The Hunt for Planet Nine
Since Pluto was demoted to a “dwarf planet” in 2006, a Caltech team has been searching for a hypothesized planet on the edge of the Solar System.

BY LIZ BOATMAN

It was a title he didn’t want. “I just found it very depressing,” Brown says. “It wasn’t my idea.” But by the late 1990s that Pluto was part of this Kuiper Belt and that it should not have been classified as a planet to begin with.” If Pluto didn’t deserve planetary status, neither did the other objects Brown had discovered. Brown doubted that the IAU astronomers would agree, he says. He didn’t attend the meeting, opting instead to “hide out” on a family trip to an island off Washington state.

But to Brown’s surprise, the IAU didn’t decide that the Kuiper Belt objects were planets. Instead, the astronomers created a new classification — Plutoid. Pluto and the other objects were now dwarf planets. Pluto had actually never been Brown’s focus — his team was working to catalog new Kuiper Belt objects. But they began to notice an odd pattern: A subset of those objects had orbital inclinations and geometries that defied explanation.

"Vibrant" US-Africa Collaborations

Despite the pandemic and even armed conflict, partnerships between researchers in the US and Africa persist.

“Like any college, we’re changing with changing student demographics, and students coming in with different kinds of interests.” While engineering programs are typically taught out of dedicated en-


Despite the pandemic and even armed conflict, partnerships between researchers in the US and Africa persist.

N euroscientist Sam Reiter fre-
quently takes his students at night to catch octopuses in the ankle-deep tide pools on Okinawa, the southernmost of Japan’s main islands. But netting an octopus involves a learning curve — particularly because they change color to blend into the environment. “Unusually the first time someone goes, they don’t see an octopus,” says Reiter. “But people with more experience will see many of them.”

Reiter and his team bring the animals back to his lab at the Okinawa Institute of Science and Technology, where they study how the octopus’s brain activity gives rise to its complex behavior, from camouflaging itself to coordinating its many arms.

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This implies that octopuses have evolved two-stage sleep independently of vertebrates, which suggests that active sleep could be a “general feature of complex cognition,” she says. The research is right up Meshulam’s alley. She’s working to develop theoretical frameworks to describe a “general feature of complex cognition,” she says. The research is right up Meshulam’s alley. She’s working to develop theoretical frameworks to describe a “general feature of complex cognition,” she says. The research is right up Meshulam’s alley. She’s working to develop theoretical frameworks to describe a “general feature of complex cognition,” she says. The research is right up Meshulam’s alley. She’s working to develop theoretical frameworks to describe a “general feature of complex cognition,” she says. The research is right up Meshulam’s alley. She’s working to develop theoretical frameworks to describe a “general feature of complex cognition,” she says. The research is right up Meshulam’s alley. She’s working to develop theoretical frameworks to describe a “general feature of complex cognition,” she says. The research is right up Meshulam’s alley. She’s working to develop theoretical frameworks to describe a “general feature of complex cognition,” she says. The research is right up Meshulam’s alley. She’s working to develop theoretical frameworks to describe a “general feature of complex cognition,” she says. The research is right up Meshulam’s alley. She’s working to develop theoretical frameworks to describe a “general feature of complex cognition,” she says. The research is right up Meshulam’s alley. She’s working to develop theoretical frameworks to describe a “general feature of complex cognition,” she says. The research is right up Meshulam’s alley. She’s working to develop theoretical frameworks to describe a “general feature of complex cognition,” she says. The research is right up Meshulam’s alley. She’s working to develop theoretical frameworks to describe a “general feature of complex cognition,” she says. The research is right up Meshulam’s alley. She’s working to develop theoretical frameworks to describe a “general feature of complex cognition,” she says. The research is right up Meshulam’s alley. She’s working to develop theoretical frameworks to describe a “general feature of complex cognition,” she says. The research is right up Meshulam’s alley. She’s working to develop theoretical frameworks to describe a “general feature of complex cognition,” she says. The research is right up Meshulam’s alley. She’s working to develop theoretical frameworks to describe a “general feature of complex cognition,” she says. The research is right up Meshulam’s alley. She’s working to develop theoretical frameworks to describe a “general feature of complex cognition,” she says. The research is right up Meshulam’s alley. She’s working to develop theoretical frameworks to describe a “general feature of complex cognition,” she says. The research is right up Meshulam’s alley. She’s working to develop theoretical frameworks to describe a “general feature of complex cognition,” she says. The research is right up Meshulam’s alley. She’s working to develop theoretical frameworks to describe a “general feature of complex cognition,” she says. The research is right up Meshulam’s alley. She’s working to develop theoretical frameworks to describe a “general feature of complex cognition,” she says. The research is right up Meshulam’s alley. She’s working to develop theoretical frameworks to describe a “general feature of complex cognition,” she says.
Jim Hartle, a theoretical physicist whose boundary-determined world sought to unite the quantum world with a cosmos shaped by gravity, died on May 17, in Switzerland. He was 83.

“Jim developed, more than anyone else, was a quantum mechanical way of thinking about cosmology,” says Thomas Hertog, a cosmologist at K.U. Leuven and a frequent collaborator of Hartle’s. Hartle was an APS Fellow and Guggenheim Fellow. In 1991, he was elected to the National Academy of Sciences. Despite his accomplishments — the 2009 Einstein Prize cited a “broad range of fundamental contributions to relativistic star, quantum fields in curved space-time, and especially quantum cosmology” — Hartle was aversive to the spotlight. He “so easily could have tried to grab some of that limelight that shows on [Stephen Hawking],” says David Brown, a colleague who shared a quasars laboratory with Hartle at the University of Oregon State University and one of Hartle’s students. “He never did.”

Jim Hartle was born Aug. 17, 1939, in Baltimore. His parents, Elizabeth and James Hartle, moved frequently due to Charles James Hartle’s job at IBM. During Jim’s teenage years, they returned to Baltimore, and he attended Gilman School, learning from physics teacher Bill Porter, whom he later thanked for “starting me off on this trail.” In college at Princeton, Jim initially studied engineering, but changed course after meeting theoretical physicist John Wheeler, who became a lifelong mentor — and, eventually, family. Years later, during a stint in Chicago, he asked Wheeler, “what ever happened to that attractive niece of yours?” And Johnanny said, “She’s just lived a few blocks away from here. Why don’t you give her a call?” So he did, and that was how, says Mary Jo Wheel Hartle, who married Jim in 1984.

At Caltech for graduate school, Hartle worked on particle physics under Murray Gell-Mann. After graduating in 1964, he briefly taught at Princeton before joining the faculty at the University of California, Santa Barbara, which he would help build into a theory powerhouse with the Institute for Theoretical Physics. In 1967, Hartle began working with Kip Thorne to calculate the characteristics of gravity waves. “We would work late into the night and start again the next day,” Thorne says. The two got along so well that they organized regular gatherings between their research groups, which eventually became the Pacific Coast Gravity Meetings.

Hartle also began to tackle questions about the foundations of quantum mechanics. “He had these
testable ideas that he would pursue for years,” says Thomas Hertog. “Elisabeth Reed encountered and resisted sex discrimination throughout her career,” wrote her daughter Katherine in an essay in 2019. “She researched and wrote this book to refute the claims that there had never been women scientists.”

Indeed, there had long been women scientists, including Eunice Newton Foote. Born Eunice Newton on July 17, 1819, in Connecticut, she grew up in New York state and attended the Troy Female Seminary, the first institution of higher education for women in the United States. Here, Foote and other attendees studied languages, philosophy, and mathematics. They also perceived the taking science courses taught in manual laboratories at the nearby Rensselaer Polytechnic Institute.

In 1841 she married a patent lawyer named Eunice Foote, and the couple moved to Seneca Falls, New York. There they befriended Elizabeth Cady Stanton, a prominent leader in the women’s rights movement. Both Eunice and Stanton attended the landmark Seneca Falls Convention in 1848 and signed its resulting “Declaration of Sentiments,” which criticized gender inequality and proclaimed women’s insalable rights.

Along the way, Foote began conducting experiments in her own laboratory. Her gas-heating experiments might have been inspired by John Henry Holland, an English physicist and director of the Smithsonian Institution, says John Perl, a visiting scholar at the University of California, Santa Barbara, who has written about Foote. Henry was interested in how weather and climate impacted agriculture, Perlins explains.

After Foote wrote up her results, Henry read her paper aloud at the AAGS meeting in Albany on Aug. 23, 1856. While the AAGS allowed women to be members and did not prohibit them from presenting work, it seemed to have been uncommon for women to do so. The reaction — and Eunice’s gender — received some attention in the press: A writer in the New York Times proclaimed, “the experiments of Mrs. Foote [sic] affirm evident abundance of the ability of women to investigate any subject with originality and precision.”

Foote’s work was also summarized in The Annual of Scientific Disc, an anthology published in 1857. But it is appeared that those who knew of her results did not know what to make of them. According to a write-up of the Henry’s, “Though the experiments were interesting they were difficult to interpret the phenomena any attempt to interpret their significance.” Foote’s paper was later included in the American Journal of Science and arts under Eunice’s own name, alongside a paper by Elisha, also an amateur scientist.

Foote did present her own researh before the university’s meeting, reading a paper on static electricity. This work was the last publication of Foote’s career, though she fled patents for several inventions, including a rubber sole to silence squeaking shoes and a paper-making machine, before her death in 1888.

In 1848, the Smithsonian Institution, an excellent predecessor to the National Academy of Science, received agriculture, Perlin explains.
Simulating Spacetime with Quantum Mechanical Materials

At the annual APS Division of Atomic, Molecular and Optical Physics meeting, physicists made the case for a new way of modeling a universe.

BY SOFIA CHEN

humans have long built models of the vast, mysterious universe. From the Greek cosmos, a sphere that maps the constellation to computer-based simulations of the universe, these models offer us more than just answers. They are a tool for us to think about the questions we haven’t even asked yet.

This June, physicists gathered at the Division of Atomic, Molecular and Optical Physics (DAMOP) meeting in Spokane, Washington, to present research in this field in a session called “Quantum Matter in Synthetic Curved Spacetimes.”

“Quantum matter” refers to “materials that obey quantum mechanics,” says Joseph Maciejko of the University of Alberta. In his presentation, researchers can manipulate these particles’ interactions to mimic the effects of gravity in different universes, including flat, spherical, or hyperbolic ones.

The physicists use the word “synthetic” to convey that current simulations are more loosely inspired by nature than reflective of it. “We don’t simulate the universe — we try to implement a simple theoretical model,” says Markus Oberthaler of the University of Heidelberg in Germany. For example, his team used a Bose-Einstein condensate to simulate quantum fields in a curved universe with just two spatial dimensions. (Our universe has three.)

Maciejko, meanwhile, presented theoretical work motivated by an experiment from Princeton collaborator that used devices called waveguide resonators, small cavities that selectively trap and transmit individual photons. Arranged in a grid of heptagons and triangles, the devices enabled photons to move around as though in a two-dimensional hyperbolic plane — a sort of Fringley-shaped universe, says Maciejko.

Studying phenomena in a hyperbol- ic type of crystal could be useful for objects that aim to unite quantum mechanics and general relativity. “We’re trying to do for Minkowski space what Misner did for Euc- lidean space from a separation from cosmology,” in essence.

Maciejko’s Princeton collaborators have created a new type of crystal geometry, with particles arranged on a curved, hyperbolic lattice — in contrast to the lattices of natural crystals, such as silicon or silicon, which are composed of straight lines in Euclidean space.

Maciejko presented research in which his team adapted electronic bands to this type of crystal. Normally, band theory describes the allowed energies of a material’s electrons. In order to understand the material’s bulk properties, such as whether it can conduct electricity, Brown said Maciejko studied band theory predicted the frequencies of photons that would transmit through the device.

This research brings together subfields of physics conventionally siled from one another. Con- tinued on page 4
A quantum chip in a University of Maryland lab — research with funding from the National Science Foundation, Credit: University of Maryland

New Budget Caps Ramp up Outlook for Science Spending Surge

BY MITCH AMBROSE

A s a result of new spending caps set by Congress, science agencies will likely struggle to secure significant budget increases for the next two fiscal years. To resolve a standoff over raising the federal debt limit, President Biden signed legislation in June that will hold discretionary spending on non-defense programs roughly flat for fiscal year 2024, which begins on Oct. 1. This cap will rise by about 1% for the year after, well below the current rate of inflation.

Since most science agencies are funded from the non-defense budget, any increases they receive will largely have to be offset by cutting other programs. Even defense re- search agencies may be constrained. The legislation only allows for a 3% overall increase to the defense bud- get for the upcoming year and a 1% increase the year after.

The cap means that Congress will almost certainly undershoot the targets it set for science budgets last year through the CHIPS and Science Act. The act recommends Congress roughly double the budgets of the National Science Foundation and the National Institutes of Health and Technology over five years, and increase the budget for the Department of Energy by roughly 50%. Instead, the House is proposing to hold the DOE Office of Science budget flat at $8.1 billion for fiscal year 2024. Some lawmakers from both parties have criticized the spending caps, vowing to push for extra spending. Senate Majority Leader Mitch Ambrose is Director of FYI, a trusted source of science policy news and analysis. Ambassador to SES.

APU News

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Looking for a job, or looking to fill one? APS has joined the Physics World Jobs Partner Network, in partnership with IOP Publishing. The platform gives job-seekers and employers a streamlined search experience, tailored to their specific needs. Employers can now access the new tiered pricing structure, post six free 14-day job postings per year and free 60-day listings for intern- ships or summer jobs, and better ad- vertise vacancies across and beyond the network. Create an account today at physicsjobs.com.
It was a heady idea with disconcerting implications, including the breakdown of time at the beginning. Many did not agree with these conclusions. Gell-Mann frequently ribbed Hartle, asking why he wasn’t more impressed with his own work. Hartle, a theorist at UCSD and a former postdoc of Hartle, “People often referred to him as a man with no boundaries.”

The description also alluded to Hartle’s collaboration with Hawking on the no-boundary wave function of the universe. “Jim used to say that physics had always been divided between the laws of motion and the initial conditions,” Horowitz says. “Why couldn’t they be the same?” In 1983, Hawking and Hartle proposed an alluring possibility: The wave function can describe a particle’s complete quantum history — it could also describe the quantum history of the whole universe from the beginning.

Conventionally, this was impossible. The truth of the universe’s beginning was supposed to be hidden behind an inscrutable dense singularity. Hartle and Hawking found a way around this barrier that began without a singularity a way a wave function could be solved.

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Several decades ago, I was a quiet girl from West Bengal, India. Even before I knew what physics was, I marvelled at the thread it stitched through the natural world — an insect that could walk on water; a rainbow that shimmered on the surface of an oily puddle.

Today, I am a theoretical physicist in Rochester, New York, and my specialty is cells and tissues. My team has bolstered scientists’ understanding of the cytoskeleton, the scaffolding that holds cells together, and the cartilage that cushions joints. This research, which has reaped millions of dollars in funding from the US government and private foundations, could shape the development of new materials — imagine a prosthetic limb that heals its own wounds.

But here’s the thing: I’m far from unique. For decades, STEM immigrants in the US like me have built great businesses, invented new technologies, and conducted crucial research. In 2019, immigrants made up 19% of the total STEM workforce, including 40% of workers with PhDs. Immigrants founded more than half of the US’s private-hold billion-dollar startups. They represent an outsized proportion of Nobel Prize winners in science. Of Americans who won the prize in physics, chemistry, or medicine between 1901 and 2022, more than 2 in 3 were immigrants.

My own subfield has many brilliant immigrants. M. Cristina Marchetti, an Italian-born physicist at the University of California, Santa Barbara, has uncovered secrets of organisms, regardless of their biology. She’s found, for example, that biologists often say, “I wish I had known the right questions to ask,” about this field is that we don’t even know the right questions to ask. Biological physics.

For the nation’s sake, let’s make it easier for them to get here — and easier to stay.

Moumita Das is a professor of physics at the Rochester Institute of Technology, where she studies soft matter and biological physics. To learn about APS advocacy efforts on immigration, see auburn, visit aaps.org/policy.