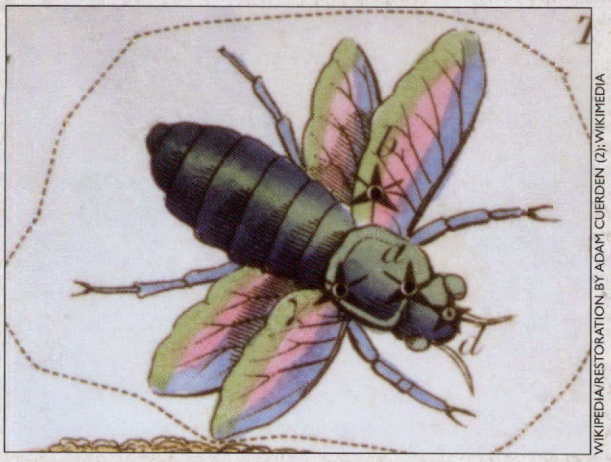
Gottfried Kirch, for example, cobbled together three constellations in 1688 to honor kings or emperors. Kirch was astronomer royal to Frederick III, Elector of Brandenburg and later king of Prussia, so his figure choices aren't too surprising. His best-known constellation, the Brandenburg Scepter, was located near Rigel, the brightest star of Orion. It took five stars from the adjoining constellation Eridanus, the river—hardly enough points to outline a royal scepter. The scepter and Kirch's other constellations might as well have been thrown into a river, though, because they quickly sank from sight—adding to the list of failed attempts to create "royal" constellations.

At about the same time that Kirch was creating his failed constellations, Polish astronomer Johannes Hevelius was putting together a set of star pictures of his own.

Hevelius was one of the most accomplished astronomers of his time. He built a major observatory with some of the best telescopes in Europe, which he used to map the surface of the Moon, chart sunspots, discover four comets, and make other important observations. And he created 11 new constellations.







WIKIPEDIA/RESTORATION BY ADAM CUERDEN (2); WIKIMEDIA

From top: Hevelius's Scutum Sobiescianum (Sobieski's Shield) has survived, while Gladii Electorales Saxonici (Crossed Swords of the Saxony Electorate) has not, Lalande's Felis, the cat, looks down on the pre-sliced Argo Navis, with Antlia, the air pump, a new constellation that survived the cut, at left; perhaps it's just as well that astronomers swatted the northern fly.

The first, drawn in 1684, was Scutum Sobiescianum, the shield of Sobieski. (It is south of the celestial equator, which, like several other "new" star patterns, technically makes it a southern constellation, but its stars were easily visible from all of Europe.) It represents a victory by Polish King John III Sobieski the previous year. Later, the name was shortened to Scutum, the shield. It's the only attempt to honor a king with a star pattern that stuck (even though it outlines only the shield, not the king).

All of Hevelius's constellations were published in a star atlas that was printed in 1690, three years after his death, by his widow and observing assistant, Elisabetha. In addition to Scutum, the lavish volume included six constellations that are still around today. One of the most important to Hevelius was Sextans, the sextant, which represented a prized astronomical instrument that was destroyed in a fire that consumed his observatory and library.

The atlas also included four constellations that are now extinct: Cerberus, a three-headed monster from mythology, beside Hercules; Mount Menelaus, which represented a mountain in the story of Boötes the herdsman; the lesser triangle, near Andromeda the princess; and Musca Borealis, the northern fly, an adaptation of Plancius's Apes, the bees.

Some efforts to add to the geography of the sky—or to reform it—were serious, while others were less so.

On the less-serious side, English naturalist John Hill published 15 new constellations in an astronomical dictionary in 1754. The names, though, suggest he was poking fun at his field: Few people were likely to wax poetic over the toad, leech, long-legged spider, eel, or limpet. Thankfully, the constellations wriggled away quickly.

And while the efforts of French astronomer Pierre Charles Le Monnier were more serious, perhaps it's just as well they failed. The Latin name of his 1776 constellation depicting a thrush, Turdus Solitarius, would have generated even more schoolboy guffaws.

Two other top-tier astronomers made more serious efforts to add to the cartography of the celestial sphere, but with no more success than Hill.

French astronomer Joseph de Lalande created several constellations, although he did so irregularly, with new ones popping up over a period of a couple of decades. (One of his acquaintances noted that his constellations often appeared after bouts of heavy drinking.)

Lalande studied law, but before he began to practice he was recruited to work on a project with Lacaille. While Lacaille plotted the Moon's position from South Africa, Lalande plotted it from Berlin. Comparing the positions revealed the Moon's distance more accurately than any previous observations. Lalande also published reports on the 1761 and 1769 transits of Venus across the face of the Sun. The transits helped zero in on the Earth-Sun distance, which is the key measurement for determining the scale of the solar system.

Lalande's first constellation, Custos Messium, debuted on a celestial globe he created in 1775. The name means "harvest keeper," but the harvest was of comets, not wheat or carrots. It honored Charles Messier, a fellow Frenchman, who had "harvested" many comets. To aid his comet hunting, Messier also compiled the most famous list of astronomical objects—galaxies, star clusters, and gas clouds (although their true nature was unknown at the time). All of them resemble comets when viewed through a telescope, so Messier made the list to keep him and other comet-hunters from wasting time when they came across them.

Lalande was a cat lover, so he also invented Felis, the cat, in 1799. It quickly used up its nine lives, although astronomers recently acknowledged it by naming a faint star in the former constellation "Felis."

All of Lalande's constellations are extinct, but a hint of one remains in the name of the year's first meteor shower, the Quadrantids. The meteors all appear to "rain" into Earth's atmosphere from near present-day Boötes. At the time the shower was discovered, though, that region was known as Quadrans Muralis, created by Lalande to depict an astronomical instrument mounted to the wall of his observatory. Although the constellation has vanished, the meteor shower retains its name.

Most of Lalande's constellations made their public debut in a star atlas compiled and published by a colleague, Johann Elert Bode, director of the Berlin Observatory. *Uranographia* was published in 1801, and is one of the most lavishly illustrated atlases in history, with beautifully detailed depictions of the animals, people, and things represented in the stars.

Bode tried to add to the list by creating a few constellations of his own, including the one honoring Prussia's Frederick the Great. He also drafted a couple that honored modern technology—the electric generator and the printer's workshop, the latter appearing near Sirius, the brightest star in the night sky. And he tossed in one that depicted older technology, a contraption that sailors used to measure their ship's speed. Like a ship sailing over the horizon, though, it soon sank from sight.

Uranographia was the last of the great artistic sky atlases. As the 19th century progressed, astronomers built better telescopes and created new instruments that allowed them to plot not just a star's position but its distance and motion through space, and to measure its temperature and even its chemical composition. That left little interest in creating elaborate illustrations of the constellations. And with most of the sky already mapped out, there was little interest in drawing new constellations or tinkering with the existing ones. Star atlases began depicting the constellations as simple connect-the-dots illustrations. And many catalogs dispensed with diagrams entirely, instead simply listing thousands of stars.

As those lists grew longer, though, the constellations began to seem unsatisfyingly random. Individual stars might belong to several constellations, depending on which astronomer's charts you looked at. So as astronomers tried to bring greater order to the heavens through the emerging field of astrophysics—learning what makes astronomical objects tick—their system of classifying the geography of the sky felt frustratingly *dis*organized.

Finally, in 1922, astronomers did something about it. At the first-ever meeting of the International Astronomical Union, in Rome, they drafted a list of 88 constellations. The list disentangled the messiness of overlapping and competing constellations, preserving most of those in use at the time but discarding many others.

The system was formalized in 1930, with the publication of two books, *Délimitation scientifique des constellations* and *Atlas Céleste*, by Belgian astronomer Eugène Delporte, a prolific asteroid discoverer. He defined the constellations not by their ancient figures but by precise boundaries based on their celestial coordinates (the equivalent of latitude and longitude on Earth). That turned the sky into a patchwork quilt of constellations large and small.

Leo, Scorpius, Gemini, Aquarius, Taurus, Hercules, and the other ancient constellations made the cut. So did more than three dozen newer constellations created during the great outburst: Lacaille's microscope and telescope, Plancius's unicorn and giraffe, Hevelius's shield and lizard, and many others.

Dozens more, however, disappeared. Argo Navis was finally scuttled, leaving only its adjoining parts. Felis made its final meow. The electric generator and printing office ground to a halt. Herschel's telescopes closed their eyes. And George's harp plucked its final string before it, too, became extinct.

Resources

Books

Ian Ridpath's Star Tales
www.ianridpath.com/startales/contents.html

The Lost Constellations, by John C. Barentine
https://link.springer.com/book/10.1007/978-3-319-22795-5

Star Names: Their Lore and Meaning, by Richard Hinckley Allen
archive.org/details/starnamestheirlo00alle

Internet

Remnants of extinct constellations
astronomy.com/magazine/2019/01/ghosts-of-extinct-constellations

Obsolete constellations
web.pa.msu.edu/people/horvatin/Astronomy_Facts/obsolete_constellations.html

Constellations that might have been
skyandtelescope.org/observing/constellations-that-might-have-been

Damond Benningfield is executive editor of StarDate *and writer/producer of StarDate radio.*

SKY CALENDAR

by Alan MacRobert

Although planet watching is limited, the warmer nights of spring bring a panoply of new stars and constellations to view. Leo is in good view at nightfall, climbing straight up from the eastern horizon in early March and standing high in the south on April evenings, led by his bright heart, the star Regulus. Virgo follows a couple of hours later. Boötes, the herdsman, is close to the maiden, marked by yellow-orange Arcturus, one of the brightest stars in the night sky.

MARCH 1-15

February was Orion's month to be king of the hill in the hour after dark. In March, it's the turn of his big dog, which follows him across the sky: Canis Major, wearing brilliant Sirius on its stick-figure chest like a dog tag.

The "hill" that constellations get to be king of, temporarily, is the sky region directly to your south. All of the stars, planets, and constellations that ever cross the southern half of the sky stand at their highest when they are due south. Orion, as seen soon after dark, marched from low in the east up this hill during December and January. He stood proudly highest after dusk in February, and now he steps down toward the southwest as the months continue to turn.

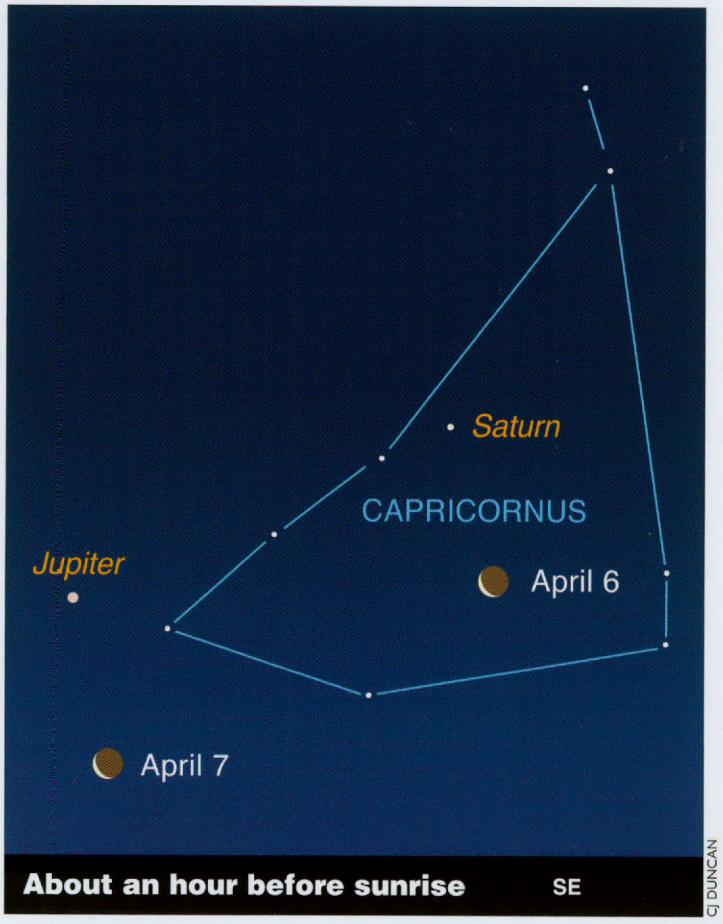
Canis Major follows him everywhere, about a month behind. Or equivalently, about two hours behind.

How does that work? When it comes to the turning of the starry sky, one month later in the year equals two hours later in the night. The hourly change is, of course, caused by Earth's rotation. Earth revolves around the Sun once a year, which makes the world's nightside—the side away from the Sun—face a different direction in space month by month. With 24 hours in a day and 12 months in a year, we get the rule that two hours works like one month. Handy for every skywatcher to know.

But that's if you do your starwatching at the same time each night by the clock. If, instead, you just go out after dark, you're doing it later and later by the clock as the days grow longer. So in late winter and early spring, the seasonal turning of the constellations may actually seem to speed up.

So, which are the king-of-the-hill constellations for the other months as night begins? Of course, several constellations will be in the south at any time; the sky is full of them. But my pick of the showiest and/or most landmarky would be:

January, Taurus. February, Orion. March, Canis Major. April, Leo. May, big Virgo and little Corvus beneath it. June, Boötes, way high. July, bright Scorpius, "the Orion of summer." August, Sagittarius. September, Aquila and Cygnus almost overhead. October, Capricornus (yes, I know it's dim). November, Pegasus with its Great Square. December, Andromeda.



Planets add their own peculiar motions to the seasonal sky turning. Right now, Mars is the only bright naked-eye planet of the evening. Spot it high in the west, near the Pleiades. Mars has been hanging onto its evening place for many months now. And it will remain in the west all spring, even while its background constellations wheel down and away.

Mars's secret? It travels around the Sun not much slower than Earth does, so it nearly keeps up with us for a while—regardless of the background stars going their own way.

Near Mars this month is one of its look-alike stars, Aldebaran. Both shine orange with, for now, similar brightnesses. To find them (if you have trouble with the Pleiades), you can start with Orion. His three-star belt lies roughly horizontal. Follow its line to the right by about two fists at arm's length, and you're near Aldebaran. Mars glows about a fist farther on.

MARCH 16-31

Winter turns to spring, astronomically speaking, at the moment of the equinox: 4:37 a.m. CDT on March 20. That's when the center of the Sun crosses the equator (both Earth's equator and, equivalently, the celestial equator) on its seasonal journey north.

With much lesser degrees of precision, the weather is shifting from wintry to springlike, "spring" constellations draw more notice in the east, and the winter constellations head toward their lingering goodbyes in the west.

One whose days are numbered is Orion. He's still fairly high in the southwest after

dark, but trudging down.

Meanwhile, a new bright star is pushing up in the east: Arcturus. It rises in early evening.

High to the upper left of Arcturus, spot the Big Dipper. It's turning over as if to dump spring showers onto the world. They have an awfully long way to fall: If you can see the Dipper, the sky is still clear! But sooner or later it'll cloud over (whether in hours or weeks), and those showers will land for sure.

To the upper right of Arcturus, by a slightly farther distance, look for Leo stalking his king-of-the-hill position, with Regulus as his starring bright light.

APRIL 1-15

Arcturus is sometimes called the Spring Star, but the title really applies better to Spica, which has come into view about three fists to Arcturus's lower right. Arcturus, being far north, will remain in view right through summer and even deep into fall. Spica keeps a closer relationship to springtime.

Spica is less showy than Arcturus, but it's the brightest light of big, sprawling Virgo, whose scattered pinpoints can be rendered into an excellent stick-figure pattern of a girl displaying Virgo's traditional ancient form: Sowing grain with one hand while holding Spica in the other. In fact, the name Spica means "ear of wheat."

Much smaller but easier to make out is Corvus, the crow. He eyes Spica from his perch to the right of the bright star. Look for the crow's boxy, four-star pattern about half as far to the right as Arcturus is from Spica.

That shape often was compared to that of a gaff-rigged sail in sky guides back when sailing ships were a common sight. To this day Corvus is still called sail-shaped, as sky writers repeat each other from one generation to the next. Some may find such anachronisms annoying; I find them charming. Now that faucets have replaced big wooden water buckets in the kitchen, how many of us have ever used a dipper that actually looks like the Big Dipper? But there's one just like it on the wall of our family's log cabin in the Maine woods; it's been there for generations.

Just to the upper right of Corvus is its companion, the constellation Crater, the cup, a little larger but much dimmer. These two often are considered a pair because they ride together on the back of dim Hydra, the sea serpent, as passenger and cargo, respectively. Why a hydra would carry these particular loads is left unanswered by ancient mythology.

Hydra itself presents a real challenge for constellation finders. It's scattered and extremely long: 95 degrees from nose to tail tip, wrapping just over a quarter of the way around the celestial sphere. Its most interesting part is the head, a thumb-sized asterism of 4th- and 5th-magnitude stars about one and a half fists east (currently left) of Procyon.

Almost the same distance to the lower left of Hydra's head is its one modestly bright star: its orange heart, Alphard. The name means "the lonely one," since Alphard resides in such a dim area.

APRIL 16-30

April is king-of-the-hill month for Leo after nightfall. That's when the lion walks highest in the south, level and treading toward the west.

He, too, has a fairly realistic connect-the-dots pattern, and it matches the orientation of the lion depicted in Greco-Roman times. First-magnitude Regulus is his forefoot. The backward question mark of the Leo "sickle," extending up from Regulus, outlines his chest, mane, and head. Denebola, the brightest star about two fists east (left or lower left) from Regulus, is the tip of his long, straight tail. The name Denebola is corrupted Arabic for "tail of the lion."

On April 22, you'll find the Moon just under Leo's belly.

High in the north, the Big Dipper is turning over as it nears its own peak height on the northern side of the sky.

And over in the west, we have the enormous Arch of Spring. The arch is a repurposed piece of the even larger Winter Hexagon, some of which is now sinking from sight.

Start with the top of the arch: the Pollux-and-Castor pair, high in the west, about three finger-widths apart and roughly horizontal. Lower to the left of them is Procyon, the arch's left end. Farther away, to the lower right of them, are dimmer Menkalinan and then brilliant Capella, the arch's right-hand end.

All these months go by, and still no bright evening planets except little Mars. Where did they all go?

Look southeast before dawn, and you'll see that's where the two biggies have been hiding out. Jupiter and Saturn, as they did last year, form a pair. The two lights have swapped positions: Jupiter, the brighter one, is now on the left.

All year they will keep their distance from each other; no more conjunctions like their beautiful one last December.

That leaves Venus and Mercury, which are out of sight in the glare of the Sun. But they'll be back. Astronomy teaches patience.

Alan MacRobert is a senior editor of Sky & Telescope.

Meteor Watch

The Shower
Lyrids

Peak
Night of April 21

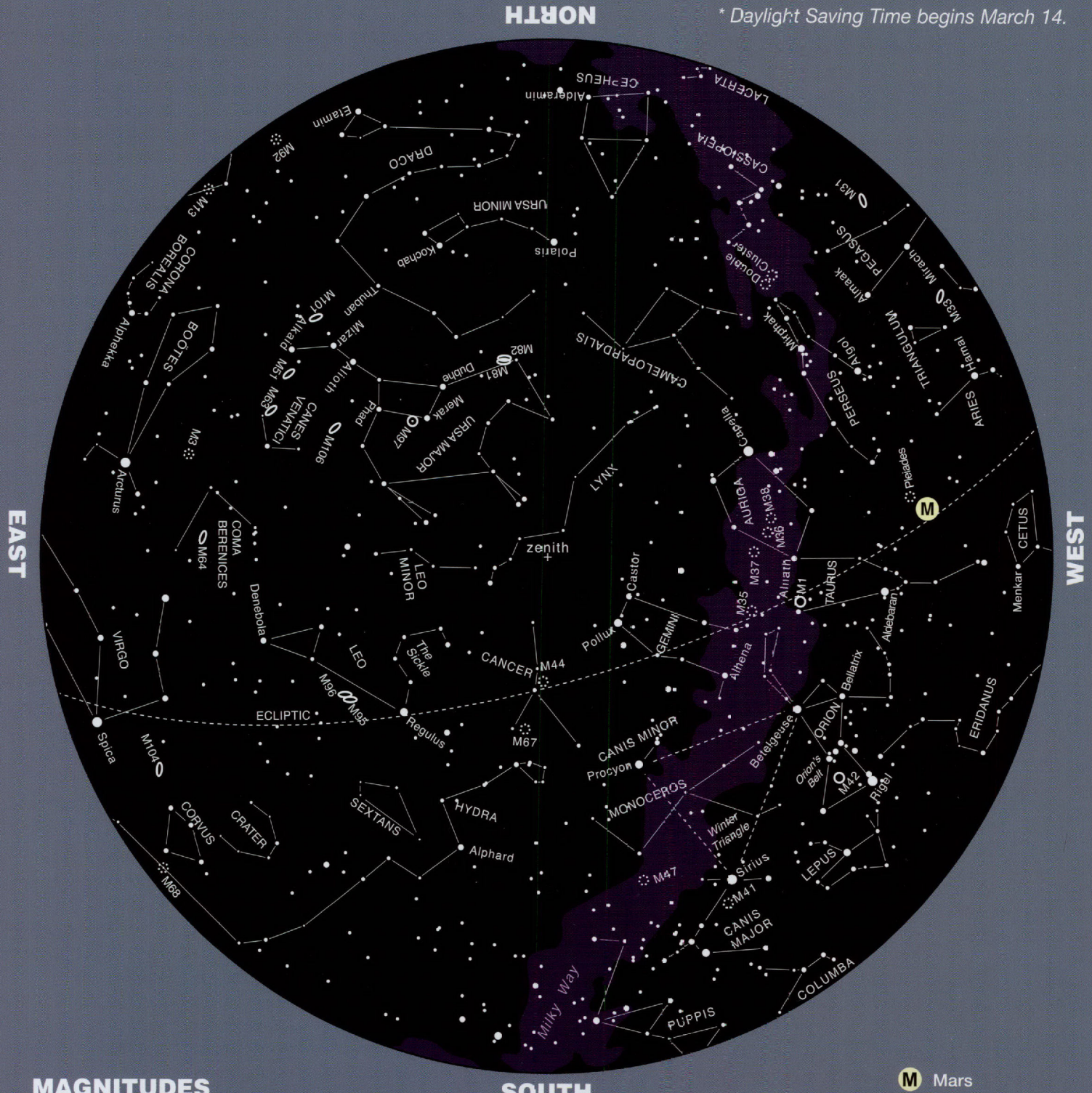
Notes
The Lyrids are modest, with around one or two dozen meteors per hour at best. The Moon is only about a day from its new phase at the shower's peak, so it won't interfere with the view of the "shooting stars."

MARCH

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

February 20	**11 p.m.**
March 5	**10 p.m.**
March 20	**8 p.m.***

** Daylight Saving Time begins March 14.*



MAGNITUDES

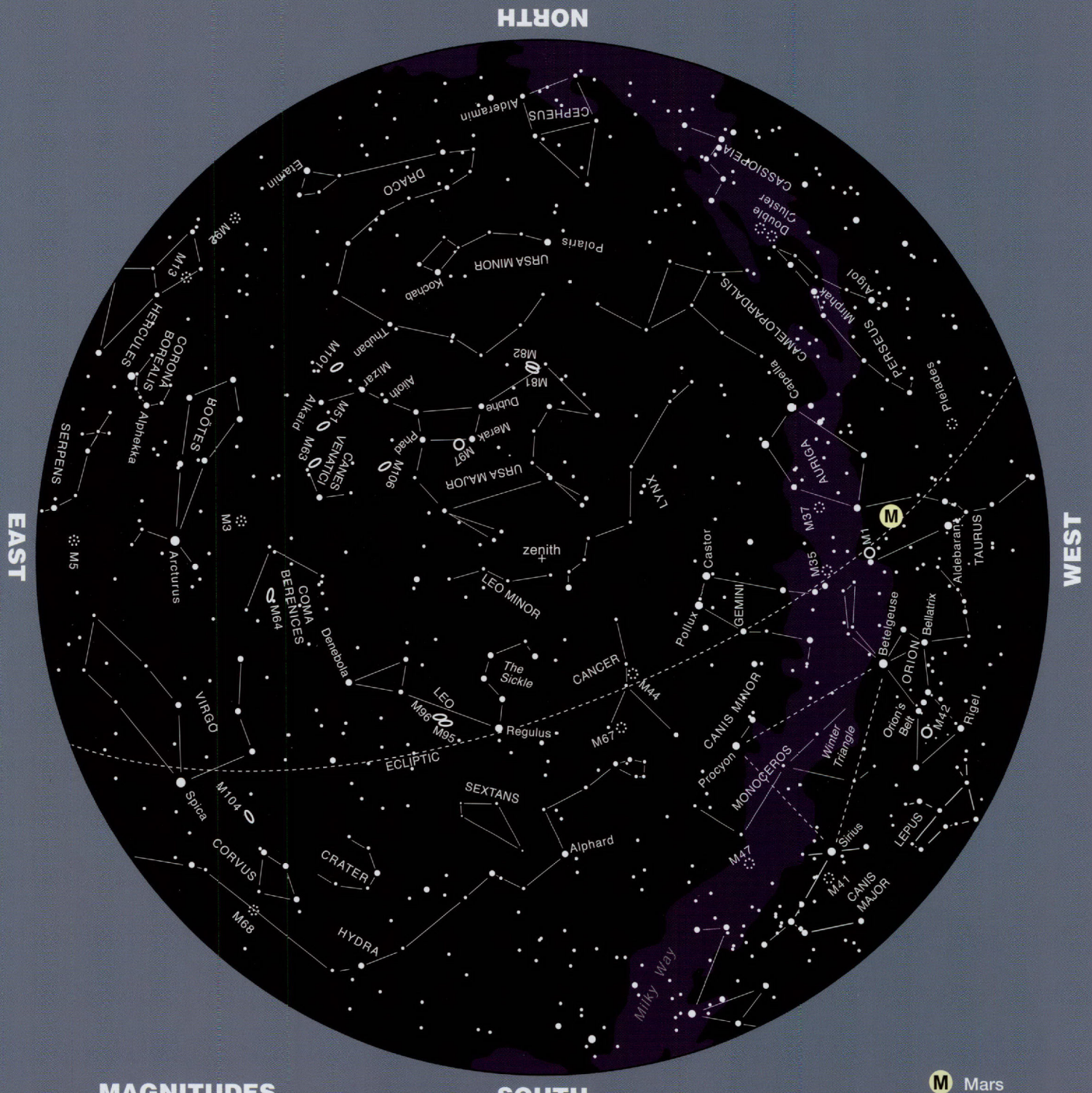
- 0 and brighter
- 1
- 2
- 3
- 4 and fainter

- Mars
- open cluster
- globular cluster
- nebula
- planetary nebula
- galaxy

APRIL

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

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



MAGNITUDES

- 0 and brighter
- 1
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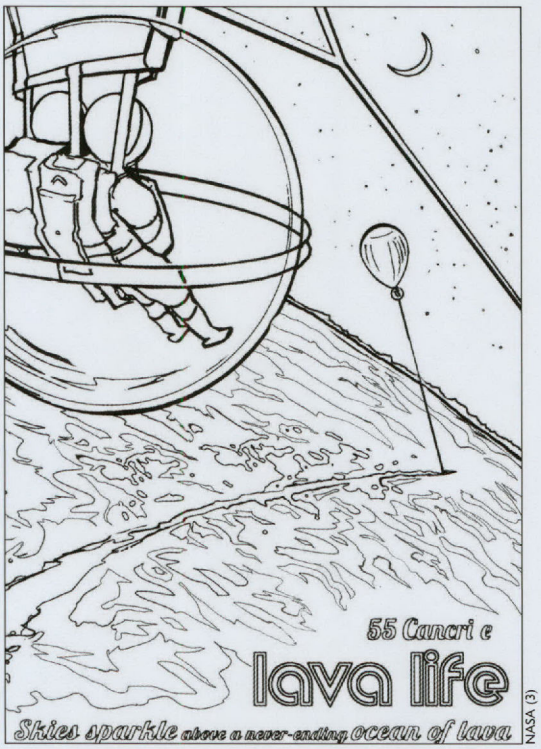
- Mars
- open cluster
- globular cluster
- nebula
- planetary nebula
- galaxy

Astronomy Between the Lines

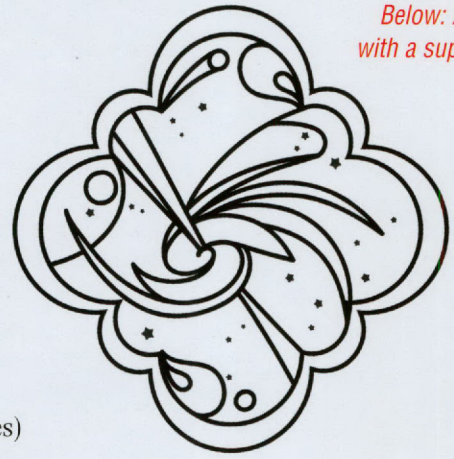
As the days of COVID-19 confinement and virtual classes continue, families with younger children probably are looking for new activities to keep the little ones occupied and entertained. Several NASA missions and projects offer coloring books with line drawings of the planets in our own solar system, planets in other star systems, and other objects. One provides stained-glass windows depicting merging neutron stars and busy black holes. Most of the images include facts about the depicted object to enhance their educational value.

Many of the coloring books are stripped-down depictions of posters or real images of the planets, allowing young artists to compare their work to that of the pros.



NASA (3)

Above: Skimming above a hot planet.
Below: A stained-glass image of a galaxy with a supermassive black hole in its heart, in outline and final forms.



Fermi Stained Glass
imagine.gsfc.nasa.gov/features/coloring_pages/fermi
(also available in 13 other languages)

Exoplanet Travel Bureau
exoplanets.nasa.gov/resources/2235/exoplanet-travel-bureau-coloring-book

Solar System
spaceplace.nasa.gov/coloring-pages/en
(with links to many other NASA coloring books or pages)

An Einstein Ring created by a galaxy cluster.

ESA-HUBBLE/NASA

Headed for the Abyss

Flying toward a black hole might be a dizzying experience, according to a simulation created by researchers at Michigan Technological University. In the simulation, the view of stars and galaxies is distorted by the black hole's immense gravity, which acts as a lens. The objects appear to race along the black hole's "surface" (the event horizon) as the perspective changes, then form a rapidly spinning ring as the viewer looks away from the black hole.

Created by Katyayani Trivedi and Robert J. Nemiroff, the simulation is designed to help scientists better understand how black holes and other massive objects, such as galaxy clusters, bend the light of objects behind them. This effect can create rings and arcs, known as Einstein Rings, which carry information about the objects whose light is distorted. Understanding how the rings are created will help astronomers decode details about the objects.

www.youtube.com/watch?v=QN3f-ZyA3Do&feature=emb_title

From left: A cutaway view of the Gemini spacecraft; a concept of a giant space colony; an astronaut floats near a fanciful space shuttle; Apollo 8 fires its engine behind the Moon to return to Earth.

Seeing Space

The space program—real and imagined—through the eyes of artists

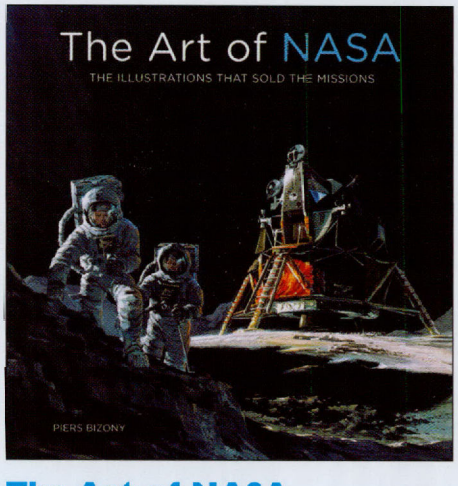
The Space Age didn't begin with Sputnik or Yuri Gagarin or John Glenn. Instead, it began with *Collier's* magazine. From 1952 to '54 it published a series of articles by Wernher von Braun, a former Nazi rocket scientist who would later build the Saturn V Moon rocket. Von Braun offered tales of satellites in Earth orbit, trips to the Moon and Mars, and giant space stations. The stories were accompanied by the brilliant illustrations of Chesley Bonestell and other artists, which featured wheel-shaped space stations, conical space shuttles with razor-sharp wings, and Moon ships made of colorful fuel tanks inside open metal frameworks. The stories and images inspired a frenzy of interest in space travel, beginning the transformation of such ideas from science fiction to science fact.

NASA and its contractors used similar images to build enthusiam for real space travel from the beginning. They offered both fanciful depictions of what might happen beyond Earth and detailed illustrations of real spacecraft and rockets. Such illustrations helped rally support for the young space program.

Many of those works are collected in *The Art of NASA: The Illustrations That Sold the Missions*, by Piers Bizony. The large-format book opens with a two-page view of a Saturn V thrusting toward the viewer moments after launch, with the Florida landscape spreading below. That's followed by a 1950s von Braun-designed three-stage rocket sitting on a craggy lunar landscape. That one-two punch is followed by more than 400 additional artworks, depicting everything from the earliest concepts of a lunar lander to cutaway drawings of the space shuttle to possible cylindrical space habitats that would house thousands.

Many of the pieces were created for the NASA art program, which gave artists almost unfettered access to launch pads, test sites, and factory floors. Participants included Robert McCall, who painted murals at NASA centers and produced concept art for such Hollywood productions as *2001: A Space Odyssey* (some of which is included in the book). Other works were commissioned by contractors to promote their role in the Moon Race.

Bizony notes that many of the original artworks were tossed away or lost over the decades. Today, only reproductions remain. But volunteers are scouring NASA and company archives and other sources, hoping to preserve an important and compelling part of the American space program.



The Art of NASA
The Illustrations That Sold the Missions
By Piers Bizony $50
www.quartoknows.com/books/9780760368077/The-Art-of-NASA.html

CELESTIAL TUNESMITHS

'Accidental astronomers' record celestial events in popular songs

BY NICK D'ALTO

PIXABAY

Twinkle, twinkle, little star, / How I wonder what you are.

These are familiar lines, but surely nothing more than a children's nursery rhyme—until you learn that their author, poet Jane Taylor, lived at a time when philosophers still wondered whether we could ever know the composition of the stars. "We understand the possibility of determining their sizes, shapes and motions," Auguste Compte advised in 1835, "Yet never, by any means, shall we be able to study their chemical composition or structure."

The scientific study of starlight soon would prove Compte wrong. But who would have imagined that such a complex astronomical issue is "encoded" in a childhood ditty we know so well? In fact, though, over the centuries, many popular songs have been inspired by astronomy. And not just vague references to the Moon and stars, but to other specific celestial phenomena. Many were written by top recording artists, who found themselves "accidental astronomers," then described what they saw. You've heard these songs on your radio or playlist. You just didn't realize they were about the stars.

Here are three:

Rocky Mountain High

John Denver, October 30, 1972

I've seen it raining fire in the sky

That line sounds poetic, but Denver was describing a real astronomical event: The Perseid meteor shower, the annual light show that treats observers to scintillating flashes across the night sky each August. Fortunately, the singer left detailed accounts of his observations of the shower in his autobiography and during several interviews.

The location was Williams Lake, near Aspen, Colorado. An experienced outdoorsman, Denver was camping just below the tree line, at about 10,000 feet. The time was about midnight. "I remember, almost to the moment, when that song began to take shape," he recounted. "At some point, I went off in a raft to the middle of the lake, and I was singing my heart out." That was when he saw it. "A meteor went smoking by!" he rejoiced. "And from all over the campground came, 'Did you see that!?' Bigger and bigger, until the tail stretched out across the sky."

Denver was witnessing Earth's passage through the trail of debris shed by Comet Swift-Tuttle. As the comet orbits the Sun,

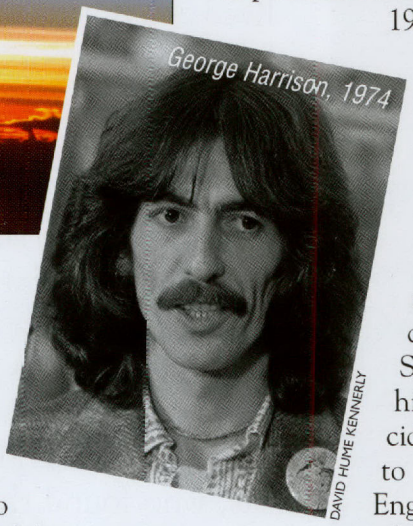
RCA RECORDS/WIKIPEDIA

NASA/BILL INGALLS

Above left: John Denver, 1974; A Perseid meteor in 2016

A sunrise seen from space

NASA



solar energy vaporizes some of the ice at its surface. That releases bits of rock and dirt that orbit the Sun along the comet's path. When Earth intersects that path, some of the comet dust (most of the grains are no bigger than pebbles) slams into Earth's upper atmosphere at tens of thousands of miles per hour. The particles quickly vaporize, forming incandescent streaks across the sky. The comet itself follows an elongated orbit around the Sun, so it was well past Pluto as Denver watched the light show.

In testimony before Congress in 1985, Denver recalled "the joy in living that one feels when he observes something as wondrous as the Perseid meteor shower on a moonless, cloudless night, when there are so many stars that you have a shadow from the starlight, and you are out camping with your friends, your best friends, and introducing them to one of nature's most spectacular light shows for the first time."

Clues in the lyrics (Denver mentions his age) confirm the singer witnessed the 1971 Perseids. His description of the event suggests a date between August 20 and 24. And though not a trained observer, Denver followed many of the best stargazing practices, choosing a dark night, then selecting a vantage point far from artificial lighting, with an unbroken view of the night sky and good reference to the horizon. He also was a keen observer. An additional lyric in the song describes seeing "the shadow of the starlight," an experience Denver said left him "blown away."

It took the Grammy-winning singer about 10 months to turn his celestial observations into the now-famous song, which was an ode to Colorado (it's now one of Colorado's two state songs). Not long afterwards, a friendship with Wernher von Braun drew Denver to the space program. He passed a NASA physical as part of a program that would have sent songwriters, poets, journalists, and others into orbit aboard the space shuttle. Soon after, though, the shuttle Challenger exploded during launch and the space agency cancelled the program—leaving Denver and hundreds of other hopefuls grounded.

Here Comes the Sun

George Harrison, September 26, 1969

Here comes the Sun,
and I say, it's all right.

To millions of Beatles fans, this joyful song offers hope for brighter things to come. In fact, it was written by George Harrison, practically spontaneously, as he watched the rising Sun not long after the vernal equinox.

The location was the garden of friend and fellow music legend Eric Clapton, at Hurtwood Edge, in Ewhurst, Surrey, just southwest of London. "It was one of those beautiful spring mornings," Clapton recalled during a BBC interview, "And we were walking around the garden with our guitars. The Sun was shining...and he just started singing the opening lines."

Clapton's estate in the rolling countryside afforded outstanding visibility as an informal observatory. Recollections by both musicians about the weather that day, as well as business records, help to narrow the time to early April 1969. The Sun rose at about 5:30 a.m. and passed neatly over a stand of distant trees just before Harrison arrived. Like a good astronomer, Harrison even sketched a quick picture of the Sun in the corner of his lyric sheet. Coincidentally, he was close to both Stonehenge, England's most iconic solar monument, and the U.K.'s elite Mullard Space Science Laboratory, which was performing its own solar observations.

Personal, medical, and legal problems had dogged the singer the previous winter, making his joy at a bright spring morning a clear artistic touch. The Sun climbed low across the sky that spring morning, staying lower than it appears from most American cities. By comparison, Harrison had passed the previous spring in India, under a Sun that was 20 degrees higher. And he would finish writing *Here Comes the Sun* on the Mediterranean, with the Sun almost overhead at noon.

So this song is all about the Sun and our relationship to it. "It seems as if winter in England goes on forever," Harrison opined in his autobiography, "And by the time spring comes, you really deserve it." Meteorological records confirm his sentiments: The winter Harrison passed in sadness had been unusually harsh, then the spring that buoyed him, unseasonably bright.

Perhaps fittingly, George Harrison's song about the Sun was recorded soon after the summer solstice in 1969, as Apollo 11 prepared for the first human landing on the Moon. It was released in late September, just as the equinox, which had given him so much hope, returned.

You're So Vain

Carly Simon, November 8, 1972

Then you flew your Learjet up to Nova Scotia,
To see the total eclipse of the Sun

Which vain jetsetter from the singer's past inspired her to write this song has become a tantalizingly unanswered question in the history of rock and roll. (Over the years, she's hinted that it was more than one.) For science, the corollary question would be, "which total eclipse of the Sun inspired this song?" By a rare astronomical quirk, two of them occurred near each other in both time and place.

Heralded as "the last…to cross the populated U.S. in the 20th century," the eclipse of March 7, 1970, cut a path of totality from central Florida northward up the Eastern seaboard. As the big day approached, newspapers across the nation provided everything from time-honored viewing tips to foldable pinhole eclipse viewers, readying millions of potential observers. At the appointed hour, in city after city, skywatchers jammed open spaces to see the Sun disappear. For pop culture, it took place just months after the famous Woodstock music festival.

By contrast, the eclipse of July 10, 1972, was far more exclusive. It cast a partial shadow across much of the United States, but required committed travel to witness totality. In fact, it inspired a watershed moment in popular astronomy: the first modern eclipse cruise. The ocean liner Olympia carried astronauts, astronomers, and 800-plus stargazers from New York. Onboard entertainment included specially choreographed "eclipse dances" plus a screening of Mark Twain's *A Connecticut Yankee in King Arthur's Court* (which includes a famous scene involving an eclipse prediction). "Eclipse-chasing" as part science, part vacation destination began here.

Living on Manhattan's Central Park West, singer-songwriter Simon would have experienced both eclipses as strong partials, with 96 percent and 80 percent of the Sun's diameter blocked, respectively. So which celestial event inspired the singer? She later recalled imagining the opening lines of her song while attending an A-list party some months after the 1970 eclipse, and writing most of the song in 1971. But the lyrics also offer a second clue. The 1972 eclipse offered totality at just one populated place in North America: Nova Scotia, which is near the elite Saratoga racetrack, which also was mentioned in the song.

Publicity surrounding the 1972 eclipse, and especially the cruise, was widely available during the year it took Simon to complete *You're So Vain*. What's more, it was exactly the kind of "martini talk" the brainy young singer would have overheard at the jet-setting parties that inspired her to write the song. She envisioned an almost James Bond-like mystery man (she's winked that not every word is true) who races eclipses in a jet—a feat actually accomplished, using supersonic aircraft, not long after the song's release.

The clues all suggest that much like the elusive man in her song, "Carly Simon's Eclipse" is a composite, too. One celestial event provided the spark, then a second took the song where it needed to go.

Please keep listening, as this connection between popular music and the heavens continues, from rock and soul to folk and country. From Elton John (a meteor sighting helped inspire *Rocket Man*) to Little Richard (who supposedly walked off the stage after seeing Sputnik pass overhead). When recording artists see the stars, they sometimes give us stellar performances.

Engineer and science writer Nick D'Alto is a frequent contributor to StarDate.

Resources

Internet

Carly Simon
www.carlysimon.com

John Denver
johndenver.com

George Harrison
www.georgeharrison.com

Music Inspired by Astronomy
www.fraknoi.com/wp-content/uploads/2018/06/Fraknoi-Music-and-Astronomy-Article.pdf

Lyrics

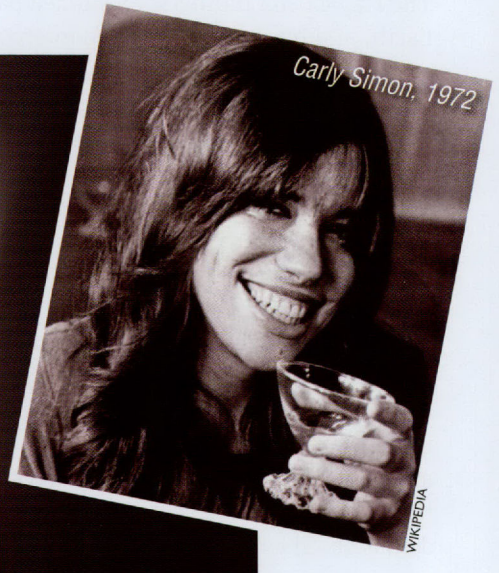
Rocky Mountain High
genius.com/John-denver-rocky-mountain-high-lyrics

Here Comes the Sun
genius.com/The-beatles-here-comes-the-sun-lyrics

You're So Vain
genius.com/Carly-simon-youre-so-vain-lyrics

A view of the 2017 solar eclipse

NASA/AUBREY GEMIGNANI



Carly Simon, 1972

WIKIPEDIA

by Damond Benningfield and Melissa Gaskill

The Hayabusa2 sample capsule, still attached to its parachute, in the Outback. Inset: The capsule leaves a fiery trail as it approaches Australia. The smaller streak is its mother craft, which continued toward another asteroid.

© JAXA (2)

Coming Home

While one asteroid explorer brings samples to Earth, a second prepares for its own return

Osiris-Rex is ready for departure. After grabbing several ounces of rock and dirt from the surface of Bennu in October, the probe will leave the asteroid in March. Arrival on Earth is scheduled for September 24, 2023.

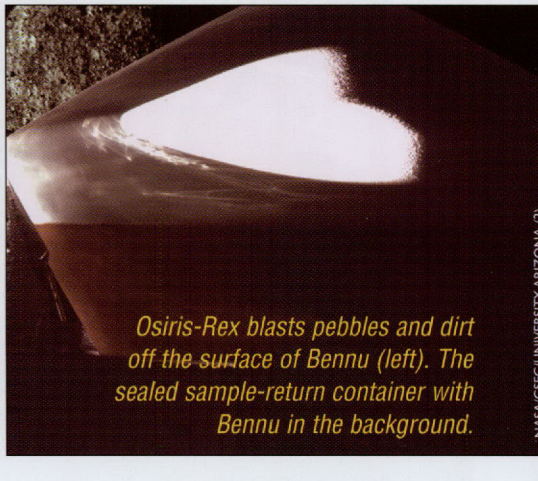
In the meantime, the return capsule of the Japanese probe Hayabusa2 parachuted to a safe landing in Australia in December with samples of another asteroid, Ryugu. The Japanese space agency plans to begin sending samples to researchers around the world by the end of the year. The Hayabusa2 mothership zoomed past Earth and has been targeted to intercept another asteroid in 2031.

Osiris-Rex's robotic arm touched Bennu for about six seconds on October 20. It fired a burst of nitrogen gas, which stirred up dirt and pebbles. Some of the debris was captured in a return capsule, which was safely sealed for the trip to Earth on October 28.

Bennu, which is about a third of a mile (500 meters) in diameter, is classified as a "primitive" asteroid, which means it hasn't changed much since it formed about 4.5 billion years ago. Samples of the asteroid therefore should reveal new details about conditions in the early solar system, when Earth and the other planets were born. And it may contain organic molecules like those that led to the creation of life on the early Earth.

Ryugu is slightly larger than Bennu, although the two asteroids resemble each other, with prominent bulges around their equators. Ryugu appears to be a fragment of a larger asteroid that was blasted to bits in a giant collision hundreds of millions of years ago. Sample analysis should provide a more detailed view of its history.

Precise tracking of both Osiris-Rex and Hayabusa2 has helped refine the orbits of the two asteroids and plot changes caused as the asteroids absorb heat from the Sun on the dayside, then radiate it back into space on the nightside. Such observations are important because both asteroids pass quite close to Earth every few years. Because of that proximity to Earth, and because both are large enough to cause major damage if they hit, Bennu and Ryugu are classified as potentially hazardous asteroids. Current projections say Bennu has a 1-in-2,700 chance of hitting Earth in the late 22nd century. Better models of their orbits will help scientists refine the odds of possible collisions with both asteroids. **DB**



Osiris-Rex blasts pebbles and dirt off the surface of Bennu (left). The sealed sample-return container with Bennu in the background.

Life on Venus! Or Not

Evidence for a compound in the atmosphere of Venus that could be produced by microscopic organisms isn't as strong as early results suggested, although the case is still open.

Astronomers using the James Clerk Maxwell Telescope in Hawaii and the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile reported signs of phosphine, a gas that's produced by microbes, in the Venusian atmosphere in September. They estimated its concentration at about 20 molecules per billion, which is significantly more than could be produced by natural nonbiological processes.

Bacteria on Earth can make phosphine, which contains hydrogen and phosphorus, and organisms could create the observed quantity working at about 10 percent of maximum productivity, according to the researchers.

Other research teams, however, found no evidence of the compound. And in November, one of the original teams acknowledged an error in the processing of the ALMA data. Reanalysis confirmed the phosphine signal, but at a level one-seventh of the earlier estimate. That level still is too high to be explained by surface volcanic eruptions or lightning strikes in the atmosphere, though.

A probe dropped into Venus's atmosphere by NASA's Pioneer-Venus mission in 1978 detected a signal that could be attributed to phosphine. Other missions have detected a layer in the clouds that absorbs ultraviolet energy, which also has been suggested as evidence of microorganisms.

India plans to launch a Venus mission in 2025 that may carry instruments capable of looking for phosphine, and researchers are seeking more time on Earth-based telescopes as well. Life on Venus? Stay tuned. **MG**

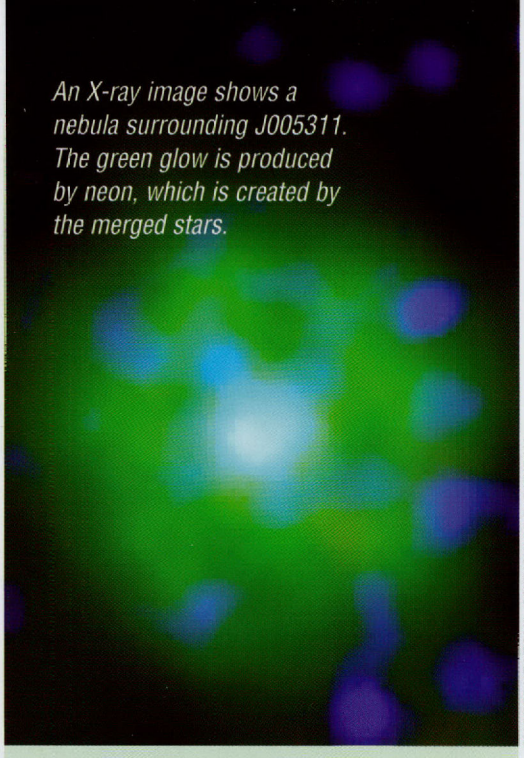
Death of a Galaxy

When galaxies stop forming stars, it means their end is nigh. Astronomers recently glimpsed the start of this process in ID2299, whose light takes about nine billion years to reach Earth. ID2299 is ejecting nearly half of its star-forming gas at a rate that will rapidly drain it of fuel to make new stars. At its current rate of star formation—hundreds of times faster than in our home galaxy, the Milky Way—it will consume the remaining gas in just a few tens of millions of years.

Scientists saw a "tidal tail" from the galaxy—an elongated stream of stars and gas escaping from the galaxy. Such tails usually form when two galaxies merge and one pulls material from the other. Tidal tails often are too faint to see and can be misidentified as winds from newborn stars or disks of hot gas around supermassive black holes. But because astronomers observed the ID2299 ejection as it happened, they were able to identify a tidal tail.

An artist's concept shows a tail of stars and gas escaping from ID2299.

ESO/L. KORNMESSER



An X-ray image shows a nebula surrounding J005311. The green glow is produced by neon, which is created by the merged stars.

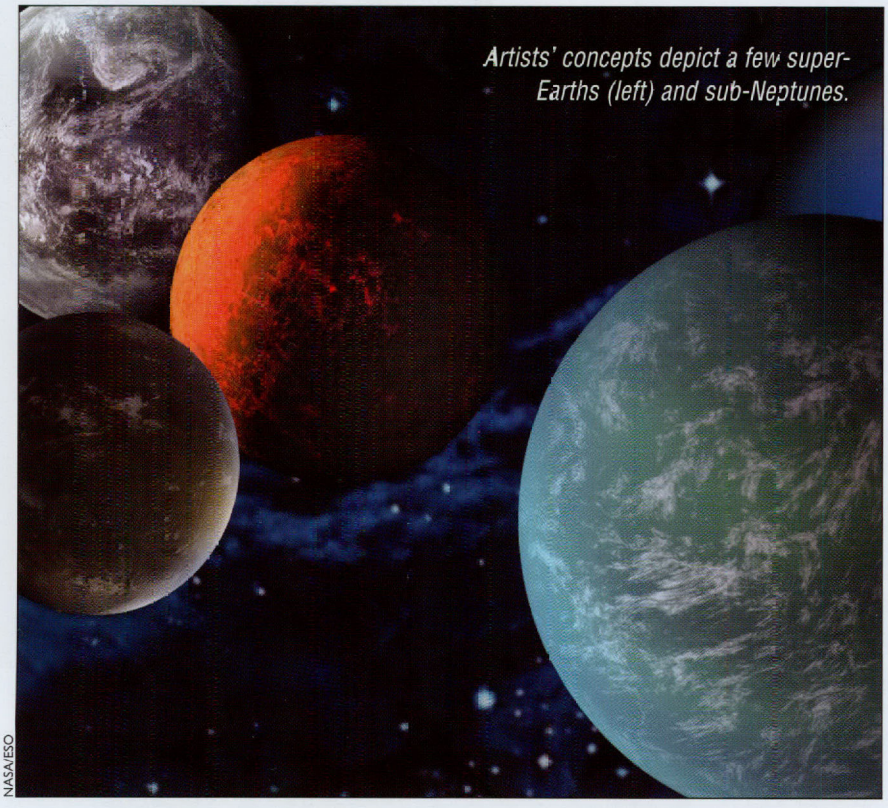
ESA/XMM-NEWTON/L. OSKINOVA/UNIV. POTSDAM

Bright Merger Creates New Type of Star

In 2019, scientists identified an unusual celestial object likely created by the merger of two long-dead white dwarf stars. Named J005311, it was too bright and massive to be an ordinary white dwarf—the core of a once-normal star that ceased producing energy and collapsed. In this case, two close-together stars drifted even closer, eventually merging and creating sufficient mass to resume nuclear reactions.

Findings reported in January support the idea that J005311 is the product of a white dwarf merger. Astronomers detected unusual X-ray emissions that suggested neon and oxygen dominated its composition.

A white dwarf packs the mass of a regular star into the size of Earth, but if it exceeds a certain mass limit it collapses to form an even denser neutron star—a ball heavier than the Sun but no bigger than a city. Researchers predict this unstable star will do so within the next 10,000 years. **MG**



NASA/ESO

Artists' concepts depict a few super-Earths (left) and sub-Neptunes.

A Chip off the Old Sub-Neptune

Stars may create super-Earths by blasting away their atmospheres

There's an old saying about how to sculpt an elephant: Start with a piece of marble, then chip away everything that doesn't look like an elephant. Nature may be following that advice in sculpting the planets known as super-Earths: Start with a sub-Neptune, then chip away everything that doesn't look like a super-Earth.

A super-Earth is a rocky planet that is about 1 to 1.8 times Earth's diameter and up to a few times Earth's mass. A sup-Neptune is roughly 1.8-3.5 times Earth's diameter and up to a few dozen times its mass, suggesting that it has a rocky core surrounded by a thick atmosphere, like Neptune. Searches have revealed hundreds of examples of both classes of planet in other star systems.

Astronomers have pondered how the two types form, which is complicated by the fact that there are no examples of either in our own solar system. And a couple of recent studies suggest that super-Earths might form from sub-Neptunes.

The studies show that the fraction of super-Earths is higher in older star systems than in younger ones. Since the planets in the studies are quite close to their host stars, that could mean that star-planet interactions can turn a sub-Neptune into a super-Earth, said Travis Berger, a graduate student at the University of Hawaii-Manoa and a member of one of the study teams, in a press briefing during the American Astronomical Society conference in January. "You start off with a sub-Neptune, you hit it with a bunch of high-energy radiation—and lots of it—over billions of years, and eventually you can strip off its atmosphere and make it a super-Earth," he said.

In a presentation at the same conference, the other team, from New York, concurred, writing that there is "compelling evidence of atmospheric loss among low-mass planets."

Berger noted, however, that there may be other ways to sculpt a super-Earth, so astronomers continue to study the births of these plentiful planets. **DB**

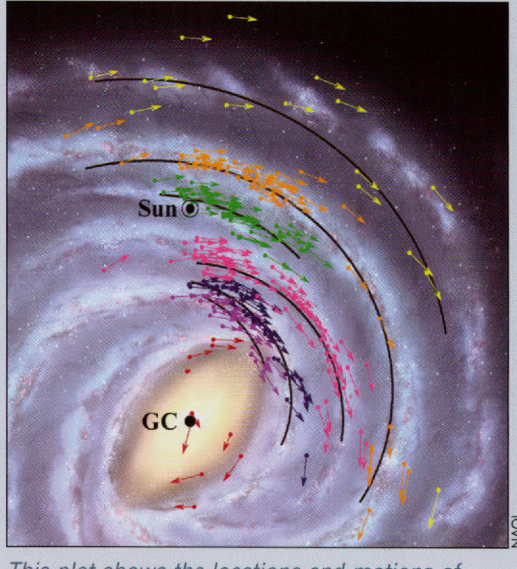
Stepping off the Distance to the Heart of the Galaxy

Our solar system is in the galactic suburbs, far from the Milky Way's busy center. The exact distance is a little fuzzy, though, with various studies producing measurements that vary by thousands of light-years. A study released late last year puts the distance at 25,800 light-years, compared to an average of about 27,000 light-years for earlier studies.

Researchers used an array of radio telescopes in Japan to determine the distances and motions of almost 100 objects in the Milky Way. Plotting the orbits of those objects, along with others observed by other projects, allowed the astronomers to determine the distance to the galactic center. The study will need confirmation, though, before its distance is accepted as the final word.

The galactic center is occupied by a black hole more than four million times the mass of the Sun. It is one of the quietest supermassive black holes yet discovered. Similarly sized black holes in the hearts of other galaxies blaze up to one billion times brighter. Yet there's evidence that the Milky Way's black hole hasn't always been so shy. A study released in January reported that it could have shined 100 million times brighter fairly recently.

Astronomers measured giant bubbles of hot gas that extend about 45,000 light-years above and below the galactic center. The bubbles were generated by a powerful event about 15 million years ago—an exploding star or an eruption from material encircling the black hole.



NAOJ

This plot shows the locations and motions of the objects astronomers used to determine the distance to the center of the galaxy (GC).

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mcdonaldobservatory.org/visitors/livestream

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stardate.org/content/engaging-universe-home

The oldest and most distant quasar yet discovered blazes brightly in this artist's concept. J1303-1860 consists of a black hole about 1.6 billion times the mass of the Sun, which is pulling in enormous amounts of gas and dust from its surrounding galaxy. As the gas and dust spiral toward the black hole they are heated to millions of degrees, so they outshine entire galaxies of normal stars. Some of the material is guided back out into space in the form of powerful 'jets' of particles. The quasar is seen as it looked when the universe was just 670 million years old.