SIMONS
FOUNDATION

Annual Report
2024 Edition

We're pleased to present you with this copy of the 2024 Simons Foundation Annual Report.

Last year, we supported programs that advanced the frontiers of research in mathematics and the basic sciences around the world. The stories in this book, which will take you from a Chilean mountaintop to a Kenyan lake to a Scottish research lab, explore how we're working around the globe to push the boundaries of scientific understanding to benefit humankind.

For additional media related to these articles, and to learn more about our work, please visit the digital edition of this report at **simonsfoundation.org/report2024** or scan the QR code below.

David N. Spergel, Ph.D.
President

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LETTER FROM THE PRESIDENT

Science and mathematics, Jim Simons once said, are "the bedrock of our civilization." Jim lived a life driven by curiosity and believed deeply in basic science and its ability to spur advances that ultimately improve human life. Jim and Marilyn built the Simons Foundation to pursue a mission rooted in that belief: to advance the frontiers of research in mathematics and the basic sciences. Sadly, we lost Jim last year, but this vision remains our guide star.

Guide stars are essential to staying on course when you're sailing in choppy waters. Indeed, we are living in turbulent times, with many questioning the traditional relationship between research, universities and the federal government. There is growing pressure to narrow federal scientific research support to a handful of fields with clear commercial and military applications, such as artificial intelligence and quantum computing. The Simons Foundation remains committed to a much broader program: We believe that the basic research we support today will pave the way to life-changing technologies tomorrow.

Already, examples of the wide-ranging impact of the foundation's basic science investments abound. The Simons Collaboration on Hidden Symmetries and Fusion Energy has contributed to renewed interest in stellarators, a promising design for nuclear fusion reactors. Our support of basic mathematics and theoretical computer science has enabled the development of more efficient LED lightbulbs and advances in quantum cryptography. The Simons Foundation's sustained support of autism research has led to an understanding of the important role genetics plays in the condition and a better appreciation of the diversity of people with autism. None of these advances happened in six months; all required a long-term commitment to fundamental research.

We invest in, and will continue to invest in, mathematics, basic science, and, most importantly, mathematicians and scientists.

The impact of our work is amplified by our frequent collaboration with Simons Foundation International, an independent Bermuda-based foundation that shares our mission. We also have a growing list of collaborations with the National Science Foundation and private foundations such as the Gordon and Betty Moore Foundation, the Secunda Family Foundation, the Nancy Lurie Marks Family Foundation, and the Wellcome Trust. Many of the programs described in this annual report are supported through these joint efforts.

The Simons Foundation supports so many outstanding programs and people, and this annual report highlights only a few of them. We hope that as you read these stories, you share in our excitement about the amazing things being done by our staff and grantees.

David N. Spergel, Ph.D.
President

LETTER FROM THE CHAIR

My husband, Jim Simons, had a lifelong fascination with the universe's origins and workings.

April 25, 2024, was his 86th birthday, and his special wish for that milestone was that the Simons Observatory in Chile — conceived and built by the collaboration Jim had assembled and funded — would be up and running. To Jim's delight, Greg Gabadadze, senior vice president of our Mathematics & Physical Sciences division, came by that day to deliver the good news: Two of the observatory's small-aperture telescopes had begun taking record-breaking measurements of the oldest light in the cosmos in search of new insights into the universe's birth and evolution.

The deep questions behind the Simons Observatory captured Jim's imagination. What happened immediately after the Big Bang? Does the Big Bang model explain our universe's origins, or did a Big Bounce occur instead as a precursor universe collapsed and then rebounded outward? What is the nature of the mysterious dark energy and dark matter that together make up 95 percent of the cosmos? How do quantum physics and gravity connect, and can Einstein's theory of general relativity be improved with the addition of a Chern-Simons term? With the observatory up and running, the hunt for answers to these questions was on!

Pondering these questions from the top floor of the Simons Foundation's New York City offices was intellectually captivating for Jim, but he also had a thirst for adventure and a zest for life that enriched all his endeavors. Consequently, Jim eagerly organized a 2023 trip to the observatory's site in Chile's Atacama Desert to inaugurate the three small-aperture telescopes there. So off we went to see the telescopes in situ.

Before ascending to the heights of the Chajnantor Science Preserve where the telescopes reside, we enjoyed a few days in San Pedro de Atacama, where we acclimated to the altitude (and dryness). The exceptionally clear night skies were awe-inspiring. Countless celestial bodies filled the heavens. A local astronomy tour group guided us through a park with telescopes positioned for viewing the planets and constellations. Gazing at the moons of Jupiter, I could feel the thrill of discovery as if I were the first to see them. I could only imagine Galileo's astonishment at observing Io, Europa, Ganymede and Callisto over 400 years ago. Can't you?

After a few days, we ascended higher into the Andes Mountains, up to 17,000 feet. With the help of supplemental oxygen, we toured the observatory's construction site and discussed our hopes and aspirations for the research. Where will our studies of the universe's oldest light — the cosmic microwave background — take us? There are so many interesting questions that we hope this research will address, and there will undoubtedly be surprising discoveries that will lead to new questions and understanding.

Sadly, Jim passed away a few weeks after his 86th birthday. While Jim will never know the answers the Simons Observatory will uncover, he valued long-term investments in math and basic science: investments that will benefit humankind and spark more discovery for generations to come.

That vision left an indelible legacy at the Simons Foundation. Much will be accomplished in his name at the Simons Observatory and through the many other foundation-supported research projects. Jim's inspiring passion for basic science continues with the work of our scientific directors, grantees and staff. Thanks to Jim, generations of scientists will experience the thrill of discovery as the Simons Foundation continues its mission to advance the frontiers of research in mathematics and the basic sciences.

Marilyn Hawrys Simons, Ph.D.
Chair

JIM AND MARILYN SIMONS' ENDURING VISION FOR THE SIMONS FOUNDATION

The "thing about basic science is, you don't know really where it's going to go, but you can hope that it's going to go far," Jim Simons said during his speech at a 2016 graduation ceremony at York University in Toronto.

Jim and Marilyn Simons built the Simons Foundation as an enduring force for mathematics and basic science. They saw an opportunity to take a long view and support research that didn't have an easily identifiable or immediate benefit. Such research is essential to driving the revolutionary breakthroughs that change the world. MRI machines, the mRNA COVID-19 vaccines, electron microscopes and lasers all came about thanks to decades of fundamental research.

Now, with the foundation having just marked its 30th anniversary, Jim and Marilyn's leadership, generosity and foresight have firmly established the Simons Foundation as a pillar of support for discovery-driven research. Each year, the foundation funds a broad portfolio of math and basic science projects, and its scientists expand our understanding of the universe. All the foundation's work is undergirded by core tenets instilled by Jim and Marilyn that guide how the organization serves the scientific community to drive new discoveries about our world.

One of those tenets is that great science is rooted in great mathematics. Over the course of his careers as a mathematician and as an investor, Jim witnessed firsthand how mathematics underpins empirical reality. At conferences, in speeches and during foundation meetings, Jim would often say how "the laws of nature are written in the language of mathematics," a quote from physicist Eugene Wigner's 1960 article "The Unreasonable Effectiveness of Mathematics in the Natural Sciences."

"Mathematics has shown that it has the power to shape, and to change, the way we see the world," Jim and Marilyn wrote in their letter in the 2015 Simons Foundation Annual Report. "The concepts of mathematics, no matter how abstruse, frequently enlighten and magnify even the deepest of scientific theories, often leading to accurate, if unexpected, empirical predictions."

Jim and Marilyn also valued the power of convening and open science. In 2024, the foundation hosted scientists from around the world at on-site scientific meetings. Since the foundation's early years, it has brought together the world's leading researchers (often from different fields or projects) to conjure up novel hypotheses and experiments.

That approach extends to the foundation's Flatiron Institute, its Simons Collaborations and even the design of its offices, all of which were created with collaboration in mind. In that same spirit of generously exchanging ideas, the foundation makes the work of its grantees and in-house researchers openly available to the scientific community.

Jim and Marilyn believed in giving the world's top researchers the freedom and resources needed to excel at their work and pioneer new ways of thinking. "Surround yourself with the smartest and best people you possibly can; let them do their thing," Jim said during the 2022 Abel Prize lectures. "Don't sit on top of them. If they're smarter than you, all the better."

In instructions to the foundation's board of trustees, Jim and Marilyn immortalized that the foundation would forever remain a supporter and champion of math and basic science. The board's composition will always include premier mathematicians and scientists who can guide the foundation's work by lending their lived experience and dedication to the sciences.

Jim and Marilyn Simons attend a 2022 event held by Stony Brook University. The gathering celebrated their generous donations to the university.
Credit: Sam Levitan for Stony Brook University

"The foundation will stay true to its mission of supporting basic science but will continue to evolve and address new questions," says Simons Foundation President David Spergel.

Although Jim died at age 86 on May 10, 2024, his presence and influence at the foundation are still keenly felt. Over the coming decades, as generations of mathematicians and scientists unravel our universe's secrets with Simons Foundation support, the impact of Jim and Marilyn's ideas and vision will only become further realized.

"I'm hoping this is going to last a hundred years," Jim told a *New Yorker* reporter in 2017. "But I won't see it."

SUPPORT FOR UKRAINIAN SCIENTISTS KEEPS RESEARCH AND COLLABORATION ALIVE

When Russia attacked Ukraine in February 2022, physicist Larissa Brizhik wanted to do something — anything — other than sit at home watching the news and waiting for missile strikes. Brizhik heads the physics department at the Bogolyubov Institute for Theoretical Physics of the National Academy of Sciences of Ukraine. The war made it impossible to concentrate on her work.

"I myself went to the local territory unit … and offered them my assistance," she says. "I wanted to take up a weapon and go fight." The unit (gently) turned her down. Brizhik was 70, and Ukraine has an age cutoff of 60 for military service.

Students work in a chemistry laboratory at the Ivan Franko National University of Lviv in Ukraine. *Credit*: Photo by EdPro

There's a saying in Ukraine, Brizhik says: "Воюй або працюй," which means "fight or work." "So I myself and my colleagues, we try to work even more than we used to before the war," she says. They now work not only to understand the nature of the universe but also to remind the soldiers protecting their country that there is still a country to defend — a country with families, children and theoretical physicists.

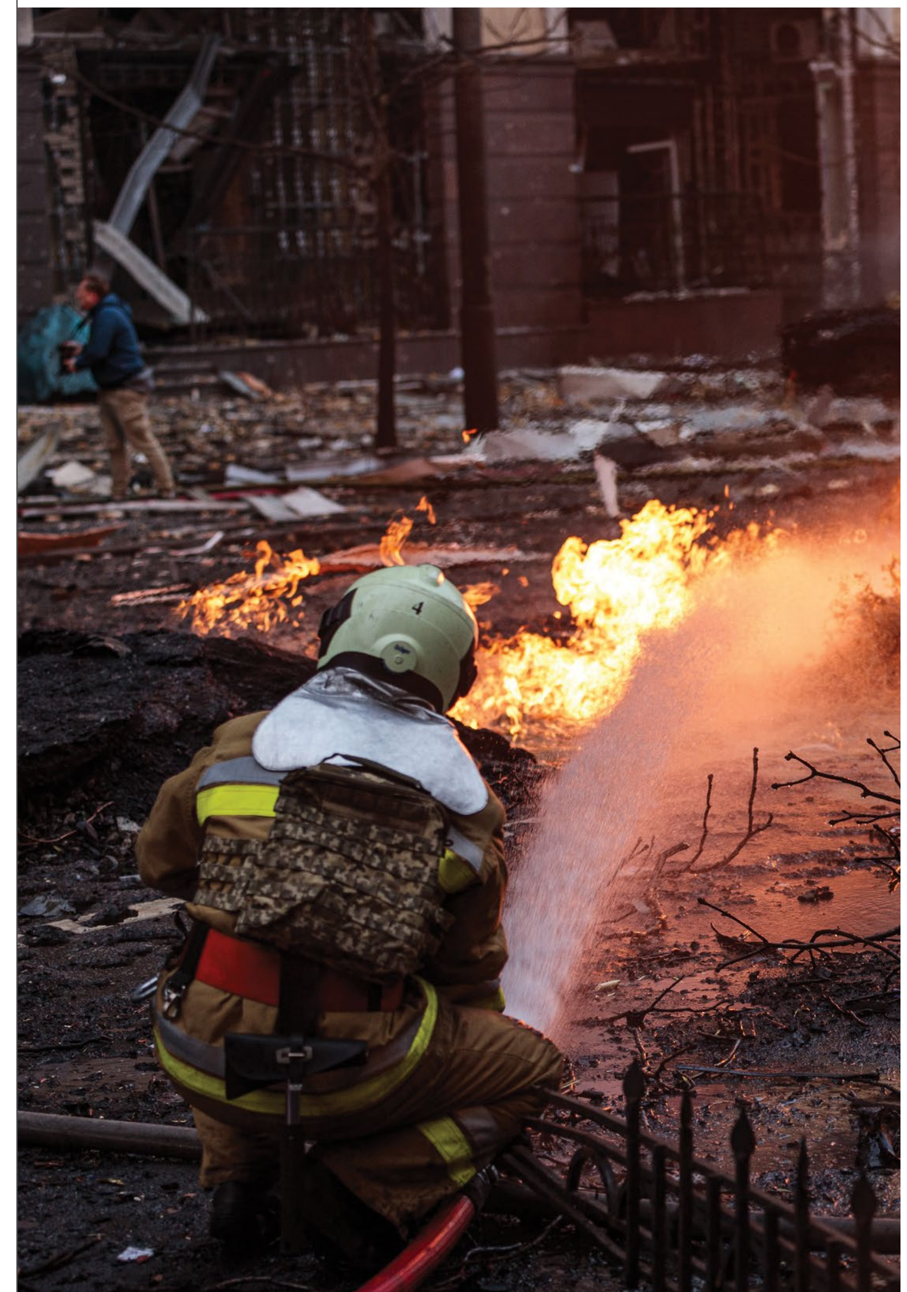
Brizhik and many of her colleagues have help from the Simons Foundation and Simons Foundation International (SFI) in maintaining their work. She is one of more than 430 grantees receiving wartime financial support from the foundations' Presidential Discretionary-Ukraine Support Grants. The grants provide Ukrainian researchers and graduate students monthly stipends to continue working in the country. Their institutions also receive assistance, and the Simons Foundation has co-hosted summer science institutes in Ukraine.

To the scientists in Ukraine, these funds and meetings are a crucial lifeline. They use the money to support themselves and their colleagues and to continue their research. Not only does the program keep math and science alive in a country at war, it is critical for training the next generation of Ukrainian researchers. It's also a source of hope, Brizhik says, a sign that the larger scientific world hasn't forgotten them.

Staying In, Hanging On

In the first weeks, then months, of the war, the uncertainty was difficult, says Grygoriy Dmytriv, a chemist and dean of the faculty of chemistry at the Ivan Franko National University of Lviv. "No one knew how the situation would develop, and many people went abroad," he recalls. His wife, son and mother-in-law left the country for Poland after the invasion. Like Brizhik, Dmytriv stayed.

There was little research happening at that point. "There was a constant risk of air attacks, and the university buildings were closed," Dmytriv says. So he and fellow volunteers stayed on watch in the chemistry department. Other scientists worked from home, analyzing data from before the invasion. The COVID-19 pandemic provided an ironic upside: Students and faculty were already used to learning and working from home.



A firefighter battles a blaze in the aftermath of a December 2024 Russian missile strike on Kyiv, Ukraine. During the attack, a missile exploded just a few hundred meters from physicist Larissa Brizhik's home. *Credit*: Kyiv City State Administration (CC BY 4.0)

Still, some students understandably left for programs abroad, and others volunteered for the army. The departure of so many early-career scientists, if permanent, could seriously compromise the future of science in Ukraine. The Simons Foundation wanted to provide support for those scientists who remained. "Ukraine traditionally has outstanding scientists and scientific infrastructure," says Greg Gabadadze, senior vice president of the Mathematics & Physical Sciences division at the Simons Foundation. "It is of paramount importance to preserve continuity in training the younger generation of scientists in Ukraine."

The funding, provided by the Simons Foundation and SFI and administered by the Simons Foundation, comes at a time when finding in-country support for Ukrainian research has become exceptionally challenging, Dmytriv says. While national grants have been sustained, many local funding sources diverted their money to the war effort. Dmytriv lost a local grant studying biodegradable plastic — though he and his department have had some success in writing grants with a defense focus, such as exploring how to make ultralight armor or better batteries.

Brizhik had a related experience: Two colleagues got funding from the Ukrainian government for fundamental research, but she did not. "There are not so many [sources of] funding to support Ukrainian scientists who work in Ukraine," she says. Most are offers to go abroad.

Funding Research, Funding Hope

Supporting scientists like Dmytriv and Brizhik was precisely what the Simons Foundation aimed to do when it launched its grant program. However, identifying who might be eligible for the grants was no easy task. Gabadadze worked with other Simons Foundation staff scientists to identify and reach out to productive labs and research groups still in Ukraine.

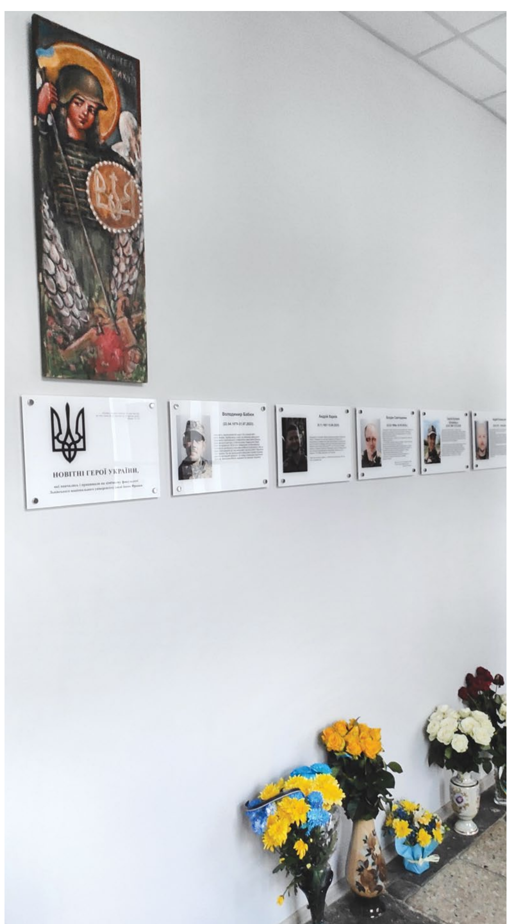
One of the foundation scientists tapped to help was Stas Shvartsman, a senior research scientist at the Center for Computational Biology at the Simons Foundation's Flatiron Institute. Shvartsman grew up in Odesa, a city on Ukraine's Black Sea coast, when Ukraine was still part of the Soviet Union. His interest in chemistry sent him away for graduate school, first to Moscow, then to Israel and then to the United States. He didn't feel particularly Ukrainian at that time, he recalls.

But when the attacks on Ukraine came in 2022, he felt them deeply. "Probably for the first time in my life, I didn't feel like [a] Jewish boy from Odesa that just happened to speak Ukrainian, but I felt Ukrainian identity as somebody who grew up there," he says. "You feel, of course, very helpless, and there is really not much to do."

Shvartsman was eager to assist in identifying those top scientists still in Ukraine. He reached out to former classmates and, through them, found the right contacts. "I identified people in Lviv, in Chernivtsi, in Kyiv, and I started talking to them over Zoom," he says.

The practicing, publishing researchers in Ukraine whom Shvartsman and his colleagues found through their networks were sent brief individual requests for proposals for grants. In the end, more than 430 scientists applied. "We reviewed all the proposals and accepted all of them," Gabadadze says. The funding is ongoing and has been provided to researchers in fields from astrophysics to biology to pure mathematics.

Brizhik and her colleagues were initially wary when they received the email asking them to apply for funding. At first, she recalls, they thought it was spam. But in the end, they took a chance and applied. Brizhik has used some of the funds to pay for internet access, a memory stick for her research, and some power banks, which she keeps with her important documents in case of evacuation. She also got a large thermos for hot water,



A memorial for alumni of the Ivan Franko National University of Lviv's chemistry department who have died in the war. *Credit*: Grygoriy Dmytriv

"Supporting scientists means supporting careful, analytical, brilliant minds. Every country needs such people, and these are the people who will play a very important part in rebuilding Ukraine, in whatever form it takes."

— Stas Shvartsman

which is critical when power and water are so uncertain. In her department, 37 scientists and five doctoral students receive grants from the Simons Foundation and SFI. In Dmytriv's department, 51 scientists and seven doctoral students receive support.

To the scientists, the funding means far more than money, though the money means a lot, Brizhik says. "It's not too big, but when the income is very low, every little bit is very important," she says. "But there is also another aspect which is not less important": She and her colleagues don't feel cut off from the scientific world. "There are other people who understand you, who want to help you, who support you."

A further sustained connection to the scientific world at large comes through data science summer institutes in Dmytriv's city of Lviv, co-hosted by the Simons Foundation and the U.S. National Academies of Sciences, Engineering and Medicine. During the annual summer institutes, experts in data science from the United States — including Simons Foundation President David Spergel in 2023 — travel into the country to meet with Ukrainian researchers and discuss topics such as machine learning, Bayesian statistics and data modeling. The institute offers a chance for Ukrainian researchers to hone new skills and stay connected to the international research community even as the war goes on.

Science Under Fire

Even as the fighting in Ukraine drags on, Dmytriv's situation has stabilized a little. "The university renovated the system of shelters, and we, step by step, continued our research," he says. His family returned home. But war is never far from anyone's mind. "Even

During their breaks, physicists at the Bogolyubov Institute for Theoretical Physics of the National Academy of Sciences of Ukraine and their neighbors craft tactical nets. *Credit*: Larissa Brizhik

in Lviv, which is relatively far from the front line, air raid sirens often sound, explosions are heard from time to time," Dmytriv says. One of the graduate students in organic chemistry, Serhiy Butenko, volunteered for the army and died in combat. Four other chemistry graduates have also died.

Kyiv, where Brizhik lives, has been harder hit, having been in the crosshairs from the beginning. "We have almost every day — and sometimes several times per day — air raid warnings. Very often, we hear explosions of missiles." During attacks, she and her daughter stay the night on the hall floor with their (understandably) upset cat. "Some attacks last several hours. The longest one was 11 hours," Brizhik says. In the morning, missiles permitting, she goes to work to continue her research. During their lunch breaks, Brizhik and her colleagues weave nets for camouflaging tanks at the front.

While the support from the Simons Foundation and SFI helps scientists like Dmytriv and Brizhik continue their research in the face of war, the funding also has a longer-term goal, Shvartsman says: to make sure that a culture of science survives in Ukraine. "Supporting scientists means supporting careful, analytical, brilliant minds," he explains. "Every country needs such people, and these are the people who will play a very important part in rebuilding Ukraine, in whatever form it takes."

SCIENCE MUSEUMS LEND EXHIBITS TO INSPIRE CURIOSITY IN UKRAINE

Who wants to go see the Fartinator, kids?

"What is the Fartinator?" you may well ask. It's part of a set of fantastical science displays recently exhibited in a shopping center in Kyiv, Ukraine, and now installed at the Science Museum in Poltava. This particular interactive display features five wooden cow butts side by side in a transparent plastic box, each with a funnel dangling overhead. When a cow is going to "fart," its tail flips up, and a child must scramble to catch the emission in a funnel. The Fartinator is a kid-designed sustainability demonstration that shows children how captured methane can be used as an energy source. It is, unsurprisingly, incredibly popular. Ukraine's children may spend some nights in bomb shelters and worry about heat and power and if their relatives in the army are safe, but they are still kids, and this exhibit offers them a lighthearted educational escape.

The Fartinator is just one element of an exhibition from Norway's VilVite Bergen Science Centre called "Project Fantasy." Originally developed by and for Norwegian children, the exhibition traveled over 2,700 kilometers from Bergen, Norway, to Kyiv in a special freight container to keep Ukrainian children's scientific curiosity alive during wartime.

> "This war destroyed our plans, but not our determination to follow our vision." — **Vasyl Dunets**

When Russia invaded Ukraine in 2022, the Simons Foundation immediately began working to support scientists in the country. But they wanted to do more for the people of Ukraine. The foundation reached out to Ecsite, a European organization that supports science engagement. After learning that several science museums and science centers in Europe were already working on donating exhibits to Ukraine, the Simons Foundation and Ecsite formed a partnership enabling the Bergen Science Centre and 11 other European museums and centers to donate and send exhibitions quickly — with the Simons Foundation covering all transport costs for these often complex shipping efforts.

In addition, to help Ukrainian science educators in their work, the Simons Foundation funded the travel of Ukrainian museum professionals to conferences across Europe for professional development. Both efforts aim to keep science engagement alive in a country under siege — and to give museum professionals and child and adult visitors a bit of normalcy.

"A modern economy rests on science and mathematics. Ukraine's future rests on its youth," says Simons Foundation President David Spergel. "A trip to a museum can inspire a lifelong interest in mathematics and science that can transform a young person's life."

Cost had been a barrier to sending "Project Fantasy" to Ukraine, says Lars Leegaard Marøy, CEO of VilVite Bergen Science Centre. "It was a godsend when Ecsite sent out an email calling for donations and mentioning support from the Simons Foundation," Marøy says. The Simons Foundation's partnership with Ecsite also helped the science centers take care of the red tape that comes with shipping a large exhibit to a country at war, he says.

Once the war is over, says Marøy, Ukraine will need to rebuild both physically and mentally. Museums and science centers, he notes, "inspire knowledge about science, technology, engineering and mathematics topics for young people. We knew how important our contribution could be."

Ukraine opened its first national science museum in 2020, and the country had plans to open more. However, the renewed Russian incursions in 2022 destroyed not only these plans but also some of the museums that already existed in Ukraine.

"This war destroyed our plans, but not our determination to follow our vision," says Vasyl Dunets, deputy director of development of science centers and international strategic projects at the National Centre's Junior Academy of Sciences of Ukraine. He was thrilled to receive the exhibition donations through Ecsite and the Simons Foundation. When exhibits arrive, Dunets and his team reconstruct them, translate their signage and place them in freely accessible shopping malls and local museums, creating spaces for science engagement. The donations they have received have ranged from robotics and math exhibits to a full-scale model of a house made of replica mammoth bones modeled on a Paleolithic house unearthed in Ukraine itself.

Science exhibits are now critical not just for science communication but also for the social integration of children, Dunets says. Ukrainian kids went through two years of isolation during the COVID-19 pandemic, he points out, and the war risks isolating them further. "The Science Museum was, and is, like a new opportunity to meet peers, to communicate, and just to change focus," he says. "To have a normal childhood."

The Simons Foundation is also making sure that science communicators in Ukraine's museum community meet and stay connected with other communicators across Europe. The foundation provided financing for 15 science communicators from Ukraine to attend the 2024 Ecsite conference in Ljubljana, Slovenia, and for five communicators to attend a five-day intensive science communication training workshop at the Copernicus Science Centre in Warsaw, Poland. It was critical, Dunets says, for his colleagues "to see not [only the] Ukrainian experience, but how it works outside Ukraine." His people came home inspired and motivated to apply what they had learned to their own spaces in different regions of Ukraine, he says.

In a country at war, little goes as planned. "I experience constant threats from missile and drone attacks, and power and water outages are frequent," says Olha Makarenko, team manager at the Science Museum in Kyiv, part of the Junior Academy of Sciences. But through it all, Makarenko and her colleagues are keeping science museums and exhibits available. "I saw how our science shows and activities helped not only the children but also some adults escape the harsh reality, even if only for an hour," she says.

The museums keep their doors open — with a few changes when circumstances demand it. "We were forced to remove all loud exhibits because they produce sounds similar to those of war," notes Makarenko. Museum and exhibit capacity is also limited, because everyone needs to fit in the shelter. "We have learned to quickly evacuate visitor groups and conduct 'pocket experiments' while in the shelter," she says.

Makarenko, who went to Slovenia for the Ecsite conference and then to Warsaw for the five-day intensive, is eager to share what she has learned. This includes skills like incorporating points of discussion into the flow of museum activities. "I am confident that this will make the entire educational process even more beneficial and engaging," she says. Makarenko also went with a group to Warsaw, where she was able to focus on interactive learning methods that "not only help to spark interest among younger visitors but also ensure active participation from adults in the scientific activities," she says. With her new experience, she is also eager to start entertaining visitors with educational evenings for adults at the Science Museum.

Dunets says that Ukrainian museums and their staff are better equipped to help kids — and help them look to the future — thanks to the support from the Simons Foundation and Ecsite. "Each of us, we work under difficult pressure, different risks," he says. "But each of us understands that if you want to have a bright future for Ukraine, if we want to rebuild Ukraine, we need to start to do something right now."

Children interact with the Fartinator at Norway's VilVite Bergen Science Centre. As kids capture methane from cow "farts," they learn about sustainability. The display is part of an exhibit designed by kids, for kids, that was lent to museums in Ukraine. *Credit:* VilVite Bergen Science Centre

SIMONS OBSERVATORY BLAZES TOWARD UNDERSTANDING OUR UNIVERSE'S BIRTH

The Simons Observatory site sits at an elevation of 17,000 feet in northern Chile. The observatory's large-aperture telescope, which achieved first light in February 2025, is visible in the foreground. *Credit*: Federico Nati

In December 2023, a brand-new astronomical observatory in the Chilean Andes buzzed with activity and anticipation. An international group of scientists was gathered there to take the first calibration data from one of a set of groundbreaking new telescopes. In the rarefied air at 17,000 feet, they wore portable oxygen concentrators as they bustled about, readying the instruments. If everything went to plan, they'd be one step closer to collecting the dataset that could explain the origins of the universe.

The telescope, one of four planned for the observatory's first phase, is part of an ambitious new undertaking poised to confirm — or disrupt — our theories and understanding of the early universe. Known as the Simons Observatory, the project aims to shed light on fundamental questions in physics and cosmology by making unprecedented maps of the sky in microwave frequencies. The images it generates could also enable discoveries across a wide swath of science areas, including the evolution of galaxies, the nature of elusive elementary particles known as neutrinos, and the properties of asteroid surfaces.

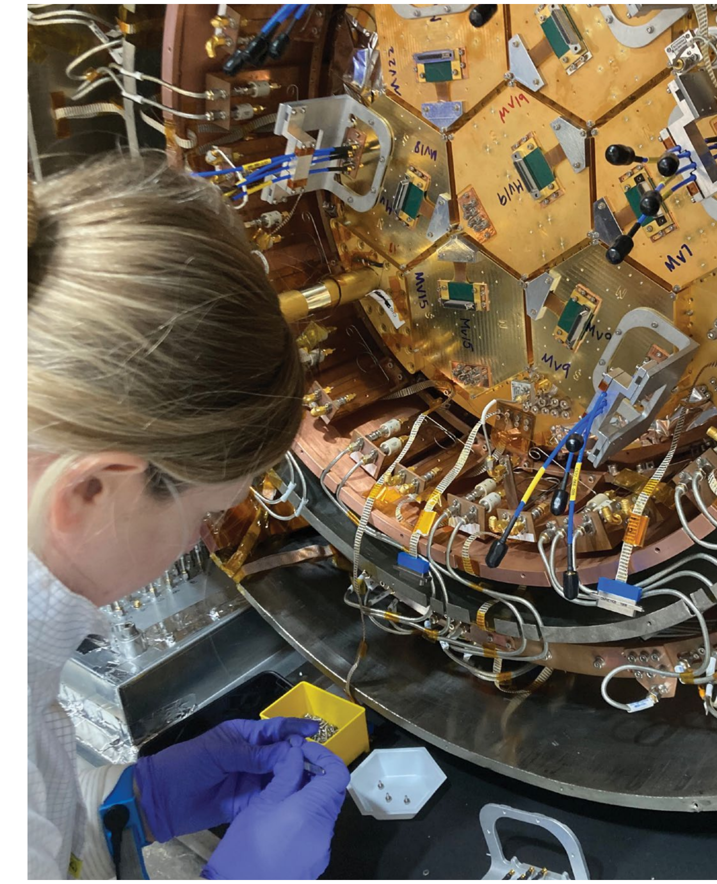
But to get to those revolutionary discoveries, the scientists first had to calibrate their sensitive instruments. The first telescope had made its first celestial observation a few weeks earlier by observing the moon. On that December night, the team on the mountain worked out the last-minute kinks as they pointed the second telescope at its first test subject: Jupiter.

"There was some scrambling, a bit of trial and error, and a lot of controlled chaos," says Suzanne Staggs, Simons Observatory co-director and a physics professor at Princeton University. "But most of all, there was a feeling of excitement and a sense of being alive and fully immersed in the moment."

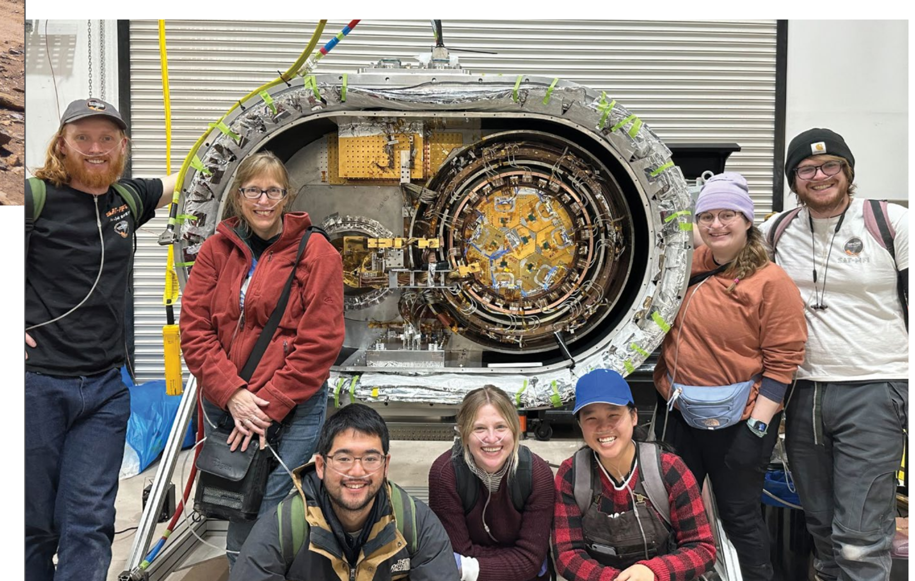
A few hours later, the scientists saw the bright signal of Jupiter in the data. After years of design and construction work, half of the telescopes were officially online. The Simons Observatory was off and running.

Cosmic Scars

Funded in large part by the Simons Foundation and the brainchild of its late co-founder Jim Simons, the Simons Observatory represents the next stage of research into our cosmic origins. At full capacity, the Simons Observatory operates 24/7, surveying the sky with 65,000 top-of-the-line detectors distributed among four telescopes. This setup allows the observatory to map the sky in microwave frequencies more quickly than any other instrument on Earth. With all these data — eventually, more than a terabyte will be collected daily — astronomers will launch dozens of investigations, chief among them the search for tiny signals called B-modes thought to exist in the universe's first light.



Simons Observatory scientist Erin Healy finalizes the installation of detector modules on one of the observatory's cameras. *Credit*: Michael J. Randall



Scientists with the Simons Observatory pose for a photo in 2023 after successfully integrating the observatory's first small-aperture telescope. *Credit*: Michael J. Randall

Those theorized signals are thought to be vestiges of the universe's first moments. A leading theory suggests that in the tiniest fraction of a second after the universe was born some 13.7 billion years ago, space rapidly expanded. During that brief period, known as inflation, tiny quantum ripples ballooned. For a while afterward, the universe was too hot and dense for light to travel very far. After around 380,000 years, the universe cooled enough for light to shine. That moment's first light, called the cosmic background radiation, or CMB, represents the limit to how far back in time we can see. Like a first baby photo, the CMB is a snapshot of the universe's infancy. It has already revealed fundamental properties of the universe to us, including its geometric shape and age.

In addition, just as scars on our skin log events in our past, details in the light from the CMB could tell us how the universe might have been pulled apart during inflation. The cosmic scars that scientists are looking for specifically are the B-modes: telltale swirling patterns seen in specific orientations, or polarizations, of CMB light. B-modes are indicators of gravitational waves, or ripples in space-time, thought to have been created during inflation. Seeing their signature would provide conclusive evidence of that short and cataclysmic period. And yet B-modes, if they do exist, would be one-billionth as bright as the already faint light of the CMB.

To see them, the astronomical community needed a next-generation observatory.

Recipe for Success

The genesis of the Simons Observatory came a decade ago during conversations between Simons and his longtime friend Brian Keating, a cosmologist at the University of California, San Diego. They had a shared interest in understanding the origins of the universe, and Simons had the idea of bringing together two competing groups of researchers, each observing the microwave background from the high mountains of Chile, to form a super-team.

"It would not have happened without the generosity and vision of Jim Simons," says Keating, now a principal investigator with the Simons Observatory. "He had this unique ability to hedge his bets and balance the requirements of collaboration and collegiality with competition."

With the support of Simons and the Simons Foundation, the observatory took a fast track to success. Instead of slogging through years-long approval processes, the project went from idea to funded proposal in mere months. Even the COVID-19 pandemic couldn't delay it for long. By early 2024, two of the observatory's smaller telescopes were fully online and gathering data. The team was able to show Simons the first data on his 86th birthday, not long before his death in May of that year.

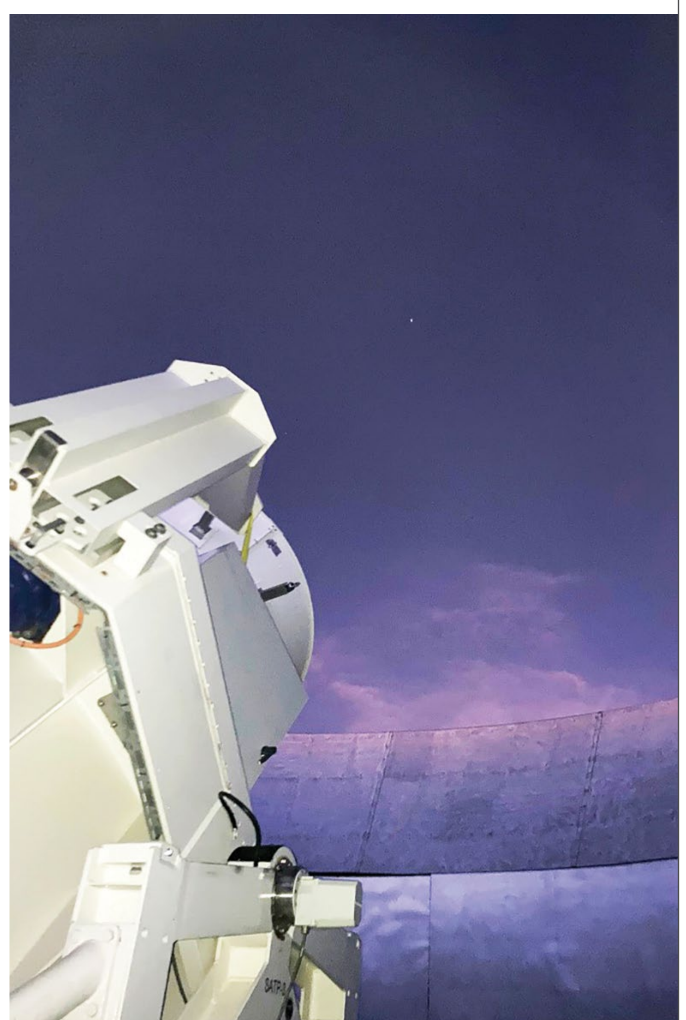
In May 2024, the observatory officially began its observation phase. A third small-aperture telescope and camera joined the first two at the site, and by February 2025, the larger, 6-meter-aperture telescope was installed and made its first astronomical observations. Meanwhile, the observatory was also awarded funding by the U.S. National Science Foundation to nearly double the number of detectors in the large telescope and fund the creation of a solar array to improve the site's energy security. Additionally, two of the three additional telescopes, funded by Japan and the U.K., are being built and are expected to go online by mid-2026. "The Simons Foundation's investment catalyzed a massive amount of additional support," says Mark Devlin, observatory co-director and a cosmologist at the University of Pennsylvania. "We've now got federal money from the U.S. and other countries coming to build on what they've started."

Today the Simons Observatory counts some 400 collaborators spread across 20 countries. Along with the new instrumentation from Japan and the U.K., researchers around the world have contributed to developing tools to calibrate the instruments and analyze the data. Scientists from Chile were essential to helping the observatory and its precursors find and build a home in the Atacama Desert. In recognition of the centrality of Chile to achieving its aims, the observatory prioritizes including local astronomers in the research efforts.

"We're making investments in the Chilean astronomical community to make sure that anyone in Chile who wants to be involved in the project is able to," says former Simons Observatory collaboration spokesperson Arthur Kosowsky of the University of Pittsburgh.

A Slow Sprint

Although the Simons Observatory is up and running, it will likely be a while before a B-mode signal can be detected.



One of the Simons Observatory's small-aperture telescopes looks up at Jupiter in the night sky as part of the calibration process. *Credit:* Allen Foster

Members of the Simons Observatory's large-aperture telescope team rest after successfully installing the telescope's camera optics and detectors. *Credit:* Simons Observatory Collaboration

> "It would not have happened without the generosity and vision of Jim Simons." — **Brian Keating**

"Because it's such a small signal, it will take us many years of data, averaged all together, to see this tiny signal emerge from the noise," Kosowsky says.

The scientists are eager to see what the observatory might reveal, but they will tread carefully in forming conclusions. To distinguish between the cosmic B-modes and other signals, such as dust in our galaxy, the scientists designed the detectors at the Simons Observatory to record in six frequency channels, which allows different signals, such as ones from dust, to be disentangled. Additionally, using multiple telescopes in tandem allows the scientists to further reduce background noise, such as that caused by atmospheric turbulence.

With this setup, the Simons Observatory astronomers are optimistic about their chances of finding B-modes. But even if B-modes don't show up, the enterprise will still be a success, the group says. The absence of detectable B-modes would itself provide important insight into the universe's origins and would narrow the number of viable theories about how the universe came to be.

With this nuanced new technology, there's no telling what surprises might show up in the data, Keating says. B-modes notwithstanding, the highly detailed data from the large telescope can also map the locations of faint objects, such as our solar system's asteroids. The data may even enable the detection — or the confirmation of a detection — of Planet Nine, a hypothetical planet in the far outer reaches of our solar system beyond Pluto's orbit.

"The data are already even slightly better than my wildest dreams," Keating says. "We have an extraordinary team, and I couldn't be more excited for what we'll see."

NOCTURNES: A HYPNOTIC LOOK AT THE STUDY OF HIMALAYAN MOTHS

In this shot from *Nocturnes*, a swarm of moths covers an illuminated sheet of fabric in northeast India. *Credit*: Grasshopper Film

On a moonless night, deep in the eastern Himalayan jungle, the stillness is pierced by the thunderous flapping of thousands of moth wings. The nocturnal insects fight for space on a lamplit tarp as researchers armed with digital cameras snap photos.

This scene from the 2024 Sandbox Films documentary *Nocturnes* occurs in an unimaginably remote location. The moth-hunting ecologist Mansi Mungee and her team — many of them indigenous to the area — drive on precarious cliffside dirt roads, clearing rockslides with a sledgehammer. They spend months braving the darkness, tabulating the sizes of hawk moths at different elevations to study how the animals are responding to climate change.

Mungee and her research were an ideal match for Sandbox Films, an editorially independent subsidiary of the Simons Foundation that creates documentaries exploring the art and beauty of scientific inquiry.

"We were introduced to this film through our partnership with the Sundance Institute, and from the very beginning we knew it would be a perfect fit for Sandbox," says Sandbox Films Executive Director Jessica Harrop. "*Nocturnes* is a portrait of the slow and beautiful process of doing science that allows your brain to quiet down and observe the natural world differently. For me, watching the film is a meditative and captivating immersive experience."

Nocturnes' directors, Anupama Srinivasan and Anirban Dutta, were drawn to Mungee's research and its remote setting. Both live in Delhi, India, "one of the most polluted places in the world — you can barely breathe there," Srinivasan says. "We were increasingly cooped up in our homes, with no contact with nature at all. We wanted to have some connection with nature, and that was the initial imperative for this film."

Nocturnes premiered at the 2024 Sundance Film Festival, where it received the World Cinema Documentary Special Jury Award for Craft. In creating the film, Srinivasan and Dutta found beauty in the moth-filled Himalayan nights and a kinship with Mungee's passion for the insects.

"What we found while making this film is that science takes years of work, and sometimes you don't find an answer; you ask more questions," Dutta says. "This is something very close to documentary filmmaking. Sometimes, you have an idea, and you might not find anything after filming for years. In both science and filmmaking, you do the same thing over and over again, and you learn to trust the process."

A moth rests on a lamplit tarp used in an ecological study of how hawk moths are responding to climate change. *Credit*: Grasshopper Film

"*Nocturnes* is a portrait of the slow and beautiful process of doing science that allows your brain to quiet down and observe the natural world differently." **— Jessica Harrop**

In this scene from *Nocturnes*, ecologist Mansi Mungee and her assistant, Bicki, use digital cameras to document the sizes and species of hawk moths. *Credit*: Grasshopper Film

QUANTUM PHYSICS COLLABORATION BRIDGES GEOGRAPHIC, INTELLECTUAL SEPARATION

Our ability to harness novel materials has powered humankind's technological revolutions, enabling everything from stone tools to silicon computer chips. The next leap forward is coming from quantum materials — those with properties deemed "impossible" by classical physics or basic quantum mechanics. Some of these materials have already entered our lives. Superconductors that transmit electricity without resistance power MRI machines, hard drives use magnetoresistance sensors and quantum computers use nanocrystal 'qubits' for running complex calculations.

Physicists are now beginning to explore a world of new quantum materials with even more fantastic properties. Although direct synthesis and characterization of new materials is the workhorse of material discovery, physicists have learned that knocking such materials out of equilibrium using magnetic fields, electricity and lasers can sometimes push them into states with new behaviors that could revolutionize fields from quantum computing to low-emission power generation. However, this approach yields materials that are incredibly tricky to develop and model, even with the use of super-computers. Studying these quantum materials has become one of the most daunting challenges in science.

"There are discoveries happening in the lab that drive theoretical ideas and theory that inform our experiments."

— Andrew Millis

In 2019, physicists in Germany and New York united to take on the challenge these materials present. The resulting collaboration, the Max Planck–New York Center for Nonequilibrium Quantum Phenomena, aims to develop new methodologies and tools for studying quantum materials and to make this type of research more accessible and interdisciplinary. By leveraging advances, the collaboration hopes to predict and study how manipulating quantum materials can change their properties.

The collaboration enables New York–based researchers at the Simons Foundation's Flatiron Institute, Columbia University, and, as of 2024, Cornell University to work closely with researchers at the Max Planck Institute for the Structure and Dynamics of Matter (MPSD) and the Max Planck Institute for Polymer Research (MPIP) in Germany.

Each partner brings essential skills to the collaboration, says the center's director, Andrew Millis, who also co-directs the Flatiron Institute's Center for Computational Quantum Physics (CCQ).

Researchers at the CCQ and the Flatiron Institute's newly launched Initiative for Computational Catalysis (ICC) bring theory and computational prowess. Physicists at Columbia have expertise in experimental physics and methods development. The Max Planck institutes bring complementary theoretical skills and the experimental tools needed to manipulate quantum systems, such as high-intensity, ultrafast lasers.

Over its first six years, the collaboration has proved so successful — amassing more than 115 research publications — that the partner institutions renewed the center for another five years and brought in Cornell University as a new partner.

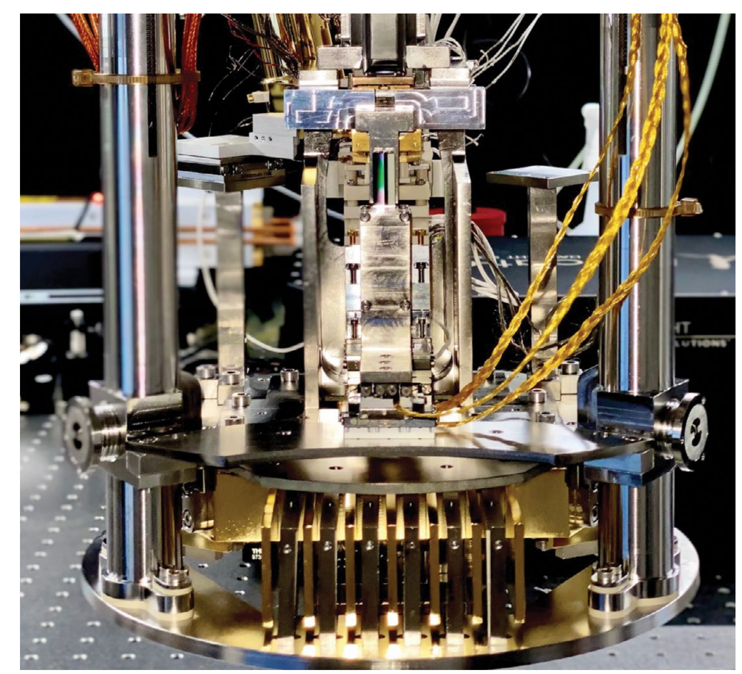
"The goal of the center was always to combine capabilities to make progress on very complicated projects," Millis says, adding that in the past, experimental, theoretical and computational physicists hadn't always communicated well with one another. "In our center, there are discoveries happening in the lab that drive theoretical ideas and theory that inform our experiments."

Collaboration Co-Director Dmitri Basov, an experimental physicist at Columbia University, devises new tools and measurement techniques for developing and testing novel quantum materials. Recently, he has partnered with Ángel Rubio, co-director of the Flatiron Institute's ICC and a theoretical physicist at the MPSD. The two researchers and their teams have investigated newly discovered properties of light, such as its ability to refract in the opposite direction from what is typically observed. Such light can be made to pass through materials such as metals that traditionally block light or to circulate between two flat objects to create a new type of resonator, a device used to study electromagnetic waves.

"We've done a lot of homework over the first few years to really get to the heart of quantum phenomena in materials," Basov says. "In the old days, the things that you could talk about experimentally were the very gross properties of materials. Now, you can expect to see us taking that foundation in exciting new directions to interrogate materials in much more detail."

Many of these discoveries have relied on tools such as ultrapowerful lasers to manipulate materials into new states. However, such tools can be prohibitively expensive. Rubio is now leveraging theory to understand whether it's possible to induce and maintain the desired states without such costly equipment.

One of Rubio's specialties is understanding how to manipulate matter using light in a condensed space, called a cavity. His team predicts that by placing atoms into tiny boxes with reflective walls that constrain the wavelength of any photons emitted or absorbed by the atoms inside, it's possible to better trigger specific behaviors in the atoms. "I'm trying to show now whether using a cavity means we can get by with less powerful lasers," Rubio says. By doing so, he wants "to turn the physics from something only a few people can do to something that everybody can do."



A custom-built optical instrument called a quantum nanoscope, used for imaging at ultrasmall length scales. The tool is helping researchers study the behavior of quantum systems. *Credit*: Shuai Zhang and Dmitri Basov

This idea of making quantum research more approachable and open feeds into a second important goal of the center: building cross-institutional networks for sharing ideas and talent. Nearly a dozen students and early-career scientists have so far benefited from its long-term visitor programs, jointly supervised research positions and permanent positions at the various partner institutions.

One former CCQ research fellow and MPIP group leader, Nikita Kavokine, arrived at the Flatiron Institute in 2021 keen to bridge his interest in fluid dynamics and the institute's focus on electron dynamics and condensed matter physics. Kavokine's work ultimately solved a decades-old riddle about why water sometimes appears to flow more easily through narrower carbon nanotubes.

The answer, he found, had to do with friction caused by the water molecules interacting with electrons in the nanotube walls. Kavokine revealed that the construction of the narrowest nanotubes leads to misalignments between the layers of their walls. This misalignment prevents electrons from hopping between layers, curbing the water–electron interactions that cause the friction and slow the flow of water.

Kavokine's findings were the first evidence of quantum effects at a solid–liquid boundary. Colleagues dubbed Kavokine the quantum plumber, and the research helped him land a tenure-track position at the Swiss Federal Institute of Technology in Lausanne in late 2024.

"Nikita is a very good example of what our interdisciplinary focus can achieve," says CCQ Director Antoine Georges. "He started as an experimentalist and then realized he needed to become a theorist to model these effects, and by partnering with other members of the center, we were able to help him master the computational and theoretical aspects, which are pretty involved, very quickly."

Moving forward into its second phase, the center will evolve its focus, Millis says. Plans include bridging materials science with seemingly disparate fields such as atomic, molecular and optical physics. The expertise of the group's new partners at Cornell University will also allow them to pursue custom-designed quantum materials through collaborations in which scientists use theory to predict new materials with desirable properties such as superconductivity.

"We're setting our sights on what's going to be most interesting going forward, and it's hard to feel anything other than optimistic about what we're likely to achieve," Millis says.

22 NEUROSCIENCE LABS TEAM UP TO MAP BEHAVIOR ACROSS ENTIRE MOUSE BRAIN

The size of an almond, the mouse brain contains around 70 million neurons, with tens of billions of connections between them. Needless to say, understanding what goes on there during the course of even the simplest behaviors is a daunting challenge.

Historically, neuroscientists studying how the animal brain encodes and executes behavior have tended to focus on the activity of a handful of neurons in just one or a few brain regions. Since then, scientists found that many different parts of the brain work together to enable animals to carry out everyday functions. A larger-scale approach was needed to truly understand how the brain drives what animals do.

Thus was born the International Brain Laboratory (IBL), a consortium of 22 independent academic labs across six countries. The IBL brings together theorists and experimentalists to work towards a common goal. The labs came together, beginning in 2017, to map activity across the entire mouse brain — that is, the electrical signals of thousands of neurons across each region of the brain — during a single behavioral task.

> "This was simply a problem that was beyond the scale of a single lab."
>
> **— Anne Churchland**

To make their idea reality, the neuroscientists approached the Simons Foundation, which led to a partnership between the Simons Collaboration on the Global Brain and the Wellcome Trust to support the IBL's formation and research.

"This was simply a problem that was beyond the scale of a single lab," says Anne Churchland, a professor at the University of California, Los Angeles and an IBL investigator. "At that time, nobody had ever funded a 22-lab collaboration. But we really believed this was a critical problem and that we had the right teams to do it."

"The Simons Foundation has been a thought leader in helping us to make this happen," says Hannah Bayer, executive director of the IBL. "They've championed the IBL as an idea and helped bring together other funders to create a coalition of support."

Two years ago, the team achieved their ambitious goal: They completed a map capturing neuronal activity from 267 brain regions, covering 95 percent of the mouse brain, during a single, standardized behavior. The map, shared openly on the IBL's website in 2023, was six years in the making.

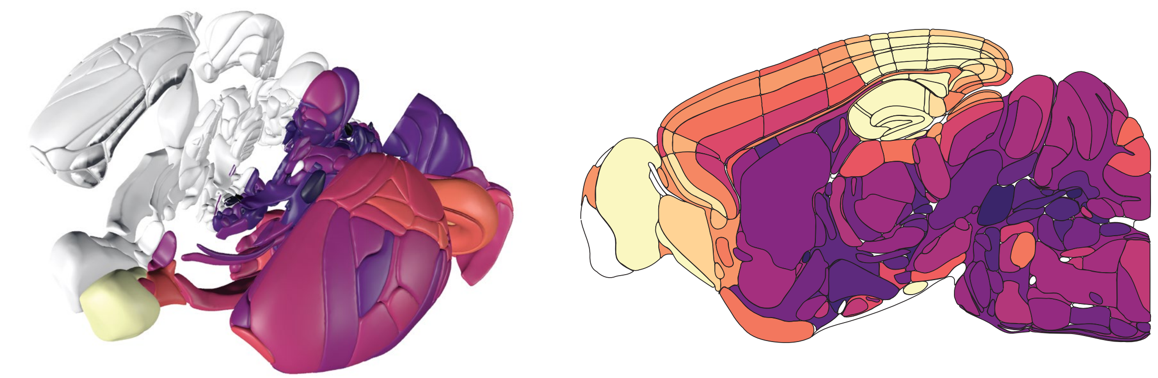
"That had never been done before," says Liam Paninski, a professor at Columbia University and an IBL investigator. "Just mapping that terra incognita was an important first goal."

The IBL's success was made possible by a ground-breaking neuron-recording technology known as Neuropixels probes, which were new on the scene in 2017. These superthin silicon probes can measure electrical activity from hundreds of neurons at once, in contrast to standard electrodes that measure only one cell's activity at a time. By using multiple Neuropixels probes in a single experiment and pooling data from multiple labs, neuroscientists can simultaneously capture the electrical spiking activity of thousands of neurons in the mouse brain.

"If we'd launched just two years earlier, the map would not have been possible," says Alexandre Pouget, a professor at the University of Geneva and an IBL investigator.

Yet even with the ability to probe so many neurons at the same time, mapping the entire mouse brain would require too many experiments for any one lab to handle. Large-scale neuroscience teams had been assembled before, but none had attempted the daunting task of capturing electrical recordings from the same animal behavior across multiple laboratory teams and institutions.

Establishing the reproducibility of the IBL's experimental setup, particularly the behavioral task, was a challenge many scientists thought would be impossible, Pouget says. The IBL teams needed to



Maps of neural activity in the mouse brain during a decision-making task created using data collected by the International Brain Laboratory. Lighter-colored regions denote higher activity. Using these data, neuroscientists are uncovering how brains make decisions. *Credit*: Dan Birman, Mayo Faulkner, Cyrille Rossant, International Brain Laboratory

establish reproducible animal behavior and recording setups across 12 different U.S. and European laboratories. Merely showing that this could be done and laying the groundwork for other teams to replicate their work was a major accomplishment.

The IBL teams used a behavioral task in which mice are trained to identify a simple visual cue on their left or right side and then turn a small tracking wheel to bring that image to the center of their vision. Once the IBL researchers designed protocols to establish faithful reproducibility in the animals performing that task, they next turned to the reproducibility of their electrical recordings. With the Neuropixels probes, the teams aimed to record from as many neurons as possible in individual animals performing the visual-cue-based task.

The resulting brain-wide map of neuronal electrical spikes during a single behavioral task comprises activity from nearly 300,000 neurons distributed across the mouse brain. As the researchers hypothesized at the start of the IBL project, performing the visual task appears to require coordinated activity from many different parts of the brain, even those that were not previously thought to be involved with decisions and motor control. Because the visual cue appears more often on one side or the other in the behavioral task, the animals learn to anticipate where it will occur. This means that the researchers can also study how the animals encode and call upon prior knowledge as they carry out the visual task. Brain signals related to this prior knowledge, too, seem to be more broadly distributed in the brain than scientists previously realized.

To make use of its vast troves of collected data, the IBL required considerable computational and software support to store and analyze it. Unique among academic collaborations, the IBL hosts a centralized technology core of dedicated software developers. The team of 12 engineers is responsible for much of the software engineering work that supports the IBL's experiments and allows the IBL to make all of its data publicly available for anyone to use. This technology core, led by Gaelle Chapuis and Olivier Winter, has proved so successful that the team plans to open its services to other academic neuroscience labs.

"There's a global trend where, more and more, we really need engineers to support science," Chapuis says. "Seeing this career path blooming for engineers and making a space for engineers in academia, this I find extremely exciting."

Several IBL investigators are themselves working on computational problems central and unique to neuroscience. The powerful tools and models they develop can transform a dataset of 300,000 neurons' raw activity into meaningful scientific information.

All computational tools developed through the IBL are openly available to facilitate other research teams' work.

"We've found the IBL dataset invaluable for understanding brain function and for testing out different tools and applying them to different sorts of problems," says Paninski, who runs a computational neuroscience lab. "Now the hope is that we can take what we've learned in this collaboration and apply it throughout systems neuroscience."

TURKANA BASIN INSTITUTE SIFTS THROUGH HUMANKIND'S ANCIENT PAST

Across the vast, open space of Africa's Turkana Basin stretches a scorching desert dotted with low scrub. Situated in northwestern Kenya, this remote area was a major highway and habitat used by the earliest human species. In the center of this landscape is Lake Turkana, a natural resting place for thirsty passersby — human and otherwise — for over 4 million years.

"It's one of the most beautifully remote parts of the world, and it's where much of the evidence of humankind first appears," says evolutionary biologist Dino J. Martins, director of the Turkana Basin Institute (TBI). "This evidence includes the fossils and stone tools that are preserved across the Turkana Basin, offering us a glimpse into the past." The unique land conditions there have preserved more of the human fossil record than anywhere else in the world. "Here there is a valley and ancient rivers and beaches that have fluctuated over time and created a perfect place for fossils to be locked away for millions of years," says Martins. "Until some-one comes along and says, 'That looks interesting, let's pick it up.'"

New York's Stony Brook University partnered with renowned paleoanthropologist Richard Leakey to establish the TBI in 2005 with support from the Simons Foundation and a goal of answering some of the big questions about the origins of apes, great apes and humans. The Simons Foundation has continued supporting the TBI in its quest to uncover clues about our distant past through evidence of early human evolution in northern Kenya. In 2019, the foundation announced a further five-year investment supporting the TBI's fieldwork, laboratory analysis of materials from the Turkana Basin, and collaborative outreach and research. "There's a lot of opportunity to scale our research," says Martins. "We want to do it in a way that encourages exchange and builds capacity in our next generation of researchers at all levels — locally, in Africa and around the world."

The TBI started as a single camp with rudimentary supplies but has grown into a full-fledged scientific operation with research and accommodation facilities on both sides of Lake Turkana. A once-inhospitable place for scientists now hosts facilities that support year-round research and educational activities.

A researcher examines a skull at the Turkana Basin Institute in Kenya. The area was home to early humans. *Credit*: Turkana Basin Institute

"Early on, we saw that when the students and scientists came together in the field, they would learn and discuss and collaborate in ways that reached beyond their normal interactions at conferences," says Lawrence Martin, who directed the institute from 2007 to 2024. Researchers would travel from around the world to the TBI and, after a day spent in the field, would share information and lively discussions over the dinner table, Martin says. "Building the infrastructure was the key to expanding the impact of this science."

Since the TBI's formation, its explorations have been brimming with breakthroughs and discoveries. To date, research in this part of Kenya has uncovered more than 10,000 mammal fossils relevant to our understanding of the human journey. In 2021, TBI researchers led by Louise Leakey came across two sets of fossil footprints along the shore of Lake Turkana. In a 2024 paper, Leakey and an international group of researchers reported that the fossils were created by two different ancestral human species roughly 1.5 million years ago. This is the first direct evidence that *Paranthropus boisei*, a cousin to humans, and *Homo erectus*, a possible direct ancestor of ours, existed at the same time and place.

> "We're looking at competing strategies between early human species and trying to understand why one ultimately outperformed another."
>
> **— Carrie Mongle**

Finding fossils that show evidence of past life in the Turkana Basin's terrain is challenging, and a long-term proposition. The hunt requires the right tools, patience, and endless sifting and seeking. The Simons Foundation's philosophy of support is well matched to the paleoanthropological long haul, says Carrie Mongle, an assistant professor of anthropology at Stony Brook who is affiliated with the TBI. This type of basic science funding — without an attached research outcome — expects nothing specific yet is critically important in this field of research. "It can be really difficult to get funding when you're just going out and looking for fossils," she says, "but that's how the discoveries happen."

Mongle identifies remnants of humankind's distant past by bringing fossils back to the lab. She looks beyond a fossil's surface, using non-destructive techniques such as computed tomography (CT) scanning and synchrotron imaging to examine the innards of hardened fossils. For example, a detailed snapshot of a tooth's enamel can reveal how quickly its owner was growing. Mongle uses such disparate information to piece together a better understanding of relationships between groups and how different species came together to form the human family tree. "Looking at and comparing these fossils is like an evolutionary experiment," Mongle says. "We're looking at competing strategies between early human species and trying to understand why one ultimately outperformed another."

In addition to expanding the fossil evidence available to science, the investment from the Simons Foundation amplifies the TBI's impact on the education of students and early-career researchers as they get hands-on field and lab experience.

One such researcher, Lmasantan Stephen Bulyar, grew up on the eastern side of Lake Turkana. After graduating from university in Kenya, he accepted an internship at the TBI that offered hands-on paleontological experience. He now works with Leakey and Mongle to describe and categorize fossils found not far from his childhood home. Bulyar earned a master's degree from the University of Cambridge in England in 2024 and now works full time back in Kenya with the TBI, uncovering clues about the region's ancient past. "It's such a special feeling coming across something that perhaps no one has seen for 2 million years," Bulyar says. "That's what makes human evolution so interesting, the possibility of a discovery that will change the whole story."

Although Kenya is a treasure trove of clues about early human evolution, participation by Kenyans in the research has historically been rare, Bulyar says. "The biggest challenge is that we don't have a lot of local people doing paleoanthropology and archaeology in Kenya," he says. With each fossil collected, Bulyar says, he's gratified to help piece together "a story that's millions of years old."

According to Martins, the original expeditions in the Turkana Basin area over 100 years ago wouldn't have been possible without the knowledge of local people and their expertise in the terrain. "The vision today is to do science in partnership with local people," Martins says. When a local community member goes into the field with researchers and learns about the science, he says, it's no longer a transactional relationship, as in days of old.

"The support from the Simons Foundation has been critical in allowing us to continually peel back this giant onion, layer by layer, of understanding human origins in Africa," Martins says. "It's about the science, of course, but the added dimension of local collaboration will always lead to better results."

FRANCE'S IHES PROVIDES A HAVEN FOR MATHEMATICS AND THEORETICAL PHYSICS

Attendees at a 2024 summer school in physics take notes during a presentation held in IHES's Marilyn and James Simons Conference Center. *Credit*: Chris Peus/IHES

Nestled in a 25-acre woodland outside Paris, the illustrious Institut des Hautes Études Scientifiques (IHES) offers idyllic spaces for mathematicians and theoretical physicists to work, dine and meet — all a short walk from their 60-apartment residence.

"It feels like a huge family, like a village where everyone knows each other," says mathematics postdoctoral fellow Dmitry Kubrak, who describes summers spending quality time with researchers and their families around the IHES-hosted accommodations. "It's a good environment psychologically to do hard research. You have better ideas when you're happier, and collaborations make mathematical research more fun and, I think, objectively more effective."

Enabling collaborations and hard, theoretical research is the cornerstone of IHES. The Simons Foundation has given the institute long-term support, including a $25 million pledge made in 2021 in partnership with Simons Foundation International. That gift, to be spread over 10 years, will support the private research institute's endowment and daily operations.

"IHES is a truly exceptional research center, with stellar faculty and exemplary leadership," says Yuri Tschinkel, executive vice president of the Mathematics & Physical Sciences division at the Simons Foundation. "We take great pride in the accomplishments of scientists at IHES and look forward to continuing our collaboration."

Founded in 1958 by French businessman Leon Motchane with the support of American physicist J. Robert Oppenheimer and inspired by the Institute for Advanced Study in Princeton, New Jersey, IHES is one of the most prestigious institutions in the world for mathematics and theoretical physics research. Among the 13 mathematicians hired as permanent faculty since the inception of IHES, eight have won Fields Medals and three have won Abel Prizes — the two highest distinctions in mathematics.

IHES currently comprises seven permanent faculty, seven affiliated faculty, two dozen postdocs and several graduate students. Every year, the institute hosts around 200 visiting researchers from over a dozen nationalities. Located within a few blocks of the elite Université Paris-Saclay, it offers a convenient home base for visitors traveling anywhere in Europe.

"There are not that many areas in the world where you have such a concentration and density of mathematicians as here in the Paris region," says IHES Director of Development Claire Lenz. "IHES has been called the CERN of mathematics and theoretical physics to indicate that it and other science hubs are important not just for one country but for all Europe. We bring in top scientists from the United States, Asia, Africa, Canada and so on."

The 1990s were an inflection point for IHES. The institute had welcomed its fourth director, Jean-Pierre Bourguignon, in 1994, and although it was thriving as a home for science, it was having trouble financing operations. Fortunately, IHES and Bourguignon had a close relationship with Jim and Marilyn Simons, who launched the Simons Foundation around that time. In the late '90s, the Simons Foundation made its first donation to IHES, and by 2003, IHES had inaugurated its auditorium, the Marilyn and James Simons Conference Center.

Researchers collaborate on a chalkboard at IHES. *Credit*: M.-C. Vergne/IHES

Between 1999 and 2020, the Simonses donated a total of $25 million to IHES through the Simons Foundation and Simons Foundation International, with Jim Simons joining IHES' board of directors in 2014. The new $25 million pledge followed in 2021. In 2022, Jim and Marilyn Simons kick-started a U.S.-based endowment with funds from Simons Foundation International, agreeing to match pledges up to $10 million. The challenge was met in December 2024, creating a $20 million endowment managed by the Friends of IHES, which Marilyn Simons now chairs. A second endowment fund in Europe, funded by the 2021 gift, has paid for an additional permanent faculty member, as well as a brand-new prestigious professorship for early-career faculty.

"This junior researcher position really gives you the possibility to fully explore your potential," says the first junior professor, mathematician Yilin Wang, who won the Salem Prize in 2024 for work connecting complex analysis, probability and mathematical physics. "With a tenure-track position, I would have had to take on students, teaching and committees and had much less time for research. I would have kept doing research I was already doing. At IHES, I'm free to explore new fields starting from zero. Since starting this position, I've really branched out in different research directions."

Like IHES' permanent faculty positions, the five-year junior professorships cannot be applied for. Instead, the faculty meets biannually to decide which researchers to invite for the jobs. Physicist Clément Delcamp, the other current junior professor, says that last year he "pretty much said yes on the spot" to the offer to work alongside the other physicists and mathematicians at IHES.

"I particularly enjoy being able to interact with mathematicians since, at many universities, the mathematics and physics departments are often disconnected," says Delcamp, who recently won a tenured position from the French National Center for Scientific Research, enabling him to stay indefinitely at IHES. "Having daily conversations makes it much easier to find common ground."

Besides the junior positions, the 2021 gift covered eight postdocs and four extended sabbaticals last year. It also supports visitors from Africa: In its first year, hundreds of people applied for a handful of visiting slots, as the gift covers travel expenses, which IHES is not usually able to offer.

> "The fewer boundaries we have, the more creative we can get. That's why this type of research institute should be protected." — **Yilin Wang**

"We want to be as universal as possible, as exchanging ideas coming from every direction is very positive for everyone," says IHES Director Emmanuel Ullmo, who has led the institute since 2013. "It's very difficult in some African countries to have access to mathematics. If we are not proactive, it would be very difficult to have a reasonable number of people coming from Africa."

That spirit of universality comes through in IHES outreach efforts as well. IHES posts dozens of lectures on its YouTube channel and hosts public conferences, annual programs on women in math, and free events such as film screenings and book readings. Bringing together researchers from different countries and backgrounds creates a certain serendipity, says Wang, with about 40 visitors eating together in the cozy dining hall on any given day.

"An advantage of IHES is that you can run into people randomly and can get a lot of help from all over the world," says Wang, who has won a prestigious 1.5-million-euro award from the European Research Council and a tenured position at ETH Zurich. "They're encouraging interdisciplinary research. The fewer boundaries we have, the more creative we can get. That's why this type of research institute should be protected."

ITALY'S ICTP IS A 'SECOND HOME' TO THE WORLD'S PHYSICISTS

In 1951, after Pakistani physicist Abdus Salam completed his doctorate at the University of Cambridge, he returned to his home country full of plans to establish a research institute in Lahore. Instead, the future Nobel laureate experienced intellectual isolation that eventually propelled him back to Europe, where he remained for most of his career. But he never forgot the plight of scientists from developing countries.

So, in 1964, when Salam founded a physics research institute in Trieste, Italy, he wove support for scientists from low- and middle-income countries into the institute's very fabric. Over the six decades since then, the Abdus Salam International Centre for Theoretical Physics (ICTP) has welcomed more than 180,000 scientists — including 3,000 from developing countries as ICTP associates. Each ICTP associate makes a series of visits to the institute over six years.

"Like every scientist, these researchers want to go where they can do the science best," says Ralf Kaiser, head of programs at ICTP. "At the same time, they have a strong motivation to give back to their communities in the countries they come from." The ICTP associates program aims to resolve this conflict by allowing researchers in developing countries to connect with an international community of scientists while still living and working primarily in their home countries.

"It's a unique program by its scope and outreach," says Greg Gabadadze, senior vice president of the Mathematics & Physical Sciences division at the Simons Foundation. The program is a two-way street, Gabadadze says. "It provides amazing opportunities to researchers whose home institutions might not be part of the mainstream, and it enriches ICTP by providing a broader community of very talented individuals."

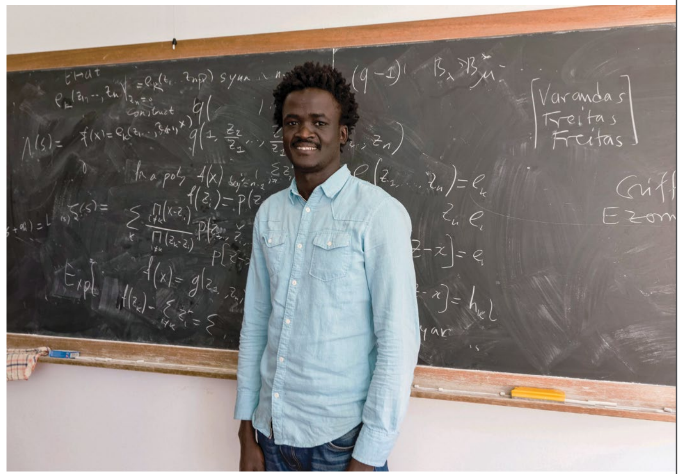
The program harmonizes with the foundation's goal of nurturing scientific talent around the globe. So, for the last decade, the foundation has provided funding for an additional set of ICTP associates known as Simons Associates. (The Simons Associates Program is now funded by Simons Foundation International, with grantmaking and administrative support from the Simons Foundation.)

Over the last 10 years, 71 Simons Associates from 20 countries have visited ICTP, conducting research that ranges from condensed matter physics to cosmology to pure mathematics. Simons Associates are among the most senior and distinguished ICTP associates. Many have gone on to win high-profile awards and invitations to deliver prestigious lectures, and their visits to ICTP have led to nearly 800 published papers.

In addition, the Simons Associates program offers researchers a unique benefit not part of the regular associates program: the opportunity to bring along a student from their home institution. Over the last decade, 60 students have visited ICTP in this way. These visits "create more connection between their institutions and ours," Kaiser says.

Forming Connections

For Meral Demirtas, a Simons Associate who studies the effects of climate change at regional scales, the annual visit to ICTP "makes me stay on track," she says. Her home institution, the recently founded Samsun University in northern Turkey, has few climate researchers. By contrast, the Earth System Physics section at ICTP runs a major regional climate model. "When I visit ICTP, I work almost day and night to make the best use of my time there," Demirtas says.



Simons Associate Khadim War. *Credit*: ICTP Photo Archives

On one visit, she met researchers running a framework called the Coordinated Regional Climate Downscaling Experiment, which evaluates the performance of regional climate models. Demirtas has now joined this project. Being a Simons Associate, she says, has "opened new avenues for me."

Demirtas is one of many Simons Associates whose visits to ICTP ease their academic isolation. At geometer Elizabeth Gasparim's home institution, the Catholic University of the North in Antofagasta, Chile, "the next geometer is a two-hour flight away," she says. ICTP is "another planet," says Gasparim, a Simons Associate from 2015 to 2020 and now an ICTP senior associate. At ICTP, she says, "there are so many geometers."

For the students who accompany Simons Associates to ICTP, visiting the institute can be a transformative experience. At many institutions, graduate students are kept at a distance from professors, says Khadim War, a Simons Associate originally from Senegal who is now a professor at the National Institute for Pure and Applied Mathematics in Rio de Janeiro. "In Senegal, we don't have a culture of socializing with students or bringing them to research talks," he says. By contrast, at ICTP, students are fully integrated into formal and informal scientific exchanges. "When students come, we are all the same," War says. "We all know each other, go to coffee together, go to lunch together."

The student visits "widen their horizons," says Prasenjit Ghosh, a computational materials scientist at the Indian Institute of Science Education and Research in Pune and a current Simons Associate. After his graduate student accompanied him to ICTP, "she was more enthusiastic and motivated to do research," he says.

At Home and Abroad

The connections Simons Associates make at ICTP carry over into their professional activities back home. While there, Ghosh met Narayan Adhikari, an ICTP associate and a physicist at Tribhuvan University in Kathmandu, Nepal. Now, the two jointly supervise one of Adhikari's graduate students.

Ten years ago, with the sponsorship of ICTP, Ghosh (then a regular ICTP associate) organized a two-week summer school in Pune on materials modeling. One hundred researchers and students, most of them from India, attended the workshop. Now, Ghosh is planning an even larger conference on electronic structure calculations for the summer of 2025.

Likewise, with encouragement and initial travel funding from ICTP, Gasparim — in collaboration with two other ICTP associates — has formed a network of physicists and geometers interested in various forms of symmetry. What started as a group of researchers at three South American universities has expanded to include mathematicians and physicists at 23 institutions in South America, Central America and Europe. The researchers exchange students and hold seminars and conferences.

The Adriatico Guesthouse in Trieste, Italy. The building houses visitors to ICTP. *Credit*: ICTP

When Simons Associates are at ICTP, many of their most fruitful interactions unfold not in the center's main building but in the beautiful Adriatico Guesthouse, which the center has rented for nearly 40 years to house visitors. Now, in what Kaiser calls "a game changer for our institute," Simons Foundation International is providing funds to build a modern science complex. The Adriatico would be a natural destination for such a complex, and the framework and details for acquiring and renovating the building are close to finalization.

The new science complex will reduce ICTP's operating costs and provide the institute with residential facilities, conference rooms, computer labs and modern offices for the more than 6,000 scientists who visit the Trieste campus each year.

The purchase is "a logical and exciting step for the entire community," Gabadadze says. "The Adriatico Guesthouse is an iconic place in Trieste that has been serving ICTP visitors for decades."

The Adriatico is "the best place to stay, anywhere," Gasparim says. "More of my collaborations have originated there than in the main building. You start discussing science over dinner, and then it's 2:30 in the morning, and you're still discussing." Sitting on the Adriatico's patio watching the sunset over the Adriatic Sea and talking science, she says, "it doesn't feel like you're working."

SCOTTISH NEUROSCIENCE INITIATIVE TAKES BASIC SCIENCE FROM LAB TO CLINIC

Science can often happen in silos, with researchers limited to the equipment and expertise of their individual labs. But for scientists involved in the University of Edinburgh's Simons Initiative for the Developing Brain (SIDB), labs tend to operate with open-door policies. Everyone shares tools and ideas, and there's no territorialism around who technically owns this microscope or that dataset.

"It makes no difference to us," says SIDB Director Peter Kind. "Anybody can come and use each other's equipment and pick each other's brains. We have found that this sort of ethos has made everybody better scientists."

SIDB has operated with this spirit of collaboration since its founding in 2017. It is currently a virtual center, meaning that its 40-plus labs are all in Edinburgh but distributed among various research sites. As one of only two research centers funded by the Simons Foundation Autism Research Initiative (SFARI), SIDB aims to discover biological mechanisms underlying autism and related neurodevelopmental disorders and to use that information to deliver therapeutic interventions. SIDB receives additional funding from Simons Foundation International.

Jim Simons was intrigued by the work already happening at the university, which he visited when receiving an honorary degree in 2016. When he returned to New York, he reported what he had witnessed to the SFARI team, who saw the creation of SIDB as a unique opportunity to support a highly collaborative environment that brought together basic, translational and clinical autism researchers.

"The number of mysteries in neurodevelopmental disorders is very large, and you never know where the next breakthrough is going to come from," says SIDB Co-Director Adrian Bird. "It could be from molecular, cellular, circuit or patient studies. SIDB aims to integrate these approaches to cover a wide breadth."

The initiative's commitment to basic research led to a promising therapeutic for Rett syndrome, a rare developmental disorder with similarities to autism that leads to loss of motor skills and language. Rett syndrome is caused by a mutation in the gene MECP2, and studies from Bird's lab demonstrated that advanced Rett-like symptoms in mice can be alleviated by introducing a functional MECP2 gene. Scientists have theorized that there could be 'critical periods' in which the brain is particularly plastic and potentially more responsive to therapies, but this work challenged that notion, suggesting that the brain may remain moldable for longer than expected.

"That result was totally unexpected because [neurodevelopmental] brain disorders have largely been regarded as irrevocable," says Bird. "It was thought that it would be too late if you administered a therapy later on in brain development, but we showed that's not true."

Based on this finding, fellow SIDB member Stuart Cobb, in partnership with the biotechnology company Neurogene (where he serves as chief scientific officer), developed a gene therapy for Rett syndrome. Low doses of this therapy have shown promising results in an ongoing clinical trial. One participant in the high-dose section of the trial died after experiencing an extremely rare, deadly reaction to the viral vehicle used to administer the therapy (called adeno-associated virus, or AAV). The high-dose branch of the trial was discontinued. The low-dose branch, which uses less AAV and therefore has a lower risk of complications, is ongoing.

"The seminal work on animal models of Rett syndrome done by Adrian and colleagues led the way for this gene therapy, which has the potential to address the underlying cause of the disease," says Cobb. "This includes relief of symptoms and gain of developmental milestones that Rett syndrome patients do not usually achieve."

People with neurodevelopmental conditions often have some level of sensory dysfunction. SIDB member Nathalie Rochefort studies the brain circuitry underlying visual processing dysfunction in individuals with mutations in the gene SYNGAP1.

Those with SYNGAP1 mutations can experience epilepsy, developmental delays, movement disorders and autism. Rochefort's group studies mice with and without the SYNGAP1 gene mutation.

"We use special imaging techniques to track the activity of hundreds of neurons in a mouse's brain while it watches different visual stimuli on a TV screen," she says. "What's interesting is that we find that our SYNGAP mice do not perceive the world as reliably as mice without the mutation."

For example, SYNGAP1 mice need more repetition of the images to master visual discrimination tasks, Rochefort says. Whereas a control mouse can easily tell when one image is tilted by, say, 20 degrees, it's not always clear to a SYNGAP1 mouse.

Further research revealed that these visual discrimination tasks are regulated by a mouse's behavioral state (like arousal or motor activity), and that this is determined by neuromodulators — chemicals secreted by the brain that influence how our neurons work. Guanfacine, a drug used to treat attention-deficit/hyperactivity disorder (ADHD) that acts on certain cell receptors to stifle the effects of the neuromodulator norepinephrine, emerged as a promising candidate for therapeutic intervention. Notably, there are many shared symptoms between those with ADHD and people with SYNGAP1-related disorders.

A graphic representing the Habitat, a house of interconnected rooms that rats can move freely between. The setup helped researchers study how rats socialize. *Credit*: Peter Kind Lab

"Guanfacine is an ADHD drug that is already approved in the U.S. for individuals diagnosed with a SYNGAP1-related disorder, but that hasn't been approved for that purpose in the U.K. yet," says Rochefort. "We are working on getting a clinical trial going based on our data with the help of Andrew Stanfield [a psychiatrist and SIDB member] and his team."

Rochefort is optimistic that we will see more instances in which basic science influences treatments in the future.

"I do think that we are at a critical moment where basic research is informing therapeutic approaches for neurodevelopmental and psychiatric disorders," says Rochefort. "Having a focused initiative like SIDB that promotes basic research is important to lay the foundation for these advances."

A hallmark of autism and related neurodevelopmental conditions is their effect on social behavior. Much of the work to understand this effect has been done in rodents living in small groups in small cages, a setup that provides only a limited understanding of how rodents would socialize with each other naturally.

"We know that even though animals like rats can live in colonies of up to a hundred, they will still form smaller peer groups," says Kind. "There's a lot of discussion about what is the correct number of animals to use when studying socialization. As scientists, we've kind of been guessing at that number. But now, we want the rats to tell us, not us to tell the rats."

Kind and his team built a system for figuring out how rats socialize: a 16-room rat house called the Habitat that includes multiple levels and ways of traveling between rooms. In the Habitat, rats are free to roam, hang out, form cliques, have offspring — just as they would in the wild. The only difference is that the rats' living conditions resemble those on the MTV show *The Real World*, with Kind's team tracking their every move via cameras that run 24/7. Kind's team is collaborating with computer scientists on machine learning software that can analyze this footage, and they aim to draw conclusions about the rats' behavior across long timescales.

"We can ask questions like 'Are these animals always interacting with each other? Who is grooming who? Is that genotype-dependent?'" Kind says. "These are questions about socialization that we couldn't ask before."

FINANCIALS

BALANCE SHEET

(Unaudited, accrual basis, in $)

ASSETS	As of 12/31/24	As of 12/31/23
Cash and Cash Equivalents	156,411,509	274,883,375
Investments	3,817,442,067	3,795,834,849
Property and Equipment, Net	361,165,471	363,047,201
Right-of-Use Lease Assets	121,709,281	126,142,182
Deposits and Other Assets	26,340,140	28,576,868
Total Assets	**4,483,068,468**	**4,588,484,475**

LIABILITIES		
Accounts Payable and Accrued Expenses	26,801,722	25,126,633
Grants Payable, Net	368,844,886	527,390,970
Mortgage and Lease Liabilities	356,837,218	356,893,479
Deferred Excise Tax Liability	12,344,287	12,344,287
Total	**764,828,113**	**921,755,369**
NET ASSETS		
Beginning Net Assets	3,666,729,106	4,015,461,927
Current Year Change in Net Assets	51,511,249	−348,732,821
Total	**3,718,240,355**	**3,666,729,106**
Total Liabilities and Net Assets	**4,483,068,468**	**4,588,484,475**

INCOME STATEMENT

(Unaudited, accrual basis, in $)

REVENUE	For the Year Ended 12/31/24	For the Year Ended 12/31/23
Investment Income	401,965,762	186,300,900
Interest Income	8,981,373	40,883,890
Rental Income	2,746,524	3,336,692
Other Program Income	−105,782	969,440
Total	**413,587,877**	**231,490,922**

EXPENSES		
Program	303,863,120	510,760,842
Management and General	58,213,508	69,462,901
Total	**362,076,628**	**580,223,743**
Change in Net Assets	**51,511,249**	**−348,732,821**

SIMONS FOUNDATION BOARD OF TRUSTEES

GRANTEES AND STAFF

In 2024, the Simons Foundation supported the work of thousands of mathematicians and scientists in New York City, across the United States and around the world.

For lists of our grantees, staff and advisory boards, please visit **simonsfoundation.org/report2024/people** or scan the QR code below.

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