ROTUNDA

American Museum of Natural History

Member Magazine
Fall 2011 Vol. 36 No. 4

Searching For Life on Mars

How to Build a Lunar Elevator

Opening November 19

BEYOND PLANET EARTH: THE FUTURE OF SPACE EXPLORATION

Astrophysics at the Museum

From the President

Ellen V. Futter

Even for those of us long past our school years, fall always feels like "back to school"—a time for new ventures and new adventures. The most exciting new venture at the Museum is our Master of Arts in Teaching (MAT) program, which marks the first time that an institution other than a university or college will offer a master's program for science teachers. Please read more about this pioneering initiative on page 3.

Fall 2011 brings a full slate of exciting offerings for the public, including our thrilling new exhibition, *Beyond Planet Earth: The Future of Space Exploration*; perennial favorite *The Butterfly Conservatory*; and the 35th anniversary of the Margaret Mead Film Festival.

The fall also brings important changes to the Membership program. Last year, in an effort to learn more about your needs and interests, the Museum conducted a comprehensive study, in which many of you participated. Based on that work, the Museum has restructured and enhanced its program to bring it more fully in line with Members' lives.

Membership categories will now more closely reflect the kinds of households that you are part of, with new Family and Adult tracks that will allow us to tailor programs, services, and benefits. And, moving forward, there will be an increased emphasis on communication, including keeping in closer touch with Members through electronic means, including a new digital membership.

Members are such an essential part of the Museum family, and I thank all of you who helped us by completing a survey or participating in a focus group. I know you have many demands on your time, and I want to personally thank you for your steadfast involvement in the Museum. Now, let's get "back to school" at the Museum and embark on some new adventures together!

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More Stars Shine Brighter With Hayden Planetarium Upgrade

A side-by-side test of the two projection systems over the summer illustrates a dramatic improvement.

There's a new, more vivid way to see the Museum's Space Show and presentations of the Digital Universe Atlas, thanks to a $2 million upgrade to the Hayden Planetarium projection system that makes it possible to view thousands of stars that had previously not shown up on the dome's surface.

A key feature of the new system is the ability to convey true black as well as allowing for brighter colors, which makes visible many more stars than had previously been displayed. The upgrade increased the video projector's contrast ratio between light and dark to 500,000 to 1. (By comparison, most movie theater projectors have a ratio of only 2,000 to 1.) The new system can also project 10-bit color–a major technological leap that required Museum engineers to develop a new file format, in addition to building new servers. The result is greater depth of color and smoother, more natural-looking color gradients.

The improved effect of the new projection system was vividly apparent at a trial run in the Hayden Planetarium this summer when a projection from the previous system was shown side by side with one from the upgrade. One half of the dome showed a darkened sky with a smattering of stars, and a few trails of interstellar gases; the new projection showed a veritable explosion of stars, gas trails, and dense, cloud like masses of stars easily recognizable as part of the Milky Way.

For upcoming Hayden Planetarium programs, visit amnh.org.

Museum To Offer Science Teaching Degree

This fall, the Museum is launching a Master of Arts in Teaching (MAT) program, marking the first time that an institution other than a university or college will offer such a program for science teachers.

The pioneering 15-month program is part of a specialized five-year pilot initiative, supported by funding provided in part by the New York State Education Department and the National Science Foundation, which is designed to ameliorate a critical shortage of qualified science teachers in New York State and help address the national crisis in student achievement in science.

The MAT program, which will draw on the Museum's scientific resources and history of leadership in teacher professional development, will be conducted in partnership with six high schools in Manhattan, Queens, the Bronx, Yonkers, and Freeport. Candidates will spend a full academic year in a partner school in addition to two summers with Museum scientists and educators.

Alumni of the program will be offered a two-year formal early-career professional development program, a critical element of support for new teachers that directly addresses high rates of attrition.

The Museum begins the planning process for the new program this fall, with the first class slated to begin next summer.

The new MAT program continues to build on the Museum's work in post-secondary education. In 2006, the Museum became the first museum in the Western Hemisphere to grant the Ph.D. through its Richard Gilder Graduate School, which offers a doctoral program in comparative biology.

For more about the Museum's MAT program, visit amnh.org/education/mat.

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Photo © AMNH/D. Finnin

Partners in Light

The ponyfish does not produce its own light but instead relies on its resident population of *Photobacterium leiognathi*, a luminous marine bacterium that lives in its light organ. The relationship between the two is mutually beneficial: the ponyfish provides the bacteria with oxygen and nutrients, and the bacteria give their host the ability to use light displays.

An Abundance of Fishes

The size of the Museum's Ichthyology collection, which includes some 2 million specimens housed in four floors of two adjacent buildings, is rapidly growing and ranks fourth among the eight major international centers for ichthyology.

Tools for Study

Sparks's research into the evolution and function of bioluminescent signaling systems in fishes is supported by two National Science Foundation grants. As part of these projects, he is collaborating with colleagues at other institutions to develop, refine, and implement 3-D magnetic resonance imaging (MRI) technology for analyzing soft tissue structures in bioluminescent marine fishes, hearing mechanisms in cichlids, and brain development in freshwater and marine fishes.

MIF at the Museum

The Museum's Microscopy and Imaging Facility offers scientists a range of state-of-the-art technologies for research. Among the sophisticated equipment is a high-powered computed tomography (CT) scanner, one of only four of its kind in the country; a scanning electron microscope, which can magnify images up to 500,000 times; and a confocal laser scanning microscope, which provides 3-D images in microscopic detail.

Safeguarding Specimens

In addition to offering a window into previously unseen phenomena, advanced instruments—such as the electron microprobe that reveals mineral composition of meteorites—provide another significant benefit: they leave valuable specimens intact.

Secutor ruconius

Cleared and Stained: Picturing a Ponyfish

While advances in imaging technologies have opened new pathways for scientists to study natural phenomena, researchers continue to make remarkable discoveries using techniques that have been around for decades. John Sparks, associate curator in the Museum's Department of Ichthyology, uses enzymes and dyes to reveal key anatomical structures in different species of fishes for study of their function and evolution.

Among his study subjects are ponyfishes (family Leiognathidae), a group of bioluminescent fishes common in the Indian Ocean and Western Pacific that have a light organ. This internal structure, which varies among ponyfish species, surrounds the esophagus and contains luminescent bacteria, the source of the fish's light. The light organ is larger in males, which have a second species-specific anatomical feature: translucent skin patches, which allow them to use the light organ in displays to attract mates in turbid waters. (Bioluminescent organisms will be explored in the exciting new exhibition *Creatures of Light: Nature's Bioluminescence*, which opens at the Museum in Spring 2012.)

In expeditions to Madagascar, Taiwan, South and Southeast Asia, and other sites, Sparks and his colleagues have collected thousands of specimens, including the *Secutor ruconius* pictured above. Back in the laboratory, Sparks treats the fish with a series of chemical dyes: red for tinting bones, blue for cartilage, and enzymes to make tissues transparent. Photos of the treated fish–including those featured in the exhibition *Picturing Science: Museum Scientists and Imaging Technologies*–show the whole body with inner organs intact in striking multi-colored images that illuminate structural differences.

Sparks is using this technique, in combination with 3-D imaging, DNA analysis, and other methods, to compare the light organs of different ponyfish species and gain insight into the evolution of light-signaling systems, the role of sexual selection in ponyfish diversification, and co evolution of the fish and the luminous bacteria abundant in its light organ.

Picturing Science: Museum Scientists and Imaging Technologies **is on view in the Akeley Gallery.**

This exhibition is made possible by the generosity of the Arthur Ross Foundation.

Brain Case: *Diplodocus longus*

In a corner of the exhibition *The World's Largest Dinosaurs*, an elegant wire outline of the head of *Diplodocus longus*, a sauropod that lived in the Late Jurassic period about 156 million years ago, anchors a fascinating fossil: one half of a bony braincase, its interior carefully color-coded to denote various functional structures once within it.

One's first impression is how very small the brain must have been, especially given that the brain itself probably took up about only 70 percent of the bony case, with protective outer layers called meninges taking up the other 30 percent. Despite the dinosaur's massive size–it was 80 feet long and weighed 20,000 pounds–its brain weighed about 4 ounces. By comparison, the average adult human brain weighs 48 ounces.

Of course, scientists can only speculate about this because brains–composed mostly of water–don't fossilize well and are extremely rare, almost nonexistent, within the fossil record.

"It's informed guesswork," says Jonah Choiniere, a postdoctoral fellow in the Division of Paleontology. "We're extrapolating based on comparative data from living animals such as birds and crocodiles."

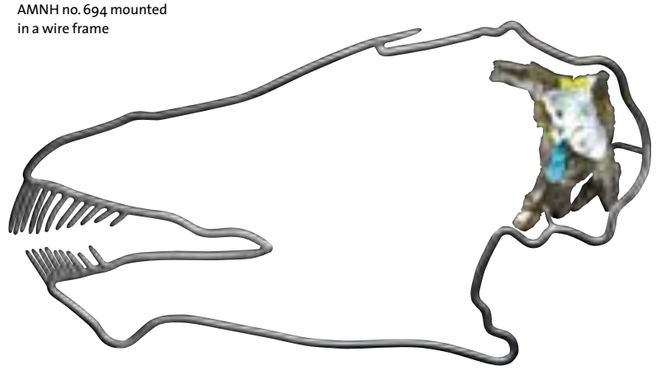
Though the brain itself is lost forever, the endocast, or cavity within the braincase, offers valuable clues to the dinosaur's basic functions, metabolism, and lifestyle. In the exhibition display, four key structures are identified with different colors: the optical nerve opening (green); the facial nerve opening (orange); the pineal opening (yellow); and the site of the pituitary gland (blue).

"This particular specimen was chosen for this exhibition because it has been delicately prepared and sectioned to expose the brain cavity," says Mark A. Norell, chair of the Division of Paleontology and curator of *The World's Largest Dinosaurs*. "Only rarely are sauropod dinosaur skulls found with the braincase relatively intact and undistorted."

Color-coding the braincase for the current special exhibition involved a process designed to be fully reversible. First, preparators covered the interior with a layer of acetone-soluble plastic–a substance commonly used to harden fossils. Then, they applied acrylic paint, which can be peeled off the plastic base that in turn can be removed with acetone, a solvent familiar to anyone who has ever used nail polish remover.

The World's Largest Dinosaurs**, which is free for Members, closes on January 2.**

AMNH no. 694 mounted in a wire frame



Original Fossil

The *Diplodocus longus* braincase was discovered on a Museum expedition in 1901 at Bone Cabin Quarry, Wyoming. The other half is on permanent display in the Hall of Saurischian Dinosaurs in the David H. Koch Dinosaur Wing. Today, such a find would be studied with a CT scanner, eliminating the need to bisect it with a rock saw to see what's inside.

By the Dozen

With the exception of frogs and salamanders, all four-limbed animals, including humans, have 12 cranial nerves that are involved in everything from smell (olfactory) to heart rate (vagus). This commonality helps scientists make sense of what they see when studying the empty braincases of extinct animals.

Breathing Room

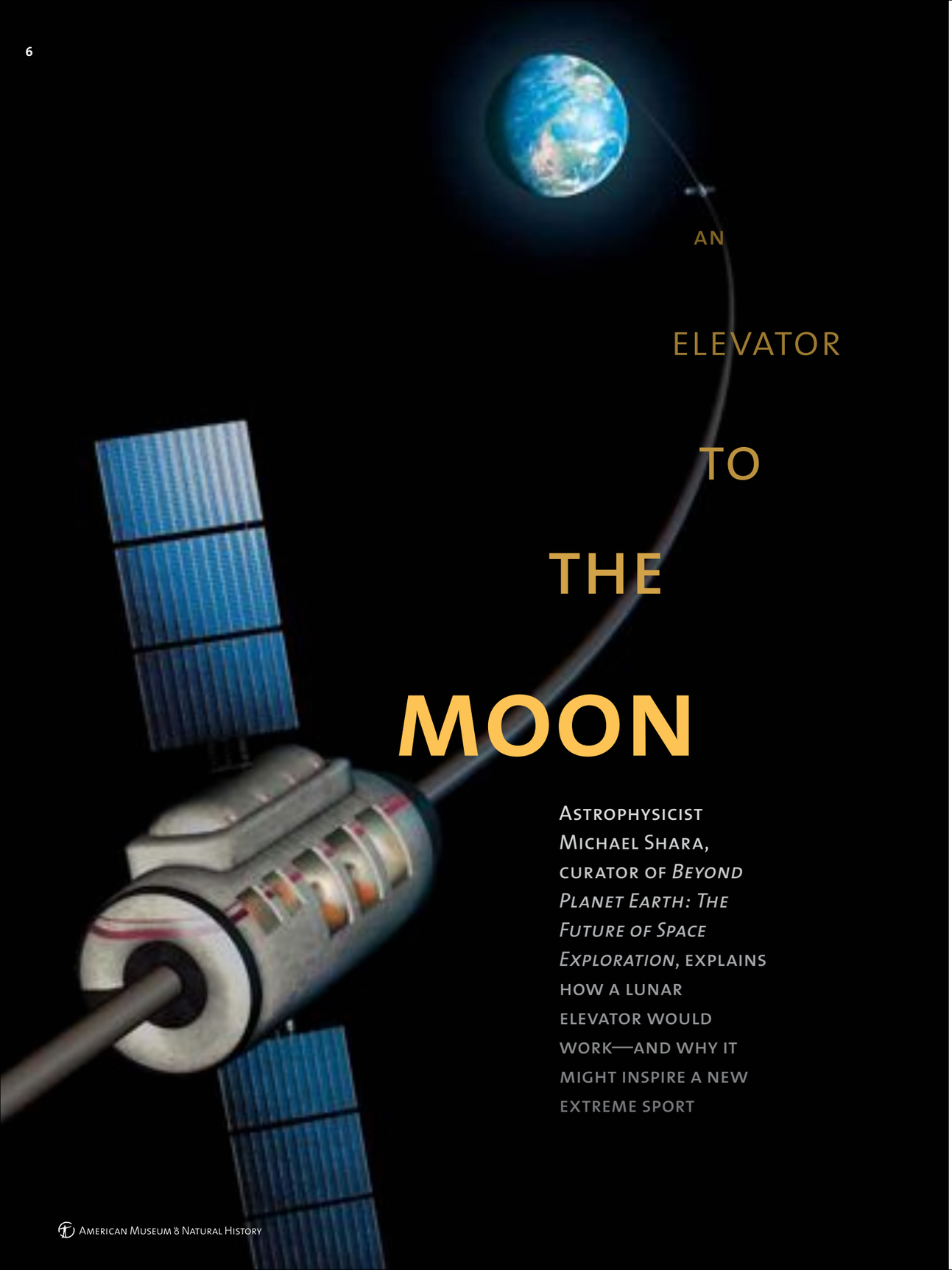
Some scientists speculated that *D. longus* had a trunk because of the location of the bony nasal opening high on the skull between the eye sockets, akin to today's elephants and tapirs. But recent research on the tiny opening for the facial nerve—at most, 1.5 mm in diameter compared to half of an inch for an elephant—suggests that the animal lacked the wiring to power the muscles needed for a trunk.

Cold Case

Sometimes called "the third eye," the pineal opening at the apex of the skull is found in some extinct and a few extant tetrapods, notably, the tuatara, a lizardlike reptile in New Zealand. In living animals, it is thought to play a role in detecting light, which may help regulate circadian rhythms and body heat. Its function in sauropods like *Diplodocus* remains a mystery.

Growth Factor

The pituitary gland secretes hormones that influence an animal's body size. In humans, the pituitary is the size of a pea, or about 0.2 percent of brain volume. In *D. longus*, the pituitary was roughly 10 percent of the brain volume. Quite simply, says Choiniere, "This tells us it was a giant!"



AN ELEVATOR TO THE MOON

Astrophysicist Michael Shara, curator of *Beyond Planet Earth: The Future of Space Exploration*, explains how a lunar elevator would work—and why it might inspire a new extreme sport

We humans are barely toddlers when it comes to space exploration. Our first baby steps off our home planet 50 years ago took us to low Earth orbit. By 1973, 12 intrepid men had walked on the moon's surface. Since then we have sent robots to every planet in our solar system. The Hubble Space Telescope has shown us that the ordinary matter we are made of comprises only 4 percent of the mass of the universe. The Kepler orbiting telescope has proved that billions of worlds orbit the stars of our Milky Way galaxy. What will we accomplish in space in the coming centuries, as our steps become surer and bolder?

The new exhibition *Beyond Planet Earth: The Future of Space Exploration* takes you on the adventures awaiting humanity in the next few hundred years. Suborbital tourism, deflecting asteroids, establishing lunar and Martian scientific bases, terra-forming Mars, and searching for life in Europa's oceans will all happen in the coming century. While we can't predict what the spaceships carrying us and our robots will look like, we do know where we're going, the challenges of getting there, and the opportunities available when we arrive at destinations as alien as anything out of "Star Trek."

The cover of this issue of *Rotunda* shows what a lunar base at the South Pole of the Moon might look like. The South Pole is a likely place for a lunar base for two reasons. First, there's probably a lot of frozen water there, from comets that crashed there and remained frozen in nearly perpetual darkness. Just as important, the Sun is almost continuously visible from the tops of the rims of South Pole craters, so that large arrays of solar panels could continuously supply power to a lunar base. A huge infrared-optical-ultraviolet telescope, larger than a football field and with a rotating liquid mirror, would capture images of celestial objects with a resolution unmatched even by Hubble or Webb.

The Moon's South Pole would also be a logical base for a lunar elevator, shown at left with its cable stretching back to Earth. This isn't fantasy. A real lunar elevator for moving people and cargo such as helium-3, a rare isotope found in lunar soil that is thought to be a clean candidate for nuclear fuel, to and from the Moon could be built with current technologies and materials. (Visitors will see a model of a lunar elevator in the exhibition.)

The principle of a lunar elevator is elegant and simple. Any object–let's say a space station–placed along a line joining the centers of the Moon and the Earth, and more than one-ninth the distance from the Moon to the Earth, will fall toward Earth. That's because Earth is 81 times as massive as the Moon, so its gravitational pull exceeds that of the Moon as soon as you travel more than 26,500 miles toward Earth from the Moon.

If you attach a cable from the lunar surface to the space station, the station is tethered: it "wants" to fall toward Earth because of Earth's dominant gravity, but it can't because it's held in place by the cable. Voilà: you've just built lunar-Jack's beanstalk pointing up to Earth from the lunar equator. Now imagine extending the cable 238,000 miles, to just above the Earth's atmosphere. Attach gripping, rotating wheels to the mechanical arm of a solar-powered gondola connected to the cable, and you have a rocket-free way of transporting anything and anybody between the Earth and the Moon's surface.

Well, almost. You do have to "jump" to about 100 miles above the Earth's surface to catch the gondola as it moves by at 1,000 miles per hour due to the Earth's speed of rotation. But rocket-airplanes suitable for this purpose are already being built by commercial companies like Virgin Galactic. One of the great advantages of this scheme is that you never need to speed up to, or slow down from, Earth-orbital speed of 17,500 miles per hour. Thus the dangerous heating and mechanical stresses generated when reentering Earth's atmosphere would be hundreds of times less on a rocket-plane-lunar elevator trip to the Moon than a trip involving rockets. A one-way trip would take about a week and could be as comfortable as an Alaskan or Caribbean cruise, though somewhat more expensive. Tourism could help support the operation of a lunar elevator.

The lunar elevator also offers the opportunity for the most extreme sport I can think of: space jumping. If you stepped off the end of a cable stretching down from the tethered space station to about 60 miles above the Earth–in a space suit, of course–you would begin to fall faster and faster. Reaching about 2,500 miles per hour when you began to encounter the outer atmosphere, you would use a combination of carefully timed drogue parachutes, a parasail, and a main parachute to slow down enough to avoid being torn apart by wind resistance. If you were really good, and lucky, you might land safely within a 100-yard bull's-eye–just 15 minutes after you left space.

Beyond Planet Earth: The Future of Space Exploration Opens Saturday, November 19

Beyond Planet Earth features a full-sized re-creation of a lunar habitat, a model of an elevator reaching up into space, a walk-through diorama of the Martian surface, and challenging computer interactive exhibits. Learn about robotic missions that are currently headed deeper into our own solar system, and explore some possible missions of the future: returning humans to the Moon, landing on and deflecting a potentially deadly asteroid, or traveling to Mars—and perhaps even establishing colonies there.

Beyond Planet Earth: The Future of Space Exploration *is organized by the American Museum of Natural History, New York (www.amnh.org).*

Beyond Planet Earth: The Future of Space Exploration *is proudly supported by* ***Con Edison****.*

Major funding for Beyond Planet Earth *has been provided by the Lila Wallace-Reader's Digest Endowment Fund.*

Additional support is provided by Mary and David Solomon.

Member Preview on Wednesday, November 16

Members are invited to see *Beyond Planet Earth: The Future of Space Exploration* at a special preview on Wednesday, November 16, beginning at 4 pm. See the show and stay for a wine reception from 6 to 8 pm. Don't forget to RSVP by calling the Membership Office at 212-769-5606 by November 7.

WINDOWS ON THE UNIVERSE: ASTROPHYSICS AT THE MUSEUM

As rain streams down the suspended glass curtain of the Rose Center for Earth and Space, the Museum is a cocoon of stillness save for the strains of music coming from a row of windows high above the Hayden Sphere.

Up on the fifth floor, astrophysicists maintain a furious working pace during their night shift. Galileo supervises from a gilt frame on the wall; bronze busts of Einstein and Copernicus wear Yankees and Mets caps. Laptops fill a long wooden table: one scientist checks coordinates, one projects black and white splotches onto a screen, and one communicates with a telescope operator in Hawaii, where clear skies open a window onto distant stars. Every two minutes the team remotely targets a new potential supernova.

"The whole point is to find all stars in the Milky Way that are going to explode as massive Type 1b and 1c supernovae [which occur when a massive star's core collapses] over the next 300,000 years," says Michael Shara, curator in the Museum's Department of Astrophysics, as he glances up from his computer. "We think there are about 6,000 of them, and we are picking them out from the other billions of stars in the galaxy to measure their spectra–to collect a frozen tissue sample, if you will."

Shara, who is also curator of the new exhibition *Beyond Plamet Earth: The Future of Space Exploration*, which opens November 19, is one of three curators in the Department of Astrophysics, which includes theorist Mordecai-Mark Mac Low, who simulates star and planet formation, and Ben Oppenheimer, who images planets that orbit distant stars. Together, these curators lead a research group of two dozen graduate students, research scientists, and postdocs who peer into the cosmos from 81st Street.

Studying Massive Supernovas

Curator Shara studies stellar populations in the Milky Way and nearby galaxies. Over the last decade, he has focused on stars known as Wolf-Rayets–hot, ephemeral bodies that start their lives 20 to 80 times more massive than the Sun and then shed much of that mass over a lifespan of a few hundred thousand years until they explode as Type 1b or 1c supernovae. There are now 600 Wolf-Rayet stars known in the Milky Way, an 80 percent increase since 2006. Shara's team has found and characterized the majority of them. His "best" and rarest specimens are from the far side of the Milky Way, which is still terra incognita to astronomers.

"We think that supernovae occur on average every 50 to 100 years in the Milky Way," says Shara. "Astronomers detected two dozen neutrinos from a supernova in the Large Magellanic Cloud in 1987, but a supernova in our galaxy would be invaluable because it would be only about 10,000 light years away and hundreds of times brighter. In addition, we can now measure gravity waves–the rattling of space time–as well as neutrinos, and that would help us understand the collapse of a star's core into a black hole as it becomes a supernova."

Shara is increasing his odds of finding massive supernovae by also looking for Wolf-Rayet stars in Messier 101, a spiral galaxy 100 times farther away, or 10 million light years from Earth. Using the Hubble Space Telescope, Shara has gathered a list of candidates by imaging the galaxy through an optical filter that transmits only the light of ionized helium–where Wolf-Rayet stars shine brightest. These candidates will be investigated further by colleagues working on the massive 8-meter Gemini telescope in Hawaii. So far, Messier 101 seems to be four to five times more supernova-rich than the Milky Way. Shara just might get his wish of "seeing" a massive supernova erupt in his lifetime.

We're trying to find all stars in the Milky Way that are going to explode as massive supernovae over the next 30 0,000 years.

—Michael Shara

The simulations we run are, in their essence, the same as programs used for weather prediction.

—Mordecai-Mark MacLow

Modeling Cosmic Evolution

Curator Mac Low's office is bright, and most of the floor space is claimed by book-lined shelves and neat stacks of papers. Just outside the door, the hall window–marked with equations scribbled in red and blue marker–looks out onto the gray top of the Hayden Sphere as sunlight pours in from 81st Street.

Mac Low also studies the evolution of stars, but his more theoretical approach to astrophysics requires months of computing time and routine digital conference calls with an international network of collaborators and students.

"I'm a storyteller," says Mac Low. "I'm verbally oriented, not primarily a mathematician…but getting a computer to do what you want it to do is something that I'm comfortable with and amused by, by and large."

One story that Mac Low likes to tell is how stars form. Until he began working on this problem a decade ago, most astrophysicists' models of star formation were based on the assumption of an idealized geometric distribution of gas. But when simulations include more realistic turbulent gas flow, it becomes clear that chaotic motions provide stability against gravitational collapse to the gas between the stars, determining the speed with which stars form.

"The simulations we run are, in their essence, the same as programs used for weather prediction," says Mac Low. "They follow the motions of a gas as it is heated and cooled and pushed around. Over millions of tiny steps, we follow the gross evolution of a supernova explosion."

Another story involves a conundrum that has stumped astrophysicists for decades: how do planetesimals–asteroids and dwarf planets–evolve from rocks and boulders in a young solar system whose star is still surrounded by its natal gaseous disk? As the rocks collide and grow larger, they orbit faster than the gas and feel a headwind that drags them into the star. Mac Low and colleagues found the answer in a phenomenon well known to cyclists: drafting behind the leader. If there are more rocks in one orbit, further rocks falling into that orbit are protected from the headwind and can accumulate there. So much material can accumulate that gravity can collapse it together, forming large asteroids and even dwarf planets in only ten or so orbits.

Exploring New "Worlds"

Associate Curator Oppenheimer's lab on the sixth floor of the Rose Center is an allergen-plagued person's dream: a room immersed in the drone of pressurized air and purification systems that keep the equipment built and refined here dust-free.

Among power drills, metal cutters, and screwdrivers, items with sci-fi names like "supercontinuum laser" and "vacuum chamber" rest on a table that can float on air. On the wall, a line drawing diagrams the test bed for an indispensable tool: the "coronagraph" that mimics an eclipse, allowing astronomers to see distant planets close to a star by eliminating much of the star's, but not the planet's, light.

The clean lab is where delicate, precise instruments are built for Project 1640, one of the few teams in the world working to image planets that orbit stars outside of our solar system, known as exoplanets.

"We image and measure the spectra of exoplanets to determine the chemical composition of their atmospheres," says Oppenheimer, who leads Project 1640. "This is technically extremely difficult–like trying to see a firefly an inch from a really bright spotlight thousands of miles away–because the planets are billions of times fainter than the stars they orbit."

Oppenheimer's team has been testing their Project 1640 equipment over the last few years at Palomar Observatory in California. Improvements allow the team to control the light to the precision of up to one one-thousandth of a wavelength–which is roughly one nanometer, or a billionth of a meter–and to simultaneously collect spectra and images to remove an optical effect known as speckles.

"Planets are hiding behind the speckles, but, because they don't move, we've made progress in distinguishing them from what does," says Oppenheimer. "And we've had a few finds along the way, like the new star in the Big Dipper, Alcor B."

This fall, Oppenheimer's team begins a three-year survey of hundreds of stars to find new planets and to begin comparative planetary science in earnest. The Project 1640 team is well-placed to discover new planets, since their readiness will allow them to begin observations about a year ahead of other teams. Interestingly enough, one of those teams, Gemini Planet Imager, includes Oppenheimer as a member. Racing against himself, Oppenheimer will continue to expand our knowledge of the universe–as will his fellow curators, Mac Low and Shara–from the Rose Center and beyond.

Imaging exoplanets is extremely difficult—like trying to see a firefly an inch from a really bright spotlight thousands of miles away.

—Ben Oppenheimer

The public has an appetite for the universe, and we are servants to that appetite.

—Neil deGrasse Tyson

Photo © AMNH/R. Mickens

Bringing Astrophysics to the Public

Space Shows about stars and the search for life, AstroBulletins that make the latest breakthroughs in astrophysics accessible, blockbuster annual Isaac Asimov Memorial Debates, a digital atlas of the universe: the Hayden Planetarium in the Frederick Phineas and Sandra Priest Rose Center for Earth and Space is a beacon of astrophysical education.

"The public has an appetite for the universe, and we are servants to that appetite," says astrophysicist Neil deGrasse Tyson, director of the Hayden Planetarium.

Since the Hayden Planetarium first opened in 1935, people have been able to contemplate the night sky from urban New York City. With the opening of the Rose Center for Earth and Space in 2000, the Museum added engaging exhibits that explore the vast spread of space and time in the cosmos; the 13-billion-year history of the universe; the nature of galaxies, stars, and planets; and the dynamic features of planet Earth.

"Kids like black holes and dinosaurs, which means to me that they like things that could eat them," says Tyson. "But there is a fascination with the universe into adulthood—you can tell by the list of science bestsellers and the Hayden's sold-out events that deliver the universe to the public."

American Museum of Natural History

A Laboratory on Mars

NASA's *Curiosity* rover will search for signs of life

Later this year, NASA will launch its biggest, most advanced rover yet: the one-ton *Curiosity*, a mobile laboratory with a two-year mission to find out whether Mars has ever supported life.

Beginning with *Sojourner*, the 23-lb rover sent to Mars in 1997 as part of the Pathfinder mission, Mars rovers have provided scientists with invaluable information about the Red Planet. Now it's *Curiosity*'s turn. The rover will carry ten scientific instruments, including a laser to vaporize Martian rock samples to reveal their composition, a set of tools to check for organic compounds in samples of Martian soil and atmosphere, and an instrument to detect ice or hydrated minerals underground.

See a life-sized model of the *Curiosity* rover in *Beyond Planet Earth: The Future of Space Exploration*.

Sample Analysis at Mars (SAM) Instrument

This toolkit of three instruments will analyze Martian atmospheric gases, rocks, and soil for traces of organic compounds. Rocks and soil will be delivered to the SAM in powdered samples by *Curiosity*'s robotic arm, then heated or treated with solvents to pull gases for analysis.

Sojourner

Launched December 1996
Landed July 1997
Mars Mileage 328 feet
Sojourner returned 550 images and analyzed 15 Martian rocks before Pathfinder's last successful transmission in September 1997.

Spirit

Launched June 2003
Landed January 2004
Mars Mileage 4.8 miles
Spirit returned more than 124,000 images before its last transmission in March 2010.

Opportunity

Launched July 2003
Landed January 2004
Mars Mileage 20.8 miles as of August 2011
At press time, *Opportunity* was exploring the rim of the 13.7-mile-wide Mars crater named Endeavour.

Curiosity

Planned Launch Late 2011
Planned Landing August 2012
Mars Mileage Engineered for up to 660 feet a day
Curiosity arrived at NASA's Kennedy Center in June for testing and final assembly.

Programs and Events

For more programs and to purchase tickets, visit **amnh.org**.

For updates and reminders, sign up for monthly **eNotes for Members** by sending your membership number and request to subscribe to members@amnh.org. The Museum does not trade, rent, or sell this information.

OCTOBER

Meet the Scientist
Saturday, October 1
Free
Visitors 7 and older can chat with a scientist and learn how she or he became interested in a chosen field. Call 212-313-7105 for details.

Live Bat Encounter
Saturday, October 1
11 am,
12:15 pm, or
1:30 pm
Member tickets are **$12**
Join **Rob Mies**, director of the Organization for Bat Conservation, for a live bat presentation.

Strange New Worlds with Ray Jayawardhana
Monday, October 3
7:30 pm
Member tickets are **$13.50**
Astronomer **Ray Jayawardhana** brings news from the front lines of the quest to find planets and life beyond our solar system. A book signing of *Strange New Worlds* will follow.

Lunchtime Bird Walks in Central Park
Tuesday, October 4,
Tuesday, October 11, and
Tuesday, October 18
Noon–1:30 pm
$40
Join **Paul Sweet** of the Museum's Department of Ornithology on lunchtime walks to identify birds in Central Park.

SciCafe
Wednesday, October 5
Wednesday, November 2
Wednesday, December 7
7 pm
Free (space is limited)
21+ with ID
Enjoy cocktails, cutting-edge science, and conversation at this popular after-hours series, now held in the Wallach Orientation Center on the fourth floor.

***Green Fire*: Aldo Leopold and a Land Ethic for Our Time**
Tuesday, October 11
5:30 pm
Free
A screening of the documentary *Green Fire*, highlighting the career of conservationist Aldo Leopold, will be followed by a discussion led by **Brooke Hecht** and **Dr. Curt Meine** of the Center for Humans and Nature.

Behind the Scenes in Paleontology
Wednesday, October 12
6:30–7:30 pm
7–8 pm
7:30–8:30 pm
$35
Tour the Division of Paleontology's collections with Collections Manager **Carl Mehling** to learn how fossils are prepared and maintained.

One Step Beyond
Friday, October 14
Friday, November 4
9 pm–1 am
$25
21+ with ID
Enjoy a night of drinks and dancing in the Rose Center for Earth and Space and a complimentary screening of a Space Show.

Van Cortlandt Park Walking Tour
Saturday, October 15
10 am–noon or
1–3 pm
$30
Join geologist **Sidney Horenstein** for a walking tour of this park, which includes some of the oldest rocks in the city.

Members-Only Highlights Tour
Sunday, October 16,
Saturday, November 12,
Sunday, December 4
3–4:30
Free (registration required)
Join a Museum tour guide for an insider's introduction to all that the Museum has to offer.

The Mind's Eye with Oliver Sacks
Monday, October 17
7 pm
Member tickets **$13.50**
Physician and author Oliver Sacks will discuss his book *The Mind's Eye*, a chronicle of resilience and adaptation. Learn how people navigate the world despite losing what many consider to be indispensable senses and abilities.

Tickets

Tickets are available by phone at 212-769-5200, Monday–Friday, 9 am–5 pm, or by visiting **amnh.org**. Please have your Membership number ready.

Please be aware that ticket sales are final for all Member programs. All programs go ahead rain or shine. There are no refunds unless the program is cancelled by the Museum.

Exhibitions and Attractions

Admission is by timed entry only.

Beyond Planet Earth: The Future of Space Exploration
Opens **Saturday, November 19**
Free for Members
Find out about robotic missions to explore our universe and what it will take to build a lunar elevator, deflect deadly asteroids, travel to Mars, and more.

The World's Largest Dinosaurs
Through **Monday, January 2**
Free for Members
This exciting exhibition features cutting-edge research about super-sized sauropods and offers new insights into how their colossal bodies functioned.

The Butterfly Conservatory: Tropical Butterflies Alive in Winter!
Opens **Saturday, October 8**
This annual favorite returns with up to 500 live, free-flying tropical butterflies housed in a vivarium that approximates their natural habitat.

Adventures in the Global Kitchen: Beer and Cheese
Wednesday, October 19
6:30 pm
$30
Garrett Oliver of the Brooklyn Brewery and **Aaron Foster** of Murray's Cheese will discuss seasonal beers and cheese.

The *World's Largest Dinosaurs* Family Tour
Saturday, October 22
10–11 am
Free for Members at Family Insider level and above (registration required)
Bring the little ones to meet *The World's Largest Dinosaurs* on this special tour.

A Night at the Museum Sleepover: Mythic Madness Halloween Celebration
Saturday, October 22
Friday, October 28
Member tickets **$119** per person
Come dressed as your best fairy, wizard, dragon, or other mythical character for these popular costumed sleepovers.

Fly Me to the Moon with Carter Emmart and Andrew Chaikin
Tuesday, October 25
6:30 pm
Member tickets are **$13.50**
Join Apollo historian **Andrew Chaikin** on a flight simulation led by the Museum's **Carter Emmart**.

Halloween Celebration
Monday, October 31
4–7 pm
Visit **amnh.org** for more information
Trick or treat in the Museum's iconic halls.

NOVEMBER

Explore Lower Manhattan
Saturday, November 5
10 am–noon or
1–3 pm
$30
Peel back the layers of Manhattan's downtown with geologist **Sidney Horenstein**.

Stories of the Night Sky: Fall Skies
Sunday, November 6
5:30–6:30 pm
$12
Practice identifying stars in this program for young astronomers.

Behind the Scenes in Ornithology
Thursday, November 10
6:30–7:30 pm,
7–8 pm, or
7:30–8:30 pm
$35
Tour the Department of Ornithology with Collections Manager **Paul Sweet**.

Margaret Mead Film Festival
Thursday, November 10-Sunday, November 13
Member tickets are **$10** except for opening and closing night
The Margaret Mead Film Festival celebrates 35 years of innovative filmmaking with exceptional programs and intimate discussions with filmmakers and film subjects. For a full schedule and details, visit **amnh.org/mead**.

The New Universe and The Human Future With Joel R. Primack and Nancy Ellen Abrams
Monday, November 14
7:30 pm
Members' tickets are **$13.50**
Join physicist **Joel Primack** and philosopher **Nancy Ellen Abrams** for a discussion of the modern vision of the universe.

Double Discount Days
Friday, November 18-Sunday, November 20
Get a head start on holiday shopping. Members receive 20% off all purchases at Museum stores, including **amnhshop.com**.

Adventures in the Global Kitchen: Speakeasy
Monday, November 21
6:30 pm
$30
Food writer **Andrew F. Smith** and **Colin Spoelman** of the Kings County Distillery lead tastings.

The Grand Tour of the Universe
Tuesday, November 29
6:30 pm
Member tickets are **$13.50**
Explore extrasolar planets and myriad galaxies on this flight with **Brian Abbott** and **Jackie Faherty**.

The Human Genome and Human HealthWednesday, November 30
7 pm
$15
Genetics experts discuss triumphs and disappointments since the completion of the Human Genome Project 10 years ago.

Frogs: A Chorus of Colors
Through **Sunday, January 8**
This exhibition introduces visitors the colorful and richly diverse world of frogs, with more than 200 live frogs in re-created habitats.

Picturing Science: Museum Scientists and Imaging Technologies
More than 20 sets of spectacular large-format images showcase the wide range of research being conducted at the Museum using various optical tools.

IMAX Movie
Tornado Alley
Through **Sunday, January 8**
This thrilling film documents two unprecedented missions to encounter one of Earth's most awe-inspiring events: the birth of a tornado.

Hayden Planetarium Space Show
Journey to the Stars
Journey to the Stars launches viewers through time and space to experience the life and death of the stars in our night sky.

December

Behind the Scenes in Entomology
Thursday, December 1
6:30–7:30 pm (families),
7–8 pm, or
7:30–8:30 pm
$35
Visit the Department of Entomology's world-class insect collections with paleoentomologist **Paul Nascimbene** and Collections Manager **Christine Johnson**.

Origami-Fest for Members
Sunday, December 4
10am–2pm
Free (registration required)
Fold, crease, and create an assortment of ornaments with a team of volunteers from Origami USA. Drop by to make one or a few to ring in the holidays.

Special Viewing: IMAX film *Tornado Alley*
Wednesday, December 7
6:30–7:30 pm
Member tickets are **$8** adults, **$5** children
Don't miss this last-chance viewing of the IMAX film *Tornado Alley*, starring Sean Casey of "Storm Chasers."

Double Discount Days
Friday, December 9-Sunday, December 11
Get a head start on holiday shopping. Members receive 20% off all purchases at Museum stores, including **amnhshop.com**.

Holiday Party for Young Members
Wednesday, December 14
6–8 pm
Free for Members at the Family Adventurer level and above (Registration required: Call 212-769-5200)
Celebrate the holidays with the dinos! Enjoy an evening of family activities and entertainment in the Museum's dinosaur halls and visit *The World's Largest Dinosaurs* before it closes in January.

Kwanzaa Celebration
Saturday, December 31
Noon
Free
The annual celebration features live performances, traditional crafts, and a bustling Kwanzaa Marketplace in the Milstein Hall of Ocean Life.

Don't Miss

Young Naturalist Awards
Submissions due Friday, March 9
This annual research-based science competition recognizes students in grades 7 through 12 who carry out scientific investigations in biology, Earth science, ecology, and astronomy. Submissions are reviewed by a panel that includes environmentalists, science teachers, and Museum scientists, and two winners are chosen from each grade level. For more information, visit **amnh.org/yna**.

Whale Watch Weekend
Friday, May 18–Sunday, May 20
$800 per person, double occupancy
$900 single occupancy
Please register before May 1
Join this weekend excursion to Provincetown with Museum educator **Jay Holmes** to enjoy two private whale watch excursions, explore the dunes, take a guided bird walk, and more. Cost includes transportation by private coach, meals at the hotel, two boat excursions, dune tour, admissions, and lodging for two nights. The program is limited to 42 Members.

Credits
The Museum's Youth Initiatives are generously supported by the leadership contribution of the New York Life Foundation.

Public programs are made possible, in part, by the Rita and Frits Markus Fund for the Public Understanding of Science.

MetLife Foundation is the Presenting Sponsor of the Museum's multicultural public programming.

Popular Science *is the media partner for Hayden Planetarium monthly astronomy programs and lectures.*

SciCafe is proudly sponsored by Judy and Josh Weston.

SciCafe is made possible by a Science Education Partnership Award (SEPA) grant from the National Center for Research Resources (NCRR), a component of the National Institutes of Health (NIH).

The Young Naturalist Awards are proudly supported by Alcoa Foundation.

Credits
The World's Largest Dinosaurs *is organized by the American Museum of Natural History, New York (www.amnh.org) in collaboration with Sístole, S.A., Bogotá, Colombia.*

The World's Largest Dinosaurs *is proudly supported by* ***Bank of America****.*

Additional support is generously provided by Marshall P. and Rachael C. Levine, and Drs. Harlan B. and Natasha Levine.

Frogs: A Chorus of Colors *is presented with appreciation to Clyde Peeling's Reptiland.*

Picturing Science *is made possible by the generosity of the Arthur Ross Foundation.*

Journey to the Stars *was produced by the American Museum of Natural History, the Rose Center for Earth and Space, and the Hayden Planetarium.*

Journey to the Stars *was developed by the American Museum of Natural History, New York in collaboration with the California Academy of Sciences, San Francisco; GOTO INC, Tokyo, Japan; Papalote Museo del Niño, Mexico City, Mexico and Smithsonian National Air and Space Museum, Washington, D.C.*

Journey to the Stars *was created by the American Museum of Natural History, with the major support and partnership of* ***NASA****, Science Mission Directorate, Heliophysics Division.*

Made possible through the generous sponsorship of ***Lockheed Martin****.*

And proudly sponsored by ***Accenture****.*

Supercomputing resources provided by the Texas Advanced Computing Center (TACC) at The University of Texas at Austin, through the TeraGrid, a project of the National Science Foundation.

October

1 Saturday
Meet the Scientist
Live Bat Encounter

3 Monday
Strange New Worlds with **Ray Jayawardhana**

4 Tuesday
Lunchtime Bird Walks in Central Park begin

5 Wednesday
SciCafe

8 Saturday
The Butterfly Conservatory **Opens**

11 Tuesday
Green Fire: Aldo Leopold and a Land Ethic for Our Time

12 Wednesday
Behind-the-Scenes in Paleontology

14 Friday
One Step Beyond

15 Saturday
Van Cortlandt Park Walking Tour

16 Sunday
Members-only Highlights Tour

17 Monday
The Mind's Eye with Oliver Sacks

18 Tuesday
Seventeenth Annual Family Party

19 Wednesday
Adventures in the Global Kitchen: Beer and Cheese

22 Saturday
Mythic Madness Halloween Celebration Sleepover

The World's Largest Dinosaurs Family Tour

25 Tuesday
Fly Me to the Moon

28 Friday
Mythic Madness Halloween Celebration Sleepover

31 Monday
Halloween Celebration

November

2 Wednesday
SciCafe

4 Friday
One Step Beyond

5 Saturday
Explore Lower Manhattan

6 Sunday
Stories of the Night Sky

10 Thursday
Behind the Scenes in Ornithology

Museum Gala

Margaret Mead Film Festival Opens

11 Friday
Margaret Mead Film Festival

12 Saturday
Margaret Mead Film Festival

Member-Only Highlights Tour

13 Sunday
Margaret Mead Film Festival Closes

14 Monday
The New Universe and the Human Future

16 Wednesday
Member Preview of *Beyond Planet Earth: The Future of Space Exploration*

18 Friday
Double Discount Day at Museum shops

19 Saturday
Beyond Planet Earth: The Future of Space Exploration **Opens**

Double Discount Day at Museum shops

20 Sunday
Double Discount Day at Museum shops

21 Monday
Adventures in the Global Kitchen: Speakeasy

Origami Holiday Tree returns

29 Tuesday
Grand Tour of the Universe

30 Wednesday
The Human Genome and Human Health

December

1 Thursday
Behind the Scenes in Entomology

4 Sunday
Origami-Fest for Members

Members-only Highlights Tour

7 Wednesday
SciCafe

Special Viewing: *Tornado Alley*

9 Friday
Double Discount Day at Museum shops

10 Saturday
Double Discount Day at Museum shops

11 Sunday
Double Discount Day at Museum shops

14 Wednesday
Holiday Party for Young Members

31 Saturday
Kwanzaa Celebration

Margaret Mead Film Festival at 35: Celebrating a Legacy and Looking Forward

Allie Humenuk and Anne Makepeace film *We Still Live Here*, featured at this year's festival.

Much has changed in ethnographic filmmaking since Margaret Mead, her husband Gregory Bateson, and cinematographer Jane Belo first recorded religious dances and other aspects of Balinese culture in the 1930s. And much has changed since the Museum organized the first Margaret Mead Film Festival in 1977 as a celebration of the pioneering anthropologist and longtime Museum curator.

Against this wave of change–driven in part by technological advances and in part by shifting views of acceptable levels of intervention by filmmakers–the one constant has been the Mead Festival's enduring distinction for bringing to the public innovative nonfiction films, a legacy that will be celebrated at this year's 35th-anniversary program held from November 10 through November 13.

"Since I first began working in film, the Mead Festival had a legendary place among film festivals," says *Black Swan* director Darren Aronofsky, who is leading the jury selection for this year's Margaret Mead Filmmaker Award. "The films are always amazing, and I am so excited that this year I will be able to see all the films that are in competition."

Next month, the Mead Festival will present some 30 films culled from more than 1,000 submissions as well as a selection of iconic films from past festivals, a retrospective that will illustrate the arc of ethnographic filmmaking over the last 35 years. A special roster of space-themed films, screened in conjunction with the major exhibition *Beyond Planet Earth: The Future of Space Exploration*, will include a presentation of sci-fi films by Curator Michael Shara as well as the U.S. premiere of Marion Kiss's *Space Sailors*, which traces the fate of the elite team of cosmonauts chosen for the Soviet Intercosmos Program, and Christian Frei's S*pace Tourists* about the burgeoning space tourism industry. (For the full festival lineup, visit amnh.org/mead.)

In an age of computer downloads and viral videos, what continues to set the Mead Festival apart is the human connection.

"One of the many unique things about the Mead is the robust conversations after the screening with not only the filmmaker but the film subjects and people who are researching the topics of our films," says Ariella Ben-Dov, artistic and festival director. "People enter into a dialogue about the regions, the topics, the human beings, the cultures, the traditions."

This year's festival will include conversations with Anne Makepeace and Jessie Little Doe Baird, filmmaker and subject, respectively, of *We Still Live Here*, the story of an extraordinary effort to restore the Wampanoag language to a corner of Cape Cod. Baird, who dreamed of reviving her people's language, studied linguistics at the Massachusetts Institute of Technology and produced a dictionary and resources for students and historians, in addition to training her daughter to become the first native Wampanoag speaker in seven generations. Last year Baird received a MacArthur Fellowship, more commonly known as the "genius" grant, for her role in reclaiming a long-silent indigenous language.

"The Mead was an innovator in utilizing film and ethnography to showcase the diversity of culture across the globe for American audiences," says Ruth Cohen, director of the Museum's Center for Lifelong Learning. "Today, with features such as *We Still Live Here*, the festival provides a uniquely deep and expansive cultural experience for modern audiences."

We Still Live Here exemplifies another important aspect of the Mead Film Festival: an emphasis on native voices. "The Mead really champions work about cultures," says Ben-Dov. "These films transport audiences. They are the vehicles through which communities speak for themselves."

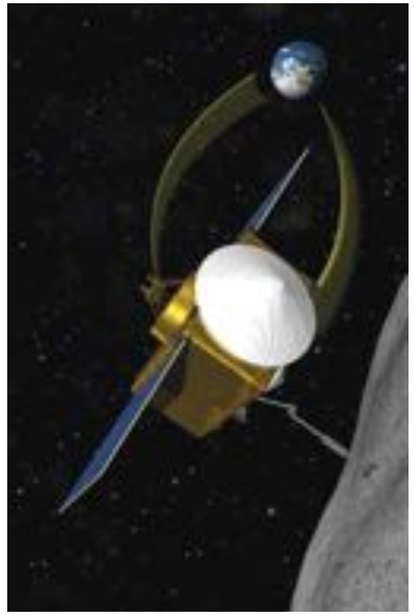
The Margaret Mead Film Festival runs from November 10 through November 13. Visit amnh.org/mead for additional details.

MetLife Foundation is the Presenting Sponsor of the Museum's multicultural public programming.

This still from *We Still Live Here* shows one of Jessie Little Doe's daughters.

Photos by J. Reed

Museum Scientist Named to NASA's 2016 Mission to Asteroid



OSIRIS-REx will seek samples from asteroid 1999 RQ36.

Image © NASA

Geologist Harold C. Connolly, a research associate in the Museum's Department of Earth and Planetary Sciences, will oversee sample analysis on the first U.S. mission to collect material from an asteroid and bring it to Earth for study.

NASA announced the new mission–which is called Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer, or OSIRIS-REx–in May as the third mission in its New Frontiers Program. An unmanned spacecraft will be launched in 2016 to the near-Earth asteroid 1999 RQ36 and will travel for four years to its destination. After OSIRIS-REx performs surface mapping of the asteroid–a process that may take up to 505 days–Connolly will be responsible for recommending locations most suitable for sampling.

"We will narrow it down to several choices to select the best location based on low risk to the spacecraft and on chemical signatures" found during surface mapping, says Connolly, who is also professor of Earth and Planetary Sciences at the City University of New York.

The spacecraft will use a robotic arm to collect at least 60 grams of material, which will be brought to Earth in 2023 for worldwide distribution for study. As mission sample scientist, Connolly will prepare the plan that specifies which researchers will receive material for analysis. In advance of the launch, Connolly will be helping to coordinate and integrate studies of the asteroid's spectroscopy and geology, which will draw on data from ground-based observations of 1999 RQ36 and reference meteorites, including specimens in the Museum's collection.

Asteroids, which contain original material from the solar nebula that gave rise to our solar system more than 4.5 million years ago, yield important clues about the formation of the solar system and planets. OSIRIS-REx aims to bring back pristine samples for study.

"Sample return sets the highest standard for unmanned missions beyond Earth, because samples 'keep on giving' as we develop better instrumentation in our laboratories," says Denton Ebel, associate curator in the Department of Earth and Planetary Sciences at the Museum. "Samples can be returned to over and over again as new questions are raised and new ideas are proposed. For example, the Museum houses a large collection of asteroid samples, the meteorites. In this case we will know the exact source, and the samples will be unaffected by entry into Earth's atmosphere."

> **"Sample return sets the highest standard for unmanned missions beyond Earth."**
>
> **—Denton Ebel,** *Associate Curator, Department of Earth and Planetary Sciences*

In addition to collecting samples, OSIRIS-REx will gather data to help scientists better understand 1999 RQ36's orbit, information that can help develop strategies to deflect asteroids that approach the Earth.

Connolly is a co-investigator on the mission with Principal Investigator Michael Drake of the University of Arizona in Tucson.

Near-Earth asteroids, as well as previous sample return missions and deflection strategies, are featured in the exhibition *Beyond Planet Earth: The Future of Space Exploration*.

An Expedition to Hawaii's Observatories

In late January, astrophysicist Michael Shara, curator of the new exhibition *Beyond Planet Earth: The Future of Space Exploration*, will lead a nine-day expedition to Hawaii that combines an exploration of the islands' unique natural history with tours of some of the world's top astronomical facilities.

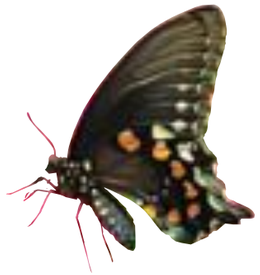
Highlights will include visits to Project Pan-STARRS (Panoramic Survey Telescope and Rapid Response System), which surveys the skies for objects on a path to impact the Earth, and to the Mauna Kea Observatory Complex. Home to the twin 10-meter W. M. Keck telescopes, the complex also houses the world's largest infrared and optical-infrared telescopes, which give this facility the most light-gathering power of any location on Earth.

"Many astronomers feel that Hawaii is as close to heaven as you can get," says Shara. "The night skies at the summits of Haleakala and Mauna Kea draw us back again and again."

The expedition, from January 21 through January 29, will also include visits to Kilauea Volcano National Park, a whale-watching cruise, and an excursion to the Kohala countryside.

For details, visit amnhexpeditions.org or call 800-462-8687.

Building The Butterfly Conservatory



Five Facts About Moths And Butterflies

Butterflies use a strawlike proboscis to drink nectar and other liquids.

Butterflies taste with special receptors on their feet and smell with their antennae.

Butterflies don't eat only nectar. Various species also dine on sap, fruit, and bird droppings. Some are even partial to the sweat on bald human heads.

Moths have a strong sense of smell. Males can detect the pheromones of potential mates a mile away.

Butterflies are the second most important pollinator after bees, and some night-blooming plants are pollinated only by moths.

Now in its fourteenth season at the Museum, *The Butterfly Conservatory: Tropical Butterflies Alive in Winter!* draws thousands of visitors each year, transporting them to a tropical ecosystem lush with vivid, live flowers and filled with hundreds of spectacular butterflies and moths. But while the flora and fauna are quite real, the conservatory is the product of careful planning and design by the Museum's Exhibition Department, which creates a "natural" garden using artificial lighting, precipitation, and climate control.

Manager of Living Exhibits Hazel Davies, who has been involved with the conservatory for more than a decade, and her team start from scratch each year by determining what species to include and where to get the plants and live specimens.

Choosing the plants is an art in itself. Following U.S. Department of Agriculture regulations, the Museum prevents the butterflies from breeding by avoiding any plants that serve as their natural hosts; butterflies are particular about where they lay eggs because the host plant will also provide food to the caterpillars that hatch. Suitability to different light levels, variations in texture and structures, and other factors are also considered in plant selection.

As for the fauna, the butterflies and moths that inhabit the exhibition–usually 550 to 600 individual butterflies, representing about 130 species–come from farms all over the world: Florida, Costa Rica, Ecuador, Kenya, Malaysia, Thailand, the Philippines, and Australia.

When selecting species, Davies looks for ones that flutter or, if sedentary, are especially showy, such as the huge and spectacular Atlas moth. She aims to include species that are active at different times of day to ensure a lively experience for all visitors.

Since many species live only a few days or weeks, new supplies of butterflies and moths arrive every week to maintain the exhibition's population. Butterflies are shipped in the chrysalis stage, a period of days or weeks when they are enclosed in a hard natural shell and can be wrapped in tissue or foam and safely sent by courier. About two weeks before the exhibition opens to the public, the earliest butterfly arrivals are released into their new home, bringing a burst of color and activity to the conservatory.

Caring for the butterflies and maintaining the conservatory requires trained staff onsite seven days a week. In addition, more than 120 trained volunteers work in groups of four for two-hour shifts each day to answer questions, interpret the exhibition, and point out interesting facts to visitors, which can number as many as 350 an hour. A key job requirement is the ability to withstand the high temperature and humidity–80 degrees Fahrenheit and 80 percent humidity–for hours at a stretch. Those who can take the heat get front-row seats to see the effect exotic butterflies have on human visitors–awe, delight, and occasionally marriage proposals, which occur with some frequency, especially on Valentine's Day.

***The Butterfly Conservatory: Tropical Butterflies Alive in Winter!* opens October 8.**

NEW MEMBER BENEFIT

Use live-animal exhibition tickets for *The Butterfly Conservatory*

Photo © AMNH/R. Mickens

Big Cat Scat: Grant Boosts Critical Research

For the past five years, Museum scientists, in collaboration with the Panthera Foundation–a nonprofit organization dedicated to protecting big cats in the wild–have been tracking tigers, lions, jaguars, and snow leopards through DNA in scat, or fecal specimens, gathered in the field. Now, through a generous grant from the Leslie and Daniel Ziff Foundation, the Global Felid Conservation Genetics Program can accelerate the pace of this important work by expanding the program's laboratory component.

"We're very excited about it," says George Amato, director of the Museum's Sackler Institute for Comparative Genomics and the Center for Conservation Genetics, which is responsible for sequencing the big cats' DNA and analyzing the results. "In terms of scale, it is now the largest project of its kind in the world."

Collecting more than 3,000 fecal samples so far and sharing the resulting data free of charge to researchers around the world, the Global Felid Conservation Genetics Program follows animals subject to a variety of threats, from diminished habitat to hunting by traders in body parts. For example, compared to more than 100,000 over a century ago, there are fewer than 3,200 tigers in Asia today, occupying only seven percent of their historic range. The research has yielded some good news–a newly identified population of tigers in Laos; more genetic diversity than expected in some areas–but researchers also found that, in a supposedly protected area in Cambodia, one population of tigers had died out.

Like all animals, big cats must breed with unrelated individuals or suffer a loss of genetic variation and the consequent effects of inbreeding, which weaken and eventually decimate a particular population. Large carnivores, like big cats, require the most space of any species to survive and thrive in the wild, a factor that not only puts them at greater risk from human encroachment but also has implications for the potential cascading effects of their disappearance from their respective ecosystems.

By way of example, Amato cites the consequences of the absence of wolves–before they were restored–in Yellowstone National Park. "The whole ecosystem changed," Amato explains. "There were too many elk. There wasn't habitat for certain birds. Vegetation changed."

Sustainable habitats for big cats require safe corridors through which unrelated cats within a species can come into contact with each other, says Amato, "because even the largest protected areas are too small to have a genetically healthy population." Reliable information about the breeding range of the various big cat populations will help conservationists determine which initiatives are likely to succeed.

Big cats are shy, nocturnal, and difficult to observe.

With the rare exception of lion prides that have become habituated to tourists and filmmakers, big cats are shy, nocturnal, and extremely difficult to observe. Genetic monitoring is a huge leap forward in tracking them compared to trip cameras and satellite tags. For one thing, the collection of fecal samples by field biologists, wildlife officials, and others is non-invasive, with no potential for harming the animals. And the results are much more comprehensive, allowing researchers to identify specific individuals and the relationships within populations–the family members, parents, siblings, and most important for assessing healthy breeding habits, the new offspring of particular pairs.

"We're learning a lot about the natural history of these animals," says Amato, adding a cautionary note, despite the program's goal to maximize big cats' chances of survival: "If they don't persist in the future, how tragic not to learn all we could."

Following Cats Around the World

The Global Felid Conservation Genetics Program tracks jaguars in Argentina, Belize, Bolivia, Brazil, Costa Rica, French Guiana, Guatemala, Mexico, Paraguay, and Peru; tigers in Bhutan, Cambodia, China, Laos, Myanmar, and Thailand; snow leopards in Afghanistan, China, Kyrgyzstan, Mongolia, Nepal, and Tajikistan; and lions in Gabon and Nigeria.

Photo © istockphoto.com/Ammit

1. Renowned paleoanthropologists Richard Leakey and Donald Johanson shared the stage at the Museum on May 5 to discuss the overwhelming evidence for evolution in the hominid fossil record.
2. Dr. Johanson, speaking at the May 5 event, discovered the early hominid skeleton known as Lucy.
3. Museum President Ellen Futter spoke to students at the 2011 Urban Advantage Science Expo, which was held in the Museum on June 12 and featured research projects by 800 middle school students.
4. Chancellor of the New York City Department of Education Dennis M. Walcott spoke to students, families, and teachers gathered in Milstein Hall of Ocean Life for the Urban Advantage Science Expo.
5. Ornithologist Paul Sweet helped identify specimens during Identification Day on June 4.
6. Visitors explored Museum collections during Identification Day.

Photos © AMNH/R. Mickens

1. Museum Trustee Ted Mathas, pictured with MetLife, Inc. Chairman and fellow Trustee C. Robert Henrikson, gave the welcoming remarks at the Nineteenth Annual Corporate Dinner, at which Henrikson was honored with the Distinguished Service to Science and Education Award.
2. Junior Council Co-Chairs Ross and Heather Schulman celebrated the season finale on June 23.
3, 4. Junior Council revelers: Ari and Danielle Lerner, Brad and Robin Roberts, Sachi Shah and Rushabh Vora, and Lori and Zachary Pomerantz (3) and Valerie Evering and Julie Marchesi (4).

Photo 1 © AMNH/D. Finnin, photos 2, 3, and 4 © AMNH/R. Mickens

Save the Date!
Upcoming Events at the Museum

JANUARY
1/4 On Wednesday mornings from January through March, **Walk on the Wild Side** with Members-only fitness walks followed by breakfast in the Akeley Hall of African Mammals before the Museum opens to the public. Call 212-769-5606 for information.

1/15 Explore the Rose Center for Earth and Space, enjoy live performances, and more at **Space Fest** from 11 am to 4 pm.

FEBRUARY
2/16 Discover the Museum after hours at **Explorer's Night**. Free for Members.

MARCH
3/1 The annual **Star Party** will include a reception in the Rose Center for Earth and Space, star-gazing on the Arthur Ross Terrace, activities for families, and more. Free for Members at the Voyager and Family Voyager levels and above.

3/8 Dance the night away at the annual **Museum Dance**, the social event of the season.

3/29 Members will have the first chance to see the exciting new exhibition ***Creatures of Light: Nature's Bioluminescence*** at this exclusive preview. Free for Members.

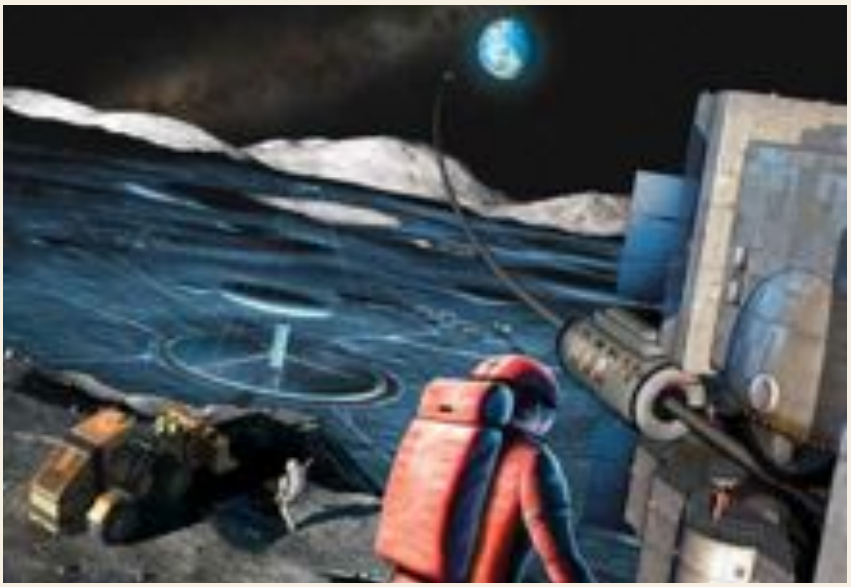
3/31 ***Creatures of Light*** opens to the public.

APRIL
4/19 Go behind the scenes to learn about the latest Museum research at the **Member Open House**. Free for Members at the Adventurer and Family Adventurer levels and above.

4/25 Join us for the **22nd Annual Environmental Lecture and Luncheon**.

American Museum of Natural History
Membership

Central Park West at 79th Street
New York, New York 10024-5192
amnh.org



Dr. Mark Garlick—an illustrator and astrophysicist—created this moonscape depicting a lunar elevator, a liquid mirror telescope, and a bulldozer mining for helium-3, some of the exciting technologies featured in the new exhibition *Beyond Planet Earth: The Future of Space Exploration*, which opens November 19.

General Information

Phone numbers

Central Reservations 212-769-5200
Membership Office 212-769-5606
Museum Information 212-769-5100
Development 212-769-5151

Hours

Museum: Open daily, 10 am–5:45 pm;
closed on Thanksgiving and Christmas.

Entrances

During Museum hours, Members may enter at Central Park West at 79th Street (second floor), the Rose Center/81st Street, and through the subway (lower level).

Restaurants

Museum Food Court, Café on One, Starlight Café, and Café on 4 offer Members a 15% discount.

Museum shops

The Museum Shop, DinoStore, The Shop for Earth & Space, Cosmic Shop, Brain Shop, Sauropod Shop, and Online Shop (amnhshop.com) offer Members a 10% discount.

Transportation and parking

Subway: B (weekdays) or C to 81st Street; 1 to 79th Street, walk east to Museum Bus: M7, M10, M11, or M104 to 79th Street; M79 to Central Park West Parking Garage: Open daily, 8 am–11 pm; enter from West 81st Street. Members can park for a flat fee of $10 if entering after 4 pm. To receive this rate, show your membership card or event ticket when exiting the garage.