

| ONE STRANGE ROCK | 10-PART TV SERIES

PREMIERES MONDAY, MARCH 26, ON NATIONAL GEOGRAPHIC

NATIONAL GEOGRAPHIC

THROUGH AN ASTRONAUT'S EYES

WHAT
WE
LEARN
ABOUT
EARTH
FROM
SPACE

*Astronaut Peggy
Whitson has spent
665 days in space
— more than any
other American*

MARCH 2018



By
**NADIA
DRAKE**

Photographs by
**MARTIN
SCHOELLER**

A woman with short dark hair, wearing a white and blue space suit, is shown from the waist up. She is looking off to the right with a slight smile. The background is a vast, rugged mountain range under a cloudy sky. The text "BEYOND THE BLUE MARBLE" is overlaid on the right side of the image.

BEYOND THE BLUE MARBLE

From space,
the majesty of
Earth can be
difficult
to describe.
But these
astronauts
will try.



MIKE MASSIMINO

NEW YORK CITY

In 2009 the NASA astronaut visited the Hubble Space Telescope, some 350 miles above the planet, on a mission to fix the beloved eye in the sky for the last time. Hubble's gaze is perpetually turned toward outer space, but tethered next to the massive observatory, Massimino was entranced by Earth. With verdant South American rain forests, rugged African deserts, and sparkling city lights spread out below him, the planet looked like a paradise.

"I thought at one point, if you could be up in heaven, this is how you would see the planet. And then I dwelled on that and said, no, it's more beautiful than that. This is what heaven must look like. I think of our planet as a paradise. We are very lucky to be here."

WATCH ON NATIONAL GEOGRAPHIC

Take a thrilling tour of one of the universe's most peculiar places – Earth – in the 10-part event series *One Strange Rock*, airing Mondays at 9/8c starting March 26.



FOR THE BULK OF HUMAN HISTORY, IT'S BEEN IMPOSSIBLE TO PUT EARTH IN COSMIC PERSPECTIVE.

Bound by gravity and biology, we can't easily step outside it, above it, or away from it. For most of us, Earth is inescapably larger than life. Even now, after nearly six decades of human spaceflight, precious few people have rocketed into orbit and seen the sun peeking out from behind that curved horizon. Since 1961, a mere 556 people have had this rarefied experience. Fewer, just 24, have watched Earth shrink in the distance, growing smaller and smaller until it was no larger than the face of a wristwatch. And only six have been completely alone behind the far side of the moon, cut off from a view of our planet as they sailed in an endlessly deep, star-studded sea.

SAMANTHA CRISTOFORETTI

ITALIAN ALPS
(Previous spread)

The Italian astronaut holds the record for the second longest uninterrupted spaceflight by a woman, having spent 199 days on the International Space Station in 2015. (NASA's Peggy Whitson, on the cover, topped that record by almost a hundred days in 2017.) The longer she was in orbit, Cristoforetti says, the more her perception of humanity's time on Earth evolved. When the massive geologic forces that have sculpted the planet are visible at a glance, the eons in which we crafted pyramids and skyscrapers become nearly indistinguishable. It's as if, from her vantage point, all our constructed monuments arose overnight.

"You've got this planet beneath you, and a lot of what you see, especially during the day, does not necessarily point to a human presence. If you look at it on a geologic timescale, it's almost like we are this flimsy presence, and we really have to stick together as a human family to make sure we are a permanent presence on this planet and not just this blink of an eye."

It's an inherently unnatural thing, spaceflight. After all, our physiology evolved specifically to succeed on this planet, not above it. Perhaps that's why it can be difficult for astronauts to describe the experience of seeing Earth from space.

Italian space traveler Luca Parmitano says that we haven't yet developed the words to truly convey the realities of spaceflight. The building blocks of modern human communication, words are necessarily constrained by meaning and connotation, no matter which language you choose (Parmitano speaks five). And until the mid-20th century, there was no need to express what it means to see our planet in the fiercely primeval essence of space. "We just don't think in terms of spaceflight," he says.

Seeing Earth from space can change a person's worldview. U.S. astronaut Nicole Stott flew twice on the space shuttle *Discovery* and returned with a new drive for creating artwork depicting the view. Canadian spacefarer Chris Hadfield says that while orbiting Earth, he felt more connected to the people on the planet than ever before.

Kathy Sullivan, who in 1984 became the first American woman to perform a space walk, returned with an abiding awe for the intricate systems that come together to make Earth an improbable oasis. "The thing that grew in me over these flights was a real motivation and desire ... to not just enjoy these sights and take these pictures," she says, "but to make it matter."

After retiring from NASA, Sullivan led the National Oceanic and Atmospheric Administration for three years, using the robotic eyes of orbiting satellites to pursue her passion. She says Earth from above is so captivatingly beautiful, she never grew bored looking at it. "I'm not sure I'd want to be in the same room with someone who could get tired of that."

Even when words fail us, a single picture of home from above can change the perspectives



of millions of people. In 1968 the Apollo 8 crew became the first people to rocket far away from Earth and loop around the moon. On Christmas Eve, astronaut William Anders snapped what would become an unforgettable image: a lush world rising above the sterile, cratered lunar horizon. Now called "Earthrise," the photograph boosted awareness of our planet's beauty and fragility.

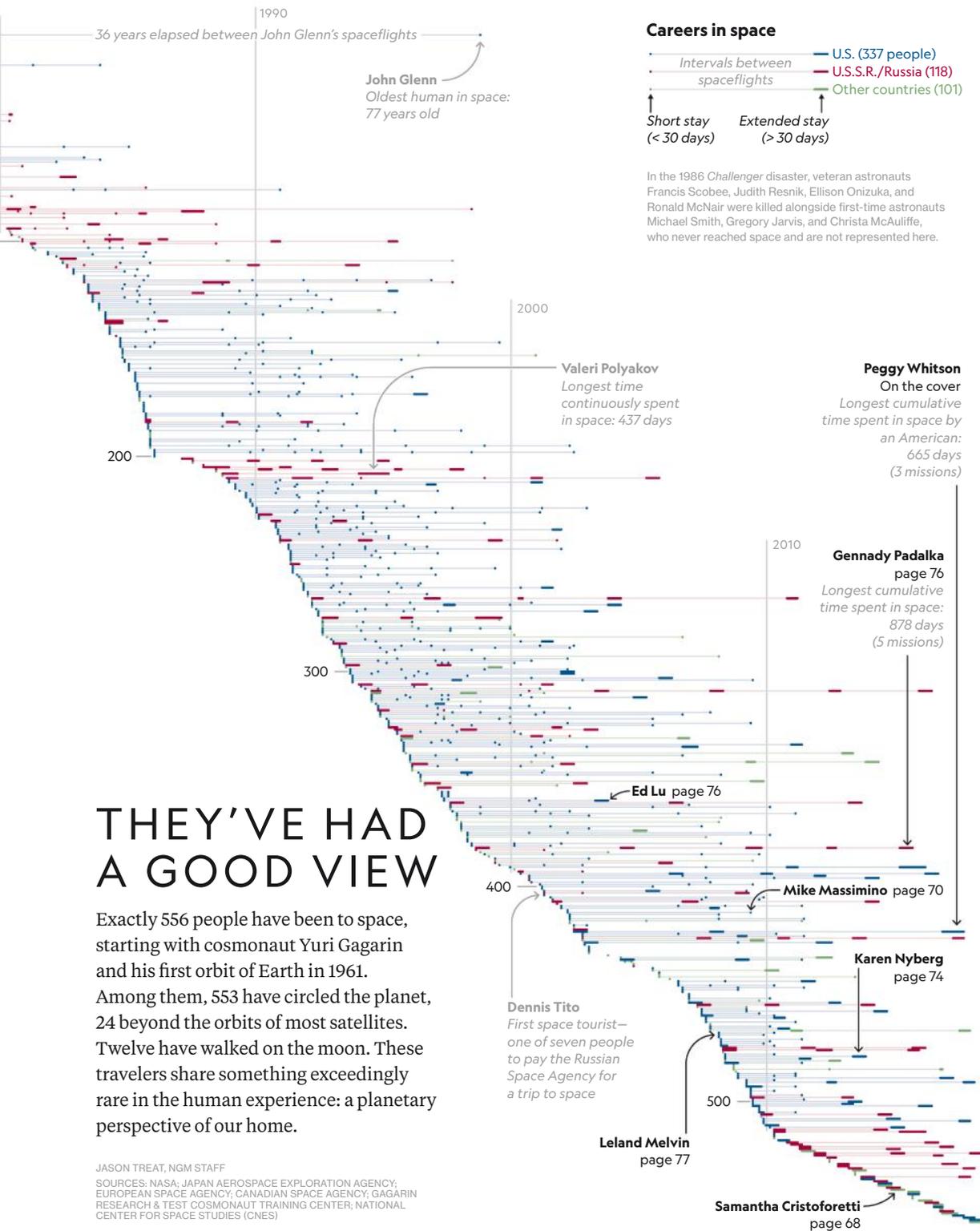
"Twenty eighteen is the 50-year anniversary of that iconic picture that helped define the environmental movement. What are the course corrections we need to do now that will help us get to the hundredth anniversary?" asks U.S. astronaut Leland Melvin. He's working with a coalition of fellow space travelers to rethink how we balance ecological health and human needs. The project will use astronauts' experiences to help others adopt more sustainable lifestyles.

Clearly, a desire to protect the planet is common among those who have left it. Russian cosmonaut Gennady Padalka has logged more cumulative days in space than anyone else. The allure of spaceflight kept him on the job for 28 years, but something even more powerful than gravity kept bringing him home.

"We are genetically connected to this planet," he says. And to the best of our knowledge, Earth is unique in its ability to support life as we know it. The past decade of astronomy has shown us that we are one among billions of worlds in the Milky Way galaxy, but our tangled web of geology, ecology, and biology makes this strange rock the only one in reach that's just right for humans.

There really is no place like home. □

Contributing writer **Nadia Drake** once applied to be an astronaut and now feeds her curiosity by covering the cosmos. Photographer **Martin Schoeller's** cover story on the Amazon's Kayapo people appeared in the January 2014 issue of *National Geographic*.



36 years elapsed between John Glenn's spaceflights

John Glenn
Oldest human in space:
77 years old

Careers in space

Intervals between spaceflights

- U.S. (337 people)
- U.S.S.R./Russia (118)
- Other countries (101)

Short stay (< 30 days) Extended stay (> 30 days)

In the 1986 *Challenger* disaster, veteran astronauts Francis Scobee, Judith Resnik, Ellison Onizuka, and Ronald McNair were killed alongside first-time astronauts Michael Smith, Gregory Jarvis, and Christa McAuliffe, who never reached space and are not represented here.

THEY'VE HAD A GOOD VIEW

Exactly 556 people have been to space, starting with cosmonaut Yuri Gagarin and his first orbit of Earth in 1961. Among them, 553 have circled the planet, 24 beyond the orbits of most satellites. Twelve have walked on the moon. These travelers share something exceedingly rare in the human experience: a planetary perspective of our home.

JASON TREAT, NGM STAFF
 SOURCES: NASA; JAPAN AEROSPACE EXPLORATION AGENCY; EUROPEAN SPACE AGENCY; CANADIAN SPACE AGENCY; GAGARIN RESEARCH & TEST COSMONAUT TRAINING CENTER; NATIONAL CENTER FOR SPACE STUDIES (CNES)

Peggy Whitson
On the cover
Longest cumulative time spent in space by an American: 665 days (3 missions)

Gennady Padalka
page 76
Longest cumulative time spent in space: 878 days (5 missions)

Ed Lu page 76

Mike Massimino page 70

Karen Nyberg
page 74

Dennis Tito
First space tourist— one of seven people to pay the Russian Space Agency for a trip to space

Leland Melvin
page 77

Samantha Cristoforetti
page 68

KAREN NYBERG

CADDO LAKE,
TEXAS

In September 2013, during her second visit to the International Space Station, Nyberg made a stuffed dinosaur for her three-year-old son. It was, perhaps, the first toy sewn in space, constructed from spare material the mechanical engineer found aboard the orbiting outpost. Making the stuffed animal helped her feel more in touch with her loved ones far below. But the creative project was also a manifestation of the deep connection Nyberg felt to ecosystems past and present while she was in orbit.

"In the future, I would like to be more of an advocate for animal conservation. Every single part of the Earth reacts with every other part. It's one thing. Every little animal is important in that ecosystem. [Seeing the planet from above] makes you realize that, and makes you want to be a little more proactive in keeping it that way. If I could get every Earthling to do one circle of the Earth, I think things would run a little differently."





GENNADY PADALKA

LOSINY OSTROV
NATIONAL PARK,
RUSSIA

The Russian cosmonaut holds the record for time spent in space, with 878 cumulative days logged from 1998 to 2015. For him, the experience was a lesson in the virtues of teamwork, which become amplified in the lethal environment of spaceflight. There's no doubt in his mind that the planet will endure, even if it is significantly altered by humanity. But he wonders if we as a species will survive our more selfish actions.



“The overriding impression I got of life on Earth is how robust it is. Life has managed to essentially completely cover this planet in all sorts of different places—it finds a way.” —ED LU

ED LU

METEOR CRATER,
ARIZONA

A veteran of three NASA spaceflights from 1997 to 2003, Lu looked back at the planet and was struck by the massive craters pressed into its crust by past bombardments. In 2002 he co-founded the B612 Foundation, a nonprofit that works on what he calls “engineering on the largest scale imaginable.” The group’s goal: to prevent any devastating asteroid impacts on Earth.





LELAND MELVIN

LONG ISLAND,
THE BAHAMAS

Drafted into the National Football League in 1986, Melvin played briefly with the Detroit Lions. But when an injury cut short his athletic career, his life took a dramatic turn—into orbit. During his two flights as a NASA astronaut, in 2008 and 2009, Melvin was gobsmacked by the sight of Earth's oceans from above. The colors were so varied, he found himself searching for new ways to describe all the shades of blue. His thirst for knowledge continues to distinguish his efforts to inspire people, especially kids, to preserve the planet and chase their dreams.

ONE STRANGE ROCK

13 THINGS THAT MAKE LIFE ON EARTH POSSIBLE

Earth is well equipped as a planet and ideally placed in our solar system and galaxy to support life as we know it. The product of some 4.6 billion years of cosmic construction, our planet is flush with life thanks to a fortuitous set of conditions, from the optimal chemical makeup of our planetary core to our safe distance from the hidden black hole at the heart of our galaxy.

BY MANUEL CANALES,
MATTHEW W. CHWASTYK,
AND EVE CONANT



3 We have a big moon to stabilize our axial wobble

Earth is tilted with respect to the sun, and teeters as it spins. This tiny wobble can shift the climate from hot to icy every 41,000 years—and might vary more without the moon's stabilizing pull.

2 We have an ozone layer to block harmful rays

Ancient plantlike organisms in the oceans added oxygen to the atmosphere and created a high-altitude layer of ozone that shielded early land species from lethal radiation.

OZONE LAYER

ALGAL BLOOM

CONTINENTAL SHELF

TRENCH

OCEANIC

1 Our planet recycles life-friendly carbon over time

Carbon dioxide is one of many greenhouse gases that trap heat and keep Earth's surface warm enough to support life. The static surfaces of Venus and Mars keep carbon locked in the air and rocks. But over millions of years, Earth dynamically cycles this vital element through its air, land, and sea due to the constant action of plate tectonics.

A: CARBON IS DEPOSITED

Chemical processes that dissolve minerals in rocks draw carbon out of the atmosphere and eventually incorporate it into Earth's crust.

4 Earth's varied surfaces support many life-forms

The dramatic effects of plate tectonics formed different surface habitats and terrains. This spurred adaptation, helping life diversify and survive several mass extinctions.



5 Our magnetic field deflects solar tempests

Sparked by charged particles from the sun, mesmerizing auroras are a visual reminder of our magnetic field, which deflects the bulk of our star's damaging radiation and solar outbursts.

A U R O R A

HUMANS ARE AFFECTING THE CLIMATE

After 11,700 years of relative stability, people are now loading the atmosphere with carbon, rapidly tipping Earth into a new climatic age.



B: CARBON SINKS DEEP

Carbon gets compacted in the crust over millions of years and eventually dives toward Earth's center in the zones where tectonic plates collide.

C: CARBON IS EJECTED

As the crust dips into the hot mantle below, it reaches a melting point and rises to the surface through volcanoes, sending carbon back into the atmosphere.

IN THE SOLAR SYSTEM

NOT TOO HOT OR TOO COLD

Not every planet has what it takes to support life as we know it. Even though eight planets formed in the solar system, Earth is the only one where we know life emerged and thrived. Having the right ingredients coalesce in just the right zone around a calm, warm star seems to be crucial for creating a life-sustaining world.



SATURN

7 We're situated safely away from gas giants

If the orbits of the solar system's biggest planets were much closer, tugs from their powerful gravity could cause disastrous fluctuations in Earth's distance from the sun.

6 We're at just the right distance from the sun

Earth orbits in the so-called Goldilocks zone, where it's not too close and not too far from the sun for water to be liquid on its surface.

Planets in the diagram below are drawn to scale. Planetary distances are scaled separately.

THE DIAMETER OF THE SUN IS NEARLY 10X JUPITER'S



URANUS

NEPTUNE

ASTEROID BELT

MERCURY

Mercury is too small to hold on to a protective atmosphere and too near the sun for liquid water to persist on its surface.



VENUS

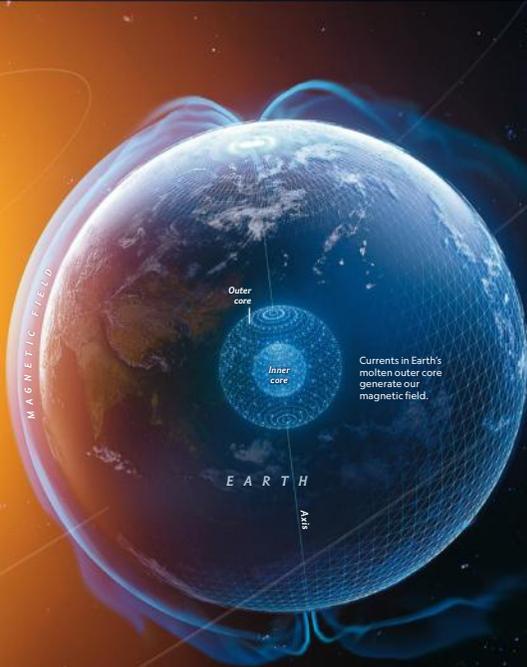
Core

Weak magnetic field

8 The sun is a stable, long-lasting star

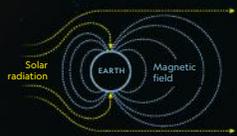
Stars more massive than the sun burn hotter and usually don't live long enough for planets to develop life. Less massive, younger stars are often unstable and are prone to blasting their planets with bursts of radiation.

Venus has a molten core and a robust atmosphere, but it's likely too near the sun, and it lacks plate tectonics—crucial for regulating climate.



9 We have the right stuff to host a dynamic core

The interstellar cloud of gas and dust that gave rise to Earth contained enough radioactive elements to power a churning core for billions of years. This creates a magnetic field that protects the planet from dangers like solar flares.



Large planets made mostly of gas like Jupiter, have crushing atmospheres swirling with powerful storms.



Mars is about half the size of Earth and a tenth its mass. With a patchy magnetic field and weaker gravity, it holds on to just a thin atmosphere and little to no liquid water on its surface.



The pull of the moon helped slow young Earth's rotation rate, giving us roughly 24-hour days and the ebb and flow of tides.

A S T E R O I D B E L T

JUPITER

10 We have giant planets that protect us from afar

Jupiter's strong gravity sent water-rich asteroids crashing into early Earth. Today the massive planet tins out the asteroid belt, protecting Earth from overly frequent collisions that might trigger extinctions.

SCALE VARIES IN THIS PERSPECTIVE.
 MARIEE CANALES AND MATTHEW W. CHWASTY, NOAA; SEAN MCNAUGHTON, ART ANTOINE COLLIIGNON SOURCE; GILBERTO GONZALEZ, BALL STATE UNIVERSITY; MICHAEL GOWANLOCK, NORTHERN ARIZONA UNIVERSITY; CAROL ASTROBIOLOGY; NASA/JPL; INTERNATIONAL JOURNAL OF ASTROBIOLOGY



Two billion mi (3.2 billion km)



IN THE MILKY WAY

A SAFE LOCATION

The Milky Way is a spiral galaxy with gracefully curving arms and a bright, central bar of stars passing through its core. To sustain life, planets embedded within the galaxy must avoid catastrophic threats such as close supernovae, gamma-ray bursts, and active black holes. They also can't be crowded in star clusters that would jostle them around too much. Luckily, Earth is in an ideal place for its inhabitants to thrive.

The Milky Way's arms are filled with hazards to habitability, including radioactive clouds, areas of active star formation, and sterilizing blasts from dying stars.



GALAXY HALO

Loose stars and some 150 dense stellar clusters orbit within the Milky Way's halo. Life-sustaining planets are unlikely here, because heavy elements are too sparse to build Earthlike worlds.

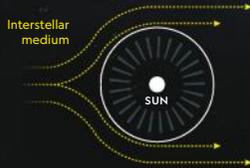
CHAOTIC CORE

A hidden black hole four million times the mass of the sun makes the galaxy's heart a dangerous place, with intense bursts of radiation hostile to life.



11 Our sun offers protection from galactic debris

The sun engulfs its planets in a bubble of charged particles that repel dangerous radiation and harmful materials coming from interstellar space.



12



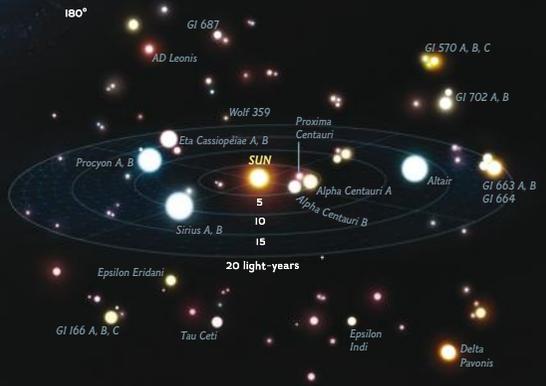
RIPE FOR LIFE?
 A 10,000-light-year-wide bulge of dust, gas, and old stars surrounds the core. Experts are divided over whether this area could support life.

Small, rocky planets like ours can't form without elements heavier than hydrogen and helium, which become less common at the far edges of the galaxy.

YOU ARE HERE
 SOLAR SYSTEM

13 **Our location is far from stellar crowds**
 There are relatively few stars near the sun, reducing risks to Earth from gravitational tugs, gamma-ray bursts, or collapsing stars called supernovae.

Our galactic path steers us clear of hazards
 The solar system is comfortably nestled in a safe harbor between major spiral arms, and its nearly circular orbit helps it avoid the galaxy's perilous inner regions.



MANUEL CANALES AND MATTHEW W. CHWASTYK, NGM STAFF; SEAN MCNAUGHTON, ART; ANTOINE COLLIGNON
 SOURCES: GUILLERMO GONZALEZ, BALL STATE UNIVERSITY; MICHAEL GOWANLOCK, NORTHERN ARIZONA UNIVERSITY; ICARUS; ASTROBIOLOGY; NASA/JPL; INTERNATIONAL JOURNAL OF ASTROBIOLOGY