How *Science* Covers the News in Japan and Asia

Dennis Normile
Contributing Correspondent
March 20, 2015

About *Science*

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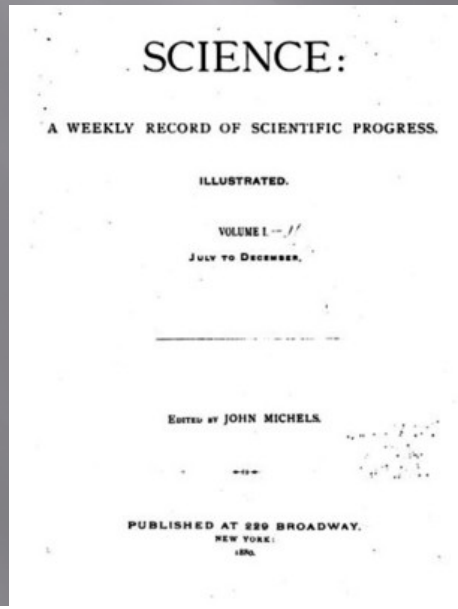
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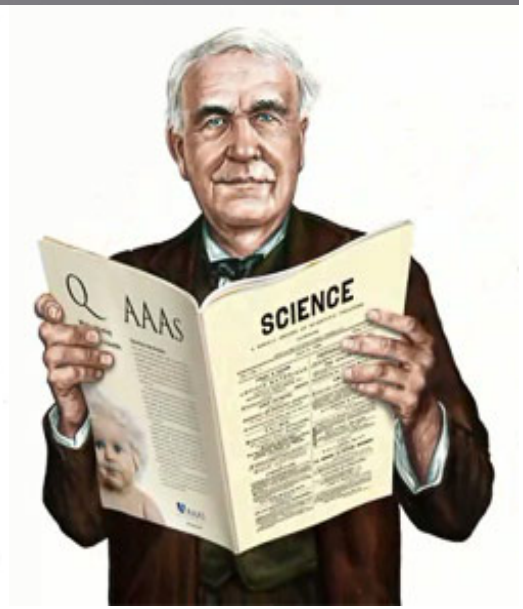

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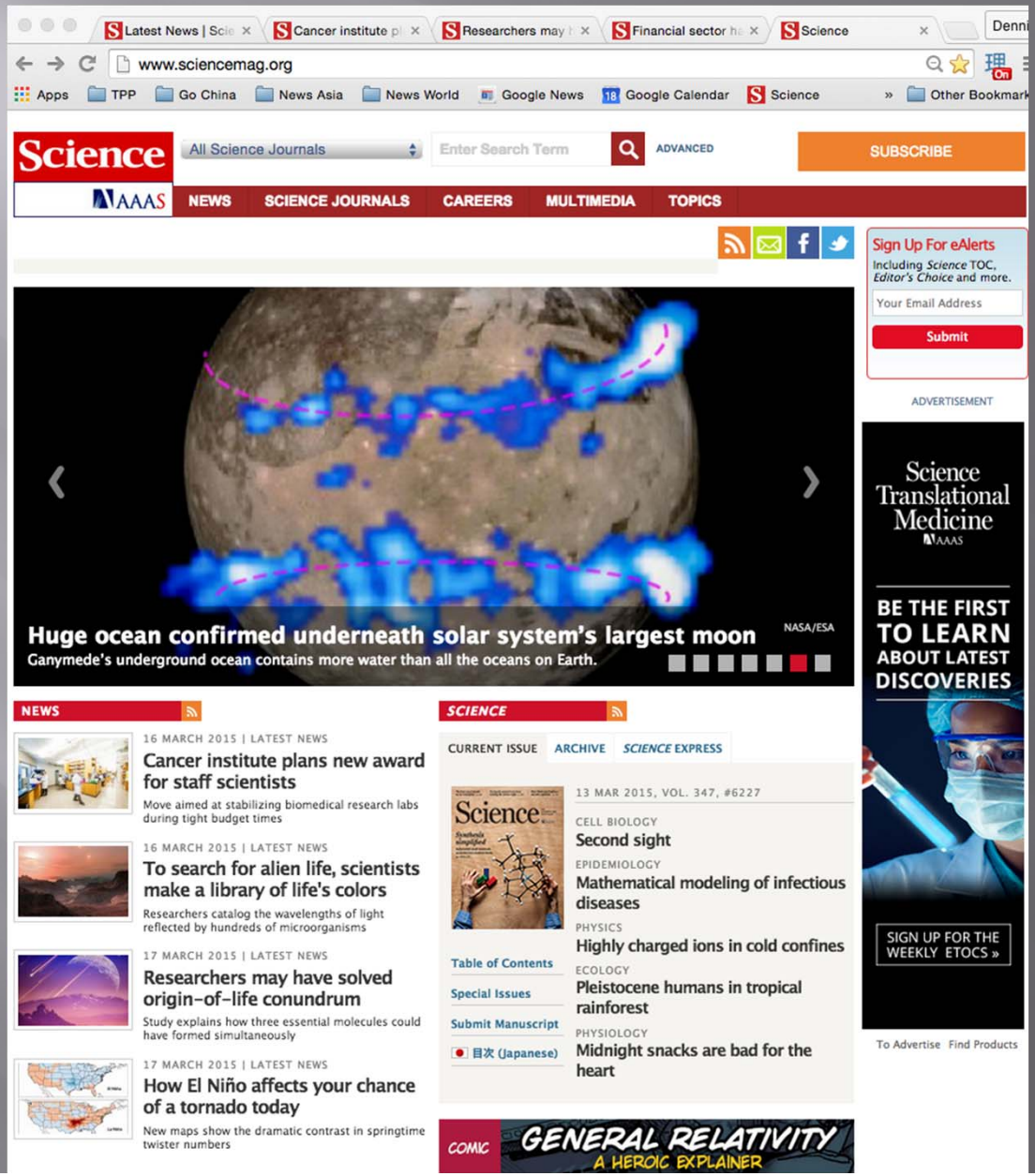

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News

LATEST NEWS

16 Mar 2015

To search for alien life, scientists make a library of life's colors

Researchers catalog the wavelengths of light reflected by hundreds of microorganisms

16 Mar 2015

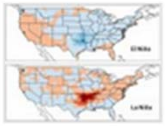
Cancer institute plans new award for staff scientists

Move aimed at stabilizing biomedical research labs during tight budget times

16 Mar 2015

Researchers may have solved origin-of-life conundrum

Study explains how three essential molecules could have formed simultaneously



16 Mar 2015

How El Niño affects your chance of a tornado today

New maps show the dramatic contrast in springtime twister numbers

16 Mar 2015

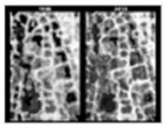
New compound quickly disables chemical weapons

Porous material can deactivate nerve agents in a matter of minutes

13 Mar 2015

Tulane pathogen release blamed on sloppy safety practices

Monkeys apparently became infected with dangerous bacterium by lab workers lacking proper protective clothing



13 Mar 2015

Alaska's ponds are disappearing

As temperatures rise, tundra ponds have shrunk—in part because of encroaching plants

13 Mar 2015

Steven Ashby named director of DOE's Pacific Northwest National Laboratory

Computational mathematician praised by peers for vision and strategic approach

Latest News: Scientific Results Announced That Day

We MUST get the information in advance

It MUST be significant

It MUST have broad appeal

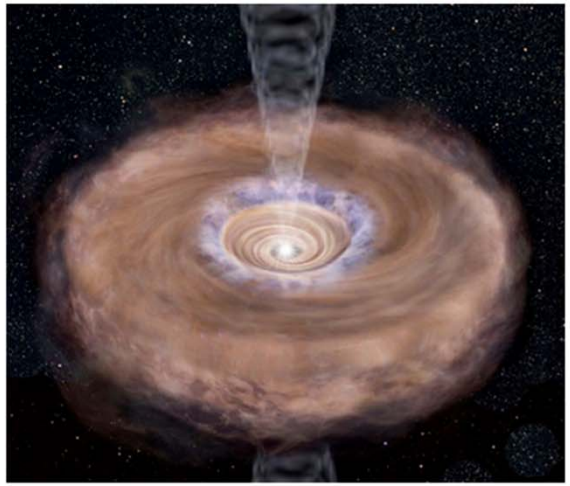
Good art helps

Science NOW UP TO THE MINUTE NEWS FROM SCIENCE

DENNIS NORMILE

Close Look at Young Star Finds a Chemical Surprise

12 February 2014 1:00 pm | 14 Comments



Nami Sakai

Out of the blue. The unexpected presence of sulfur monoxide (bluish tinge) marks the transition zone between the outer doughnut-shaped envelope and the central disk rotating around a forming star.

The basics of star formation are easy. Find an unusually dense region within a molecular cloud filled with dust and gas in interstellar space and let gravity do the rest. The gas and dust will eventually coalesce into a doughnut-shaped envelope that encircles an inner rotating disk. As material accumulates over hundreds of thousands of years, the central region collapses into a star while the disk solidifies into planets.

Astronomers have understood this overall scenario for decades, but the details are fuzzy because telescopes haven't been good enough to check theorists' computer models. That changed in 2011 with the partial completion of the Atacama Large Millimeter/submillimeter Array (ALMA). The collection of radio antennas is being erected on the Chajnantor Plain, 5000 meters above sea level in the Chilean Andes, where the dry, sparse air causes minimal distortion of the faint waves from the far reaches of the universe. Using 24 of the antennas—the final array will have 66—an international group led by astrophysicists at the University of Tokyo, has taken the most detailed look yet at the heart of a star-forming region and found a chemical surprise.

The researchers trained ALMA on a very young star still forming in the constellation Taurus, about 450 light-years from Earth. As is typical at such an early stage, the star is encircled by an envelope and disk of gas and dust. The new scope's power enabled the team to identify the chemical composition of the gases at different locations throughout this star- and planet-forming system. Previously, astronomers thought that the envelope and disk must be made up of the same gaseous molecules of hydrogen found throughout interstellar space plus dust particles made up of other elements. To the surprise of the University of Tokyo group, ALMA detected something different—sulfur monoxide gas—in a narrow band where the envelope meets the disk. Collisions between particles in the envelope and those in the rapidly spinning disk generate heat that thaws frozen sulfur monoxide molecules stuck to dust grains, explains Nami Sakai, an astrophysicist at the University of Tokyo. Sulfur monoxide can't be detected when it is frozen to dust grains. But ALMA can spot it in its gaseous state. Knowing just what gases are swirling around young stars should lead to a better understanding of where and how elements found in planets, comets, and asteroids are formed. Sakai and colleagues report their findings online today at *Nature*.

"These are beautiful data and very interesting results," says Ewine van Dishoeck, an astrophysicist at the Leiden Observatory in the Netherlands. "This work shows that ALMA will provide ample observational evidence" that will challenge theoretical models, adds astrophysicist Stéphane Guilloteau of University of Bordeaux in France. "This paper is a beautiful example of the new discovery [capabilities] offered by ALMA."

LATEST NEWS

IMAGE COURTESY OF TIM MACKRELL, CONSERVATION LABORATORY, THE UNIVERSITY OF AUCKLAND

A sea turtle carved in raised relief on an early wood voyaging canoe. Turtles are rare in pre-European New Zealand carvings.

Unusual climate gave Polynesian explorers a boost

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Email Dennis

By Dennis Normile | 29 September 2014 3:00 pm | 3 Comments

Polynesian seafarers colonized Pacific islands stretching from Samoa and New Zealand to Easter Island and Hawaii centuries before Europeans discovered that ocean. But the details of when and how the Polynesians managed to traverse such vast stretches of open water are little understood. Now, a new archaeological find illuminates the construction of Polynesian canoes, while a study of ancient climate patterns bears on a long-standing debate about when Polynesians acquired the capability to sail into the wind.

EXPERTS!

From previous reporting

By looking at citations

By asking the paper’s authors

By asking Science Media Centers

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Breaking news and analysis from the world of science policy

THE ASAHI SHIMBUN/GETTY IMAGES

Haruko Obokata

Key Researcher Agrees to Retract Both Disputed Stem Cell Papers

By Dennis Normile | 4 June 2014 9:15 am | 4 Comments

TOKYO—After several months of fiercely defending her discovery of a new, simple way to create pluripotent stem cells, Haruko Obokata of the RIKEN Center for Developmental Biology in Kobe, Japan, has agreed to retract the two *Nature* papers that reported her work.

Satoru Kagaya, head of public relations for RIKEN, headquartered in Wako near Tokyo, confirmed press reports today that Obokata had finally agreed to retract both papers. He said the institute would be notifying *Nature* and that the decision to formally retract the papers would be up to the journal.

SCIENCEINSIDER

Breaking news and analysis from the world of science policy

THE UNIVERSITY OF HONG KONG/COMMUNICATIONS AND PUBLIC AFFAIRS OFFICE

Peter Mathieson

University of Hong Kong head ponders impact of protests

By Dennis Normile | 9 October 2014 3:00 pm | 0 Comments

Though not generating the headlines it did a week ago, the standoff in Hong Kong between a pro-democracy movement and the government continues. University students are still boycotting classes. Occupy Central movement leaders have threatened to ratchet up acts of civil disobedience. The government has responded by threatening to call off planned talks with student leaders. Regardless of how the impasse is resolved, the events of this fall are likely to reverberate through the university system for years.

At 11 p.m. on 3 October, Peter Mathieson and Joseph Sung, the vice chancellors of University of Hong Kong (HKU) and the Chinese University of Hong Kong, respectively, urged students at one of the main protest sites to remain calm and eschew violence. Protesters had set a midnight deadline for Hong Kong's chief executive, Chun-ying Leung, to resign. At 11:30, the government announced an agreement to hold talks with student leaders, who in turn shelved their call for Leung's resignation. Mathieson and Sung then held a midnight press conference welcoming the breakthrough. In a telephone interview with *Science*, Mathieson, who took the top job at HKU in April, recalled the experience of addressing the protesters and discussed the impact of the democracy movement on the university community. His remarks have been edited for clarity and brevity.

SCIENCEINSIDER

Breaking news and analysis from the world of science policy

AES256/WIKIMEDIA COMMONS

Pacific bluefin tuna

Fisheries group to cut Pacific bluefin tuna catch

By Dennis Normile | 10 September 2014 1:00 pm | 1 Comment

TOKYO—A multinational organization that coordinates fishing activities in the western Pacific is throwing a lifeline to heavily overfished Pacific bluefin tuna stocks.

Speaking today at a press briefing, Japanese officials provided details on a plan agreed to last week that aims to rebuild the spawning population by halving the catch of juveniles and limiting takes of mature fish as well. The proposal calls for total Pacific bluefin catches to be kept below the 2002 to 2004 annual average levels and for catches of fish weighing fewer than 30 kilograms—juveniles too young to spawn—to be reduced to 50% of those levels.

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FCCJ

Shuji Nakamura says the Asian educational system "is a waste of time."

Nobel laureate Shuji Nakamura is still angry at Japan

By Dennis Normile | 19 January 2015 8:15 am | 6 Comments

TOKYO—Age and recognition haven't mellowed Nobel physics laureate Shuji Nakamura. He and fellow Japanese Hiroshi Amano and Isamu Akasaki shared 2014's physics award for developing a blue light-emitting diode (LED), which was at the center at a bitter patent dispute more than a decade ago at about the time Nakamura left Japan. At a press conference here on Friday—the first in his native country since he picked up his medal in Stockholm last month—Nakamura lashed out at the way Japan treats technology pioneers and criticized what he says is a failing education system.

The Nobel Prize committee cited the development of the blue LED as leading to a new, more efficient, and environmentally friendly way "to illuminate the world." Amano and Akasaki laid the groundwork by getting gallium-nitride, a notoriously finicky material, to emit a dim blue glow while working together at Nagoya University in the late 1980s. In 1993, Nakamura, who held only a master's degree and was toiling practically on his own at a small specialty chemical manufacturer in rural Shikoku, cracked the fabrication challenges to get a bright blue LED that was commercially viable.

Science (magazine) NEWS

IN BRIEF

IN DEPTH

FEATURES

NEWS

> “The lives of people in poor countries will improve faster in the next 15 years than at any other time in history.”
>
> **The Bill & Melinda Gates Foundation’s “Big Bet” for 2015**, noting improved African GDP and agricultural productivity and new ways to combat epidemics.

IN BRIEF

Tug of war over Arctic oil

Brooks Range in Alaska’s Arctic National Wildlife Refuge.

The Obama administration has announced several big moves on Arctic oil. On 27 January, the White House issued a long-term plan for offshore drilling that would put several areas in the Arctic’s Chukchi and Beaufort seas off limits (while opening swathes of the Atlantic from Virginia to Georgia). On 25 January, officials announced they want to expand protections for 5 million hectares, including 600,000 in an oil- and gas-rich coastal plain, within Alaska’s Arctic National Wildlife Refuge. Both plans are drawing criticism from politicians in Alaska, which depends heavily on the oil and gas industry for revenues. “We are going to fight back,” vowed Senator Lisa Murkowski (R-AK), who heads the Senate’s energy committee. The moves come on the heels of an executive order released last week by President Barack Obama aimed at improving coordination of U.S. policy in the Arctic as the United States prepares to assume the chairmanship of the multilateral Arctic Council later this year. The order creates an Arctic Executive Steering Committee to streamline agency policies and collaborate with state, local, tribal, and other groups.

AROUND THE WORLD

Senate: Climate change no hoax

WASHINGTON, D.C. | In a symbolic move, the U.S. Senate voted 98 to 1 on 21 January to approve a measure stating that climate change is real and “not a hoax.” The measure, sponsored by Senator Sheldon Whitehouse (D-RI), was aimed at forcing Republican senators to take a stand on an issue that is sensitive with conservative voters. It also poked fun at Senator James Inhofe (R-OK), who has called climate change “a hoax.” But Inhofe turned the tables at the last minute, endorsing the measure and redefining it: Only the idea that humans could affect climate is a hoax, he said. The switch gave Republicans political cover to vote for the measure, but 15 Republicans also supported a separate, ultimately unsuccessful, measure that said humans do contribute to climate change. http://scim.ag/climvote

No patent for hepatitis C drug

NEW DELHI | The Indian Patent Office this month rejected a patent on hepatitis C drug Sovaldi, produced by U.S.-based Gilead Sciences Inc. Sovaldi has transformed care for hepatitis C by dramatically cutting treatment time and side effects, but has also come under fire for its $84,000 price tag for a 12-week course. Gilead offered India a discount of 99%—still out of reach for most Indians. The patent rejection opens the door to sale of a generic form of Sovaldi in India; according to a 2014 study in *Clinical Infectious Diseases*, manufacturing a 12-week course of the generic would cost at most $136. Gilead has challenged the decision. In 2013, India rejected a patent on the leukemia drug Gleevec.

Ebola triggers WHO reforms

GENEVA, SWITZERLAND | The World Health Organization (WHO) has embarked on reforms to make it better able to deal with events like the Ebola epidemic in West Africa. At a special session on 25 January in Geneva, WHO’s Executive Board adopted a resolution that calls for strengthening the agency’s operational muscle, extending its global health workforce, and putting in place a contingency fund for future emergencies. The United Kingdom has already pledged $10 million to that fund, WHO Director-General Margaret Chan said on Sunday. The reforms, which must be approved by the World Health Assembly in May, come after WHO’s acknowledgement that it bungled its response to Ebola last year. “The world, including WHO, was too slow to see what was unfolding before us,” Chan told the board, which consists of representatives from 34 members states.

Published by AAAS

The return of the tortoises

In the mid-18th century, sailors who landed on the Galápagos island of Pinzón helped create an environmental catastrophe on the island: Rats stowed in their ships ran rampant, eating the eggs and hatchlings of the giant tortoises that lived there. Humans tried to right the wrong, first with a conservation project launched in the 1960s that collected the few unhatched eggs, incubated them on another island, and then transported the 5-year-old tortoises back. The eggs were still threatened by the rat populations, however—until, in 2012, biologists distributed a rat-specific poison on the island via helicopter, making the island rat-free. Now, more than a century since the last baby tortoise was seen on the island, researchers have spotted 10 new hatchlings—which, they say, likely means a hundred times more are in the wild.

A Pinzón Island tortoise hatchling at the Charles Darwin Research Station on Santa Cruz Island.

PHOTO: © PATRICK J. ENDRES/LAIF/AGE FOTOSTOCK/SCIENCE

Research dog breeders sentenced

ROME | An Italian court has found three employees of Green Hill, a company that breeds beagles for animal studies, guilty of unjustified killing and mistreatment of dogs. The accusations against Green Hill in Brescia, Italy, a subsidiary of U.S.-based Marshall BioResources and one of Europe’s largest suppliers of dogs for research, were filed in June 2012 by the environmental organization Legambiente and the animal rights group Lega Anti Vivisezione. The complaint noted that the dogs were never outdoors, were exposed to artificial light night and day, and lived in spaces that weren’t properly cleaned, among other charges. The European Animal Research Association strongly condemned the verdicts, calling them a “legal travesty” and part of a “campaign to end animal research in Italy.” The court has to release a written motivation for the verdicts within 60 days. http://scim.ag/_GreenHill

Volunteers from Legambiente holding beagle puppies rescued from Green Hill.

PHOTOS: (TOP TO BOTTOM) PETE OXFORD/MINDEN PICTURES/NATURE PICTURE LIBRARY; © ALESSANDRO BELOTA/CORBIS

Meetup with Neandertals?

WESTERN GALILEE, ISRAEL | Most Europeans and Asians have up to 2% Neandertal DNA in their genomes, but when and where did any love matches between Neandertals and modern humans take place? The discovery of a 55,000-year-old partial skull in Israel’s Manot Cave, not far from previously excavated Neandertal fossils of similar age, shores up the suggestion from ancient DNA that these two human lineages engaged in at least some limited mating in the Middle East between about 50,000 and 60,000 years ago. Anthropologists agree that the new fossil, reported this week in *Nature*, is a member of *Homo sapiens*, the first to be found outside our African homeland during this crucial time period. Researchers also think it could represent the population of modern humans that soon afterward swept across Europe and Asia.

BY THE NUMBERS

2

Treatment beds available for each suspected, probable, or confirmed case of Ebola in Sierra Leone, Liberia, and Guinea, according to the World Health Organization’s Ebola situation report last week.

30%

Jump in tiger population from 2011 to 2014 in India (from 1706 to 2226), due to better conservation. India is home to 70% of the world’s tigers.

$90 million

Cost of the roughly 3% of methane delivered to Boston that leaked into the air from 2012 to 2013, finds a study in the *Proceedings of the National Academy of Sciences*.

Published by AAAS

A 55,000-year-old modern human skull found in an Israeli cave.

Bill to revamp medical treatment

WASHINGTON, D.C. | A U.S. House of Representatives panel this week released a widely anticipated, bipartisan proposal for speeding the development of new medical treatments. The 393-page draft bill, dubbed the 21st Century Cures Act, has been under development by Fred Upton (R-MI) and Diana DeGette (D-CO) of the House Energy and Commerce Committee since April. The provisions aim to involve patients in drug development; speed clinical trials; streamline regulations; modernize manufacturing facilities; and encourage personalized treatments while also expanding support for young scientists at the National Institutes of Health. The bill is a discussion document, said Upton, who invited comments via the Twitter handle #Cures2015: “Some things may be dropped, some items may be added, but everything is on the table as we hope to trigger a thoughtful discussion toward a more polished product.” http://scim.ag/21centure

The National Synchrotron Radiation Research Center in Hsinchu.

Asia’s newest synchrotron sees first light

Taiwan’s scientists will shortly have a new research tool for use in biology, nanotechnology, and materials science in the new Taiwan Photon Source at the National Synchrotron Radiation Research Center (NSRRC) in Hsinchu. After nearly 5 years of construction and testing, the facility achieved first light on 31 December. The 518-meter-circumference storage ring is designed to accelerate electrons to 3 gigaelectronvolts. NSRRC claims it will be one of the world’s brightest synchrotron x-ray sources. Envisioned uses include protein microcrystallography, studies of protein interactions with other biomolecules, and the development of new materials. Phase one of the project includes the construction of seven beamlines. The facility will become available to users by the end of this year.

NEWSMAKERS

Corruption case snares scientist

A prominent cancer researcher has become entangled in a high-profile corruption case in New York state. **Robert Taub**, former director of the Columbia University Mesothelioma Center, has been named as the “Doctor-1” described in a criminal complaint that accuses Democratic state Representative Sheldon Silver, the speaker of the New York State Assembly, of arranging bribes and kickbacks that netted Silver millions of dollars. The complaint alleges that Silver steered $500,000 from a state health care research fund to Taub; in exchange, Taub referred patients suffering from asbestos-related disease to Silver’s law firm, investigators allege. Doctor-1 is cooperating with federal investigators, according to the complaint, and will not be charged with any crime. However, Columbia University noted in a statement on 23 January that “Dr. Taub no longer serves as” the center’s director. http://scim.ag/Taubcase

New head of NOAA research

Attorney **Craig McLean**, a veteran of the National Oceanic and Atmospheric Administration (NOAA), will be the new head of its research division, the agency announced on 21 January. A deputy chief of NOAA’s Office of Oceanic and Atmospheric Research since 2006, McLean served as the first director of NOAA’s Office of Ocean Exploration and Research. He’s also been a top deputy at the National Ocean Service and the National Marine Sanctuaries Program and was a NOAA Corps officer for more than 2 decades. McLean “understands how to move ocean information out of the laboratory and into operations”—a transition that NOAA has struggled with, says Scott Rayder, a former chief of staff at NOAA and now a senior adviser at the University Corporation for Atmospheric Research in Boulder, Colorado. “He’s a huge asset to the community. It’s a clear signal that NOAA is placing a premium [on this].”

PHOTOS: (TOP TO BOTTOM) CLARA AMIT/ISRAEL ANTIQUITIES AUTHORITY; NSRRC

Published by AAAS

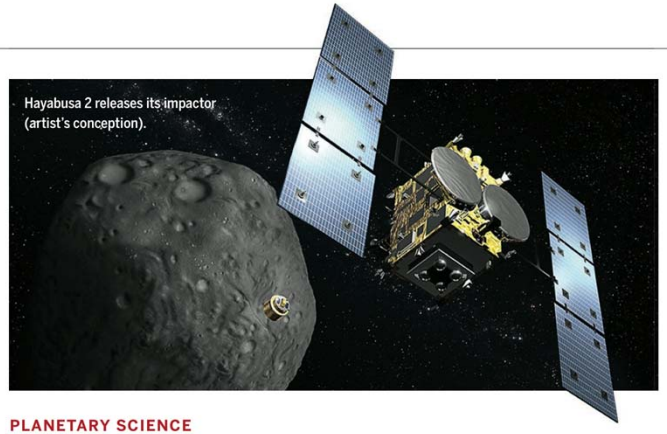
that is sorely needed: "People are dying at home of many other diseases than Ebola, because they have no access to health care." But medical staff still face an important risk. One in every hundred or thousand patients may carry the Ebola virus—which could start new cycles of infection. There are reports that doctors at some clinics are now doing surgery and delivering babies in Ebola protection suits.

At Redemption Hospital in Monrovia, whose inpatient department was closed this summer after several doctors died from Ebola, MSF is trying to protect staff with a new triage unit, which opened on 19 November. Patients with Ebola-like symptoms are interviewed; if they meet the criteria for a suspect case, they stay in one of 10 small rooms while their blood is tested. Those who test negative can enter the inpatient ward, while an ambulance takes Ebola patients to a treatment unit. MSF has also started distributing malaria drugs to hundreds of thousands of people, not just to lower the burden of that disease, which was neglected for months, but also to reduce the number of people visiting hospitals with a fever.

Reopening Monrovia's schools poses similar quandaries. One idea is to screen pupils' temperature as they enter the school. "But what do you do if a 10-year-old kid has a high temperature and the other kids start pointing at him and shouting 'Ebola'?" Rosling says. In a meeting with President Sirleaf, he has argued for a cautious approach: Opening some schools and carefully studying what happens.

The capital region still serves as a reservoir from which patients travel to rural areas and spark fresh outbreaks, De Cock says—and now that the rainy season has ended, travel may pick up. In Bong County, for instance, a few hours northwest of Monrovia, two big outbreaks are spreading, at least one seeded from the capital. The treatment unit in the district of Suakoko, run by the International Medical Corps, is full, and new patients are brought in daily. Sambhavi Cheemalapati, the unit's program coordinator, says she is seeing far more patients than are accounted for in the official numbers. Aid should focus on spreading prevention messages in these remote locales, Goffeau says. "If the people really understand what Ebola is and how to avoid infection, we might stop this epidemic," he says.

Such regional flare-ups make it unlikely that the Liberian epidemic will be over anytime soon, Rosling says. Still, he believes it's possible that the country may see its first day without a single case as early as December. Given the cataclysmic projections of just 2 months ago, that would be a remarkable turnaround. ■



Hayabusa 2 releases its impactor (artist's conception).

ILLUSTRATION: JAXA DIGITAL ARCHIVE

PLANETARY SCIENCE

Japan to assault asteroid

Hayabusa 2 will blast open carbon-rich celestial body

By **Dennis Normile**

Eighteen days after the European Space Agency's Philae lander touched down on a comet, another spacecraft will set out to attempt an even more intimate encounter with a small solar system body. On 30 November, Hayabusa 2 will lift off from Japan's Tanegashima Space Center on a 6-year round trip to asteroid 1999 JU3. If all goes as planned, it should bring home samples not just from the asteroid's surface but also from beneath it, by blasting a crater and collecting ejecta.

"By comparing samples from the surface and from underground, we'll get a better idea of what kind of material makes up asteroids and how it has changed over time," says Sei-ichiro Watanabe, project scientist and a planetary scientist at Nagoya University. Observations of the impact will also provide clues about the kilometer-wide body's structural properties, says Erik Asphaug, a planetary scientist at Arizona State University, Tempe, who is not involved with the mission. That could help scientists foretell the destruction in store should an asteroid ever hit Earth.

A decade ago, the original Hayabusa was the first probe to sample an asteroid. It snagged a few grains from asteroid Itokawa, an S-type, or stony, asteroid thought to have formed in the inner regions of the asteroid belt, where water and organic material have burned off. Overcoming fuel leaks and numerous equipment failures, Hayabusa delivered the samples to Earth in June 2010.

Its successor's target is a carbonaceous, or C-type, asteroid from the outer regions of the asteroid belt, potentially bearing water and organic elements. Watanabe says that combining findings from the two asteroids and the comet will help scientists sharpen their picture of the early solar system and which of its varied bodies might have brought water and organic material—the seeds of life—to Earth.

The roughly $245 million Hayabusa 2 uses thrusters and stabilizers similar to but more robust than those of its predecessor, says Hitoshi Kuninaka, project manager at the Japan Aerospace Exploration Agency's Institute of Space and Astronautical Science in Sagamihara. Hayabusa 2's instruments are also largely updated versions of its predecessor's, but "they are tuned for a C-type asteroid," which has a very dark surface, Kuninaka says. The first Hayabusa carried a single small lander, which missed Itokawa and drifted off into space. Hayabusa 2 will release four landers carrying a variety of cameras and instruments. One, the Mobile Asteroid Surface Scout, or MASCOT, contributed by the German Aerospace Center and the French government space agency, will explore the surface by hopping across it.

Hayabusa 2's most audacious gambit will be blasting that crater. The spacecraft will touch down to capture surface samples. Then it will release an explosive-laden impactor and duck behind the asteroid for safety. Detonating the explosives will drive a projectile into the asteroid at 2000 meters per second, digging a crater anywhere from 2 to 7 meters in diameter. "We really don't know what the asteroid is made up of," Watanabe says.

A floating camera will record the show. Once the dust settles, Hayabusa 2 will touch down near the crater, retrieve ejecta, and then head home. ■

NUCLEAR POWER

The trouble with tritium

Japan searches for a way to cleanse contaminated water from the damaged Fukushima plant

By **Dennis Normile**, *in Fukushima Prefecture, Japan*

Hulking water tanks are popping up like gray mushrooms at the Fukushima Daiichi Nuclear Power Station. Nearly 1000 of the 10-meter-tall steel vessels hold more than 560,000 tons of radioactive water that has accumulated as ground water leaked into the wrecked reactor buildings and was pumped out. The plant operator, Tokyo Electric Power Co. (TEPCO), says it can now remove most of the radionuclides from the stored water—but not tritium. So, for the moment, the company dares not release the tainted water into the Pacific. "This contaminated water is the most urgent matter that we have to address," says plant manager Akira Ono.

A solution may be in sight. A U.S.-based firm says it has tweaked a catalytic process that, in principle, could concentrate all of Fukushima's tritium into just 5 cubic meters of water, at a cost of about $1 billion. The company is one of three that have won government grants to develop promising tritium-removal techniques. They have until March 2016 to demonstrate that their technologies can meet the Fukushima challenge.

Nearly 4 years after the 11 March 2011 earthquake and tsunami that led to meltdowns of three of Fukushima's six reactors, TEPCO is still in the early stages of a projected 40-year, $80 billion decommissioning task. Last month it removed the last of 1331 radioactive spent fuel rods stored in unit 4, clearing the way for its demolition. Next they need to find and retrieve damaged fuel. TEPCO determined that in one of the three stricken reactors, fuel debris likely melted its way through the reactor vessel and into the concrete containment building. But "we do not know exactly where those fuel rods are," Ono says. Intense radiation keeps human inspectors from venturing close to the epicenter of the meltdowns, but remotely operated devices may eventually be able to inspect and remove the damaged fuel.

In the meantime, crews must continuously circulate water through the buildings to cool the fuel and capture the 300 tons of ground water that leak in every day. After more than a year of struggling to purify the stored water with a balky system of filters and adsorbers, Ono says they are now reliably removing 62 radionuclides.

Removing the tritium is a steeper challenge. An isotope of hydrogen, tritium can replace a hydrogen atom in water and pass straight through the filters and adsorbers. Tritium's radiation risk is modest, as it gives off only low-energy beta particles. There would be "very limited human health concern from oceanic discharge," says James Seward, a radiation health specialist at the University of California, San Francisco.

This system strips nuclides from Fukushima's contaminated water but misses the tritium.

PHOTO: EPA/SHIZUO KAMBAYASHI/POOL POOL PHOTO

> ***"This contaminated water is the most urgent matter that we have to address."***
>
> **Akira Ono**, Tokyo Electric Power Co.

The political risk is another matter. Japanese regulations allow nuclear power plants to discharge tritium in concentrations of up to 60,000 becquerels per liter into the environment. Virtually all nuclear power plants worldwide release tritium into the environment as part of normal operations. But they don't typically dispose of massive amounts all at once. Even a gradual release of Fukushima's tritiated water would likely be opposed by fishers who "worry that consumers won't be convinced" of the safety of seafood caught off Japan's northeast coast, says Jota Kanda, a biogeochemical oceanographer at Tokyo University of Marine Science and Technology.

Existing techniques for separating tritium from tritiated water are "very challenging, cost a lot, and take time," Kanda says. In December 2013, a Ministry of Economy, Trade and Industry advisory committee reported that no current technologies were suitable for use at Fukushima. In August, the ministry offered $8.4 million development grants to three groups with promising alternatives. One withdrew; the ministry is recruiting a replacement. A second group, FSUE Radioactive Waste Management Enterprise of Moscow, did not respond to *Science*'s requests for details. But Kurion Inc., of Irvine, California, was happy to talk up its project.

Kurion has modified a process called combined electrolysis catalytic exchange. It starts by splitting the contaminated water molecules into gaseous oxygen and a mixed gas of hydrogen and tritium. The hydrogen mixture flows into the bottom of a column filled with a platinum catalyst while water trickles in from the top. The catalyst triggers a swap in which a hydrogen atom in the water trades places with a tritium atom in the gas. Clean hydrogen flows out the top of the column; water containing a higher concentration of tritium collects at the bottom.

The process is similar to one used to cleanse contaminating tritium from the heavy water used in certain nuclear reactors. But Gaëtan Bonhomme, Kurion's chief technology officer, says his firm has optimized the column's design so that one trip through squeezes the tritium into 25% of the original volume of water entering the electrolyzer. Repeatedly recirculating the water further concentrates the tritium.

After the development program wraps up in early 2016, the ministry and TEPCO will decide on their next step. Ultimately, says Masao Matsuyama, director of the Hydrogen Isotope Research Center at the University of Toyama, how to handle the tritium "will be a decision for TEPCO and the politicians." ■

PARTICLE PHYSICS

Japanese neutrino physicists think really big

A proposed Hyper-Kamiokande would be the largest neutrino detector ever

By **Dennis Normile**, *in Kashiwa, Japan*

Japanese physicists, already among the world's leading neutrino hunters, want to cement their position with a million-tonne instrument—dubbed Hyper-Kamiokande, or Hyper-K—capable of catching these elusive particles at 20 times the rate of its predecessor. The 250-meter-long behemoth should be a powerful tool for physics, dissecting the properties of neutrinos beamed from a remote particle accelerator. It could also boost astronomy, by capturing neutrinos spraying from supernovas in deep space. "Hyper-Kamiokande is very well placed to be the greatest experiment of its generation," says Francesca Di Lodovico, a particle physicist at Queen Mary University of London.

The challenge will be getting the $800 million or so needed to build it. To make their case, scientists from 13 countries this past weekend formally launched a protocollaboration to develop a firm plan they can take to funding agencies. Given Japan's fiscal woes, "we will have to work very hard to convince the government that this is a most important scientific project," says Takaaki Kajita, director of the University of Tokyo's Institute for Cosmic Ray Research, which oversees the Kamioka experiments. It will also be in competition with other big physics projects. Some Japanese physicists want Japan to host the next great particle smasher, the proposed International Linear Collider. And physicists in the United States are planning a huge neutrino experiment that could beat Hyper-K to the punch (*Science*, 30 May 2014, p. 955).

Hyper-K's grandfather, Kamiokande (for Kamioka Nucleon Decay Experiment), surprised many 3 decades ago when it demonstrated that it could pinpoint the direction and energy of incoming neutrinos from the sun, from cosmic rays colliding with particles in the atmosphere, and from a supernova. The sightings netted the head of the experiment, Masatoshi Koshiba of the University of Tokyo, a share of the 2002 Nobel Prize in physics. By then, researchers had already moved on to the larger Super-Kamiokande, or Super-K, and showed that neutrinos have mass, upsetting previous theories. Now researchers believe an even larger detector will allow them to fill in the remaining blanks in the neutrino profiles, study the early universe, and probe why matter is more common than antimatter.

Chargeless and almost massless, neutrinos flow through matter as if it wasn't there. But occasionally a neutrino collides with another particle. In the purified water that fills the Kamiokande detectors, the interaction produces a blue cone of light known as Cherenkov radiation. By observing these flashes with photosensors, physicists can determine which of the three types, or flavors, of neutrinos produced it and the incoming particle's direction and energy. To screen out background noise, the detectors are placed 1000 meters underground in a mine near the Gifu Prefecture town of Kamioka.

As with many scientific instruments, size matters. Kamiokande contained 3000 tonnes of water watched by 1000 sensors. In 1996, Super-K upped the ante to 50,000 tonnes of water and 13,000 sensors. As presently planned, Hyper-K will comprise two 250-meter-long, 50-meter-high oval-shaped tubes together holding 1 million tonnes of water and 100,000 photosensors. Hyper-K will be able to collect in 5 years the amount of data Super-K would take a century to gather.

Research teams have grown proportionally. Kamiokande had a couple of dozen scientists, primarily from the University of Tokyo. About half of Super-K's 120 collaborators are from outside Japan. Hyper-K already has at least 240 researchers from 67 institutes working on R&D.

Besides snaring neutrinos from the atmosphere and from space, Super-K caught and studied neutrinos beamed from the Japan Proton Accelerator Research Complex (J-PARC), 295 kilometers to the east in Tokai. For Hyper-K, J-PARC is planning to triple the intensity of its neutrino beam. By watching the neutrinos in the beam transform from one flavor to another, researchers will try to understand why there is more matter than antimatter in the universe, a condition known as charge-parity violation that is "one of the major questions in physics," Di Lodovico says. The neutrino changes, or oscillations, should also help researchers determine which flavor is the heaviest—a goal shared by smaller neutrino projects in other countries (*Science*, 30 January, p. 464).

Meanwhile, neutrinos from astronomical sources could shed light on how stars live and die. Should a supernova explode in our galaxy, Hyper-K could catch 250,000 neutrinos within 10 seconds, providing new clues to these cataclysms.

The same photodetectors that watch for neutrino interactions should also be sensitive to a momentous event in the water itself: the decay of one of its protons. Proton decay, postulated but never observed, would indicate that all matter in the universe will eventually break down into subatomic particles. Observing it "would be an amazing result," says Christopher Walter, a physicist at Duke University in Durham, North Carolina.

The goal of Hyper-K's protocollaboration is now to produce a more detailed design by next December in hopes of starting construction in 2018 and taking data in 2025, a schedule that Masato Shiozawa, the University of Tokyo physicist heading the project, admits will be challenging. But, Di Lodovico says, "It's time to move forward now to keep the momentum and gather together all our efforts in order to create this experiment." ■

In the firing line

Neutrinos will beam from J-PARC to Hyper-K's giant water tanks (bottom).

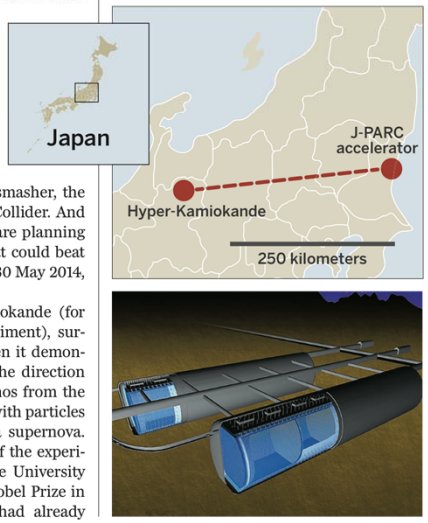


ILLUSTRATION: (BOTTOM) HYPER-KAMIOKANDE COLLABORATION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Thank You!

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