2024 ANNUAL REPORT

SFI

Simons Foundation International (SFI) is a philanthropy whose mission is to advance the frontiers of research in mathematics and the basic sciences. SFI makes grants primarily to scientific institutions, providing general support.

ADDITIONAL PHOTO CREDITS:

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GIVING IN BERMUDA

Photo by: Michael Lisnet

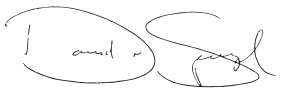
LETTER FROM THE PRESIDENT

The motto of Bermuda, *Quo Fata Ferunt*, which translates to 'Whither the Fates Carry Us,' reflects the island's history of resilience and adaptability. The island was first colonized in 1609 when a storm tossed sailors and travelers aboard the *Sea Venture*, the flagship of a London Company flotilla bound for the Jamestown Colony in Virginia, onto the reef. Those first Bermudians persevered, established St. George and began their new lives. Throughout its history, Bermuda has endured numerous challenges, including natural disasters and economic upheaval. Despite these hardships, the island has thrived, largely due to its ability to adapt to changing circumstances, whether in maritime trade, agriculture or tourism. The motto thus symbolizes Bermuda's determined spirit in overcoming adversity, carrying the island forward through time.

The theme for this inaugural public annual report of the Simons Foundation International, 'Where May Science Lead Us?' reflects the deep belief of its two first chairs, Jim and Marilyn Simons, in the power of basic science. They believed that investments in mathematics and basic science are investments in the future of humanity. As with the discovery of Bermuda, serendipity plays an important role in science. When scientists explore questions motivated by their curiosity, the journey can be a tumultuous one filled with surprises and many challenges. Nature does not always yield its secrets easily.

Simons Foundation International provides researchers and their institutions with the sustained support that enables them to take on fundamental problems and to strive for translational results. Like the journey of the *Sea Venture*, scientific exploration can yield novel insights, moments of deep beauty and great opportunities.

You can read about some of the recent successes of our many grant recipients in the pages that follow. I hope that you will be inspired by their work and by their journeys.



David Spergel

Photo by: Brian Fraser

LETTER FROM THE CHAIR

It has been both inspiring and gratifying to see Simons Foundation International (SFI) expand its efforts in supporting basic science research over the past decade because we know the power of fundamental research in fueling technological progress. At SFI, we have confidence in the ability of science to advance society and solve myriad confounding theoretical questions and problems. SFI takes a long-term view in its support of basic science and its potential for impact.

As my husband Jim Simons, the first Chair of the Board for SFI, once said to a graduating class at York University: Basic scientists try to understand the world about them without necessarily thinking to use that knowledge [for] immediate applications. ... Newton invented calculus to better understand planetary dynamics but couldn't imagine that calculus would underpin all of engineering. Darwin, too, didn't know that his discovery of evolution would underpin all of biology, and ultimately most of medicine. ... 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.

True to its mission, SFI bases funding decisions on the potential for answering tough questions that will elucidate fundamental scientific and mathematical problems. It's always interesting to consider how such knowledge might have an impact. Will it bring a deeper understanding? Will an insight reprioritize the questions to be addressed? Will a new interpretation change the direction of research? With this in mind, our theme for this year's annual report is *Where may science lead us?*

I hope you enjoy reading about the work of SFI and about the visionary behind the foundation, Jim Simons, in the pages that follow. While the fields of scientific inquiry supported by SFI vary, they share an underlying similarity: to fulfill Jim's vision to push the frontiers of knowledge by asking big questions.

In closing, I would like to add a personal reflection on Bermuda. Over the years, Jim and I made many wonderful trips to this lovely island. My most memorable trip, however, was my first visit as a young girl of 12. I still have vivid recollections of that family vacation: shopping with my mother in Hamilton; walking up the lighthouse steps; listening to miscellaneous facts about the agriculture products and the many Portuguese farmers; and being astounded at seeing the fish there in the water with me! Bermuda is a beautiful country that embodies tradition and values progress. With its crystal-clear waters and pink sand beaches, it is pristine and remote, yet also contemporary and forward-thinking. SFI is pleased to be based in Bermuda and will continue to endeavor to be a supportive member of its community.

Marilyn Simons

REMEMBERING JIM SIMONS

For his many accomplishments, James H. Simons, the late chair of the Board of Simons Foundation International (SFI), will always be remembered as a mathematical genius and a financial wizard. But to acknowledge his spirit, it might be better to think of him as an adventurer, someone who defied conventions and pushed at boundaries. As a college student on break, he and friends hopped moving freight trains and rode the rails on a lark. His contributions to geometry and topology advanced quantum field theory and string theory. He worked as a codebreaker for the U.S. government until he was fired for speaking out against the Vietnam War. At age 30, he became the chair of the Stony Brook University mathematics department. He pioneered the use of advanced quantitative trading modeling in finance, leading to the extraordinary successes of the management firm Renaissance Technologies and its legendary Medallion Fund. And in his philanthropy, he funded extraordinary research

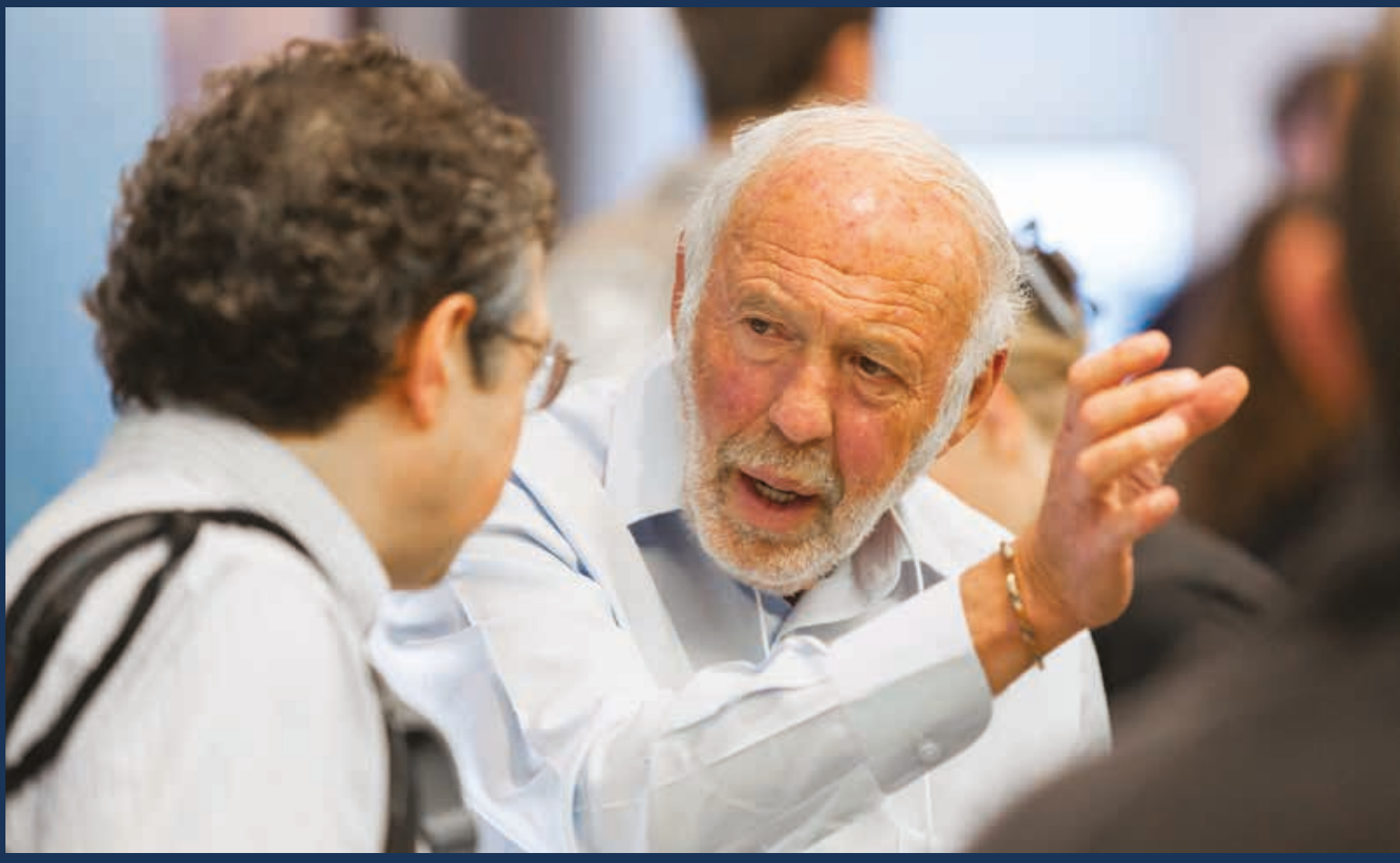


Photo courtesy of Simons Foundation

Photo by: Michael Lisnet

Photo courtesy of the Simons Family

projects in the fundamental sciences while also revolutionizing the understanding of the genetics of autism. His passing in 2024 at age 86 was a colossal loss to all who knew him.

Jim often said that one of the key principles of his life was "Be guided by beauty." With his twin tendencies toward adventure and beauty, perhaps it was inevitable that Bermuda would become the home to SFI today.

"Everybody knows Jim was highly intelligent, and a person who sometimes had limited patience with those who weren't on his wavelength—which meant most of us," recalls Jan Spiering, a director of SFI who knew Jim for more than four decades. "But even when Jim was a complete outsider to a field, people always respected what he brought to discussions and his ability to ask tough, insightful questions. He had this abiding curiosity about everything."

In the early days of SFI, Jim asked Jan to suggest projects to support, and Jan immediately thought of the scientific work of Bermuda Institute of Ocean Sciences (BIOS). "I think Jim was surprised at the internationally respected level of research going on in Bermuda," Jan says. Indeed, Jim was so excited by the work at BIOS that he agreed to fund an autonomous underwater vehicle, or 'glider,' for collecting microbial life and data on ocean conditions.

Jan also introduced Jim to the Bermuda-based group Tomorrow's Voices, which provides a kind of social support for autism quite different from the gene analysis and data gathering that Jim's philanthropy was supporting in the U.S. "We are conscious that we are a Bermudian foundation, and we want to give back to the community," Jan says.

SFI's contributions to scientific and mathematical progress and to the welfare of Bermuda's people have only expanded since then. Although Jim is gone now, Jan and the entire Board and staff of SFI are committed to carrying on Jim's remarkable determination to explore the frontiers of human knowledge.

BIOS-SCOPE UNCOVERS HOW MARINE MICROBES NURTURE THE PLANET

The zooplankton that marine ecologists Amy Maas and Leo Blanco-Bercial study are barely a centimeter across. Yet compared to the microbes that concern most of their colleagues in the BIOS-SCOPE (Bermuda Institute of Ocean Sciences–Simons Collaboration on Ocean Processes and Ecology) program, those tiny organisms are downright massive. When the two researchers first joined the team, they felt rather like misfits, Maas recalls.

BIOS-SCOPE team aboard the RV *Atlantic Explorer.*

Researchers gather samples in the Sargasso Sea.

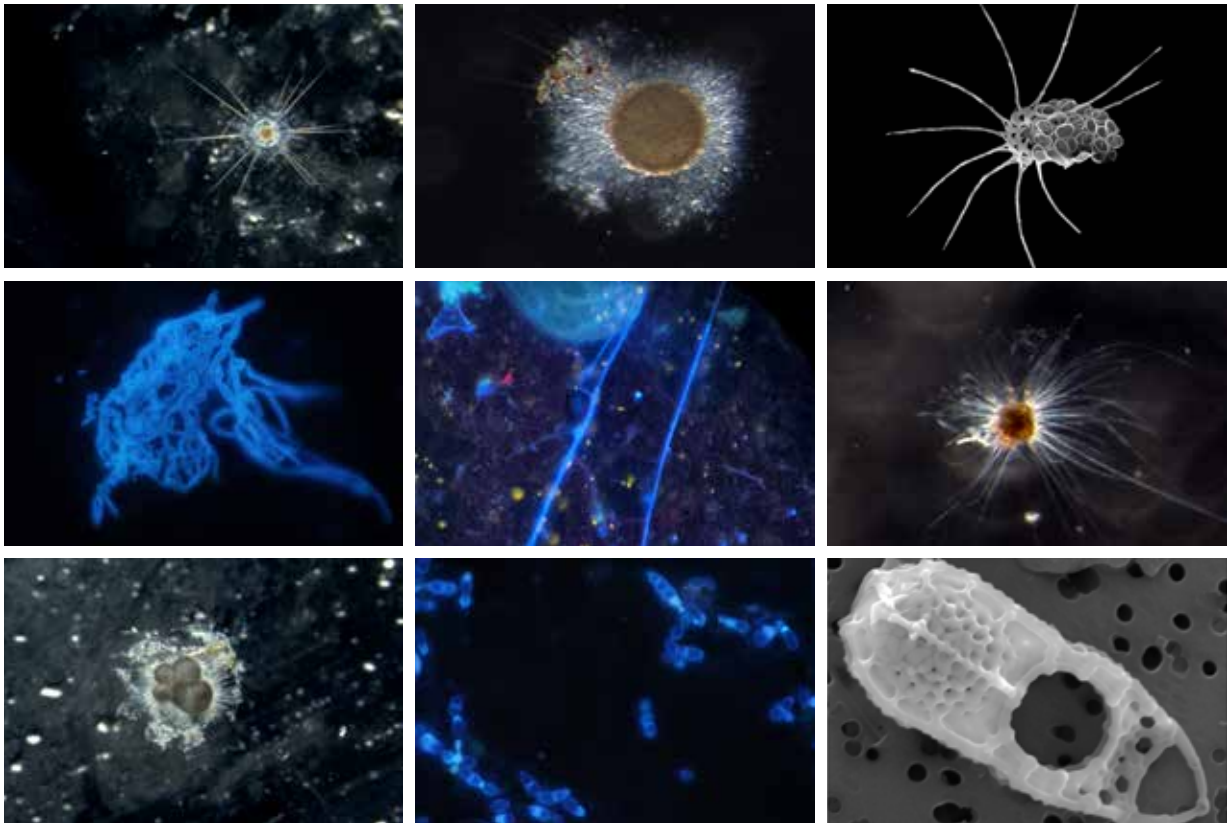
For the past 10 years, since funding from Simons Foundation International (SFI) helped establish BIOS-SCOPE, this group of scientists from Bermuda, Europe, the U.K. and the U.S. has annually embarked on a dedicated research cruise aboard the RV *Atlantic Explorer* to a well-studied region of the Sargasso called the Bermuda Atlantic Time-series Study site. There, they collect samples and take measurements from various depths, seeking to understand how the teeming microscopic life in the seas shapes the vast chemical cycles that move nutrients and other essential molecules throughout the biosphere and sustain all life on Earth.

From the outset, Maas and Blanco-Bercial were adamant that as the big zooplankton migrate up and down through the water column, responding to the sun and daily cycles of food production by photosynthetic algae, they must influence the flow of carbon through the seas. Zooplankton, however, are less abundant in the ocean than the dense clouds of other microbes are. Sampling them is also consequently much more laborious because it involves towing a net up to hundreds of meters long.

Initially, other scientists on the team were skeptical and questioned whether these little creatures were "too scarce to really matter," as Maas and Blanco-Bercial put it. But after about three years of accumulating evidence, they came around. Maas recalls one of the senior scientists admitting over dinner after one of the cruises that she and Blanco-Bercial were indeed fleshing out an interesting detail of carbon cycling.

"BIOS-SCOPE, very broadly, is trying to understand how carbon in the surface ocean exchanges with carbon at greater depths and then how all of that together affects the global carbon cycle," said Elizabeth Kujawinski, a senior scientist at the Woods Hole Oceanographic Institute who has worked as an investigator for BIOS-SCOPE since its founding in 2015. In 2024, she received the prestigious G. Evelyn Hutchinson Award for scientists in limnology or oceanography who have made "considerable contributions to knowledge and whose future work promises a continued legacy of scientific excellence."

Kujawinski likens the global carbon cycle to international trade, in which countries exchanging raw materials and processed goods collectively drive the global economy. Earth's oceans hold about 30 percent of the carbon dioxide in the world, and it moves through a constant, vibrant exchange known as the global carbon cycle. But what are the equivalents of those raw materials, products, and rules governing the trade relationships in ocean exchange?



A menagerie of zooplankton collected by BIOS-SCOPE.

The Sargasso Sea, with its predictable seasonal mixing patterns, provides the perfect testing ground for scientists to find out. In 2024, the cruise set sail in March, when the waters of the Sargasso were in the throes of their shift from winter mixing to summer stratification.

Many of those on board were curious about what happens to the fragments of animal body parts, droppings and vegetation that rain down through the ocean as variously sized particles. As these particles sink from the surface into the ocean twilight zone called the mesopelagic, 200 to 1,000 meters deep, they degrade and get smaller. But how much of that lost material is lost from organisms eating the particles? How much dissolves into the ocean water? And which parts disappear first? BIOS-SCOPE aims to understand the role of microorganisms in those changes.

Kujawinski and others are still parsing the data collected in spring 2024, but other recent work spearheaded by Stephen Giovannoni, an SFI-supported microbiologist at Oregon State University, illustrates how well the cross-disciplinary collaboration can address these questions.

Previously, BIOS-SCOPE researchers had observed that a set of microorganisms deep in the water column seemed to respond to the arrival of a certain group of tough organic compounds—such as humic acid, lignin and benzoic acid that surface organisms can't consume—after seasonal mixing events. Giovannoni and his lab took one such

microorganism, called SAR 202, and identified which of its enzymes conferred this ability.

When Craig Carlson, then the scientific director of BIOS-SCOPE, and Shuting Liu, a postdoc in Carlson's microbial oceanography lab at the University of California, Santa Barbara, put these hard-to-digest organic compounds into seawater cultures with SAR 202 bacteria, the strains equipped to digest them flourished. Carlson, who was named the new director of BIOS early in 2025, hailed it as a "full circle" collaboration: "Observation to lab work, to computer work, to in silico work, to back into the field and doing experiments," he said.

This kind of interdisciplinary approach is the beating heart of BIOS-SCOPE, and although it's not unique to the project, it is the key to its vast potential. "It's that specialization but also cross-fertilization that's just so powerful," said Maas. "Everybody on this team is pushing the extreme edge of our technological capabilities for measurement in the ocean."

That cutting-edge technology also opens up new questions. A new Flow Cam that Maas and Blanco-Bercial took into the field for the first time in 2024 offered a novel way to grasp the changes that small zooplankton undergo as they sink. Until now, Blanco-Bercial said, there has been a "big gap" in measurement for the changes in midsize organisms. "We know that these cells die, and these animals poop, and then all that material is sinking and getting transformed," he explained, but the particles were too small for conventional underwater cameras to monitor them and too big to observe usefully under a microscope.

Grasping what happens to these mid-size particles at this mid-water level is crucial, Maas stressed: Knowing how much carbon cycles between the ocean and atmosphere and how much is sequestered in particles that become seafloor sediments is key to calculating global carbon budgets. Those calculations in turn depend not only on how much photosynthesis is happening but also on how much grazing and sinking by zooplankton occurs. "It all depends on life in the midwater," she said.

Kujawinski also brought new methods to sea in 2024, allowing her lab to track changes in seawater with finer precision. For the first time, she deployed three methods adapted from the biomedical sciences for tagging molecules. They allowed her lab to measure low-concentration molecules that are ordinarily difficult to extract from seawater samples. Those technical improvements, she hopes, will lead to a better understanding of how long a molecule survives in the ocean before it's taken up by some chemical process.

Getting more accurate estimates, particularly for carbon, is increasingly urgent in the face of anthropogenic climate change. As human activity continues to pump more carbon dioxide into the atmosphere, seawater could become warmer and more acidic, disrupting how long essential nutrients persist in different parts of the ocean. The consequences of that for all life, both above and below the sea, could be grave.

Or in Maas' words, "If you want to fiddle with the knobs controlling the ocean, you really have to know what the knobs do first." ▬

> **"EVERYBODY ON THIS TEAM IS PUSHING THE EXTREME EDGE OF OUR TECHNOLOGICAL CAPABILITIES FOR MEASUREMENT IN THE OCEAN."**
>
> **Amy Maas, marine ecologist, BIOS-SCOPE**

SPARK EMPOWERS AUTISM RESEARCH FOR ALL

LaVell Juricich spent half a century fighting a war with herself and losing. Despite learning in elementary school that she had a high IQ, many of life's basic tasks were challenging for her. Getting to work on time, keeping a house clean, doing homework and deciphering the rules of social interaction felt monumental. As a kid, she was bullied; as a college student, she learned to fit in but couldn't keep her grades up. Every failure reinforced a nagging belief that something was wrong with her. She ended each day feeling spent from just trying to do what came naturally for others.

Then, at age 50, she was diagnosed with autism and everything changed. Suddenly, her struggle had a name and her exhaustion a reason. For the first time, she felt she had permission to be herself. “I feel like my whole life was a paint-by-numbers that I was trying to understand, and [the diagnosis] gave me all the colors,” she said.

Almost immediately, she enrolled in SPARK (Simons Foundation Powering Autism Research for Knowledge), the world’s largest research study aimed at understanding the full complexity of autism. She was drawn to the study’s genetic program and its potential to change people’s lives. “I just loved that they were doing genetic testing and getting help for people when they needed it,” she says.

As she pored through the resources SPARK offered and read everything she could about people like her, she felt lighter. She began to appreciate her strengths and embrace her differences. She could recognize her unusual ideas as being creative and her sensitivity as an advantage. “SPARK gave me the colors to fill in what my picture looked like,” she said. “I re-lived my life in my mind through a different filter, and it is amazing.”

Although scientists have spent decades studying children on the spectrum, millions of adults like Juricich have largely slipped through the cracks. Not only was autism traditionally diagnosed in children, but it was also diagnosed four times as often in boys, and most of the participants in autism

research studies were male and white—biases that left significant gaps in our understanding of how autism manifests in girls, adults and people of different racial and ethnic backgrounds. For that reason, one of SPARK's primary goals in 2024 was to expand recruitment.

> **"WE NEED PEOPLE FROM ALL PARTS OF THE AUTISM POPULATION IF WE WANT TO HAVE A COMPREHENSIVE VIEW THAT IS NOT BIASED."**
>
> **Pam Feliciano, scientific director, SPARK**

SPARK was launched in 2016 by the Simons Foundation. In 2024, participant-facing activities of the SPARK study moved from New York to Boston, and Simons Foundation International (SFI) began supporting SPARK with a grant to Boston Children's Hospital. SPARK has enrolled more than 390,000 participants, including 162,000 people with autism spectrum disorder (ASD) and their first-degree family members. Of that cohort with ASD, almost 33,000 are adults.

SPARK collects medical, behavioral and genetic information from individuals with autism and their families across the U.S. The inclusion of family members allows SPARK researchers to look for spontaneous new genetic mutations that contribute to ASD. It also enables them to see weaker genetic associations through recessive genes, which only reveal their effects when inherited from both parents.

SPARK enrolls qualifying individuals of all ages because understanding how autism manifests and evolves throughout a person's lifetime remains one of the most significant gaps in the research. Feliciano says that adults with autism are "grossly understudied," especially those who have intellectual disabilities.

Because the autism diagnosis was not coined until the 1940s, we're only now seeing the first generation of diagnosed individuals with autism entering their senior years. That demographic shift presents both an opportunity and a challenge for the healthcare system, according to Wendy Chung, chief of the Department of Pediatrics of Boston Children's Hospital and principal investigator of SPARK. Chung is especially interested in better understanding how autism evolves over the course of a person's life. Knowing this, she says, will help clinicians support patients as they age. "We hope to get better at predicting the trajectories of autism," she says. "We want to get better at bending the curve" toward desirable outcomes.

Those outcomes could extend to conditions beyond autism itself. In 2024, by studying some members of the SPARK community, scientists were able to publish landmark research on Parkinsonism—a constellation of neurological symptoms that includes tremors, slowed movement, muscle rigidity and balance problems—in adults with autism. The study tracked roughly 400 autistic adults, ages 40 to 83, and compared the quality of life and management of everyday tasks between those who showed signs of Parkinsonism and those who didn't. The autistic adults with movement problems had a much harder time overall, reporting more trouble with memory, poor sleep and greater depression.

Moreover, research using SPARK data has identified specific genetic conditions associated with Parkinsonism and autism, and has shown that people at risk are likely to show telltale signs in adolescence, which may offer an opportunity to detect the symptoms early and prescribe effective medications. Understanding and identifying Parkinsonism sooner could get treatments to autistic patients earlier in the disease and prevent debilitating symptoms.

Researchers sequence DNA samples, seeking genetic clues to autism.

SPARK has similarly helped to identify a variety of other challenges faced by groups traditionally underrepresented in autism studies. In 2024 alone, papers made possible by SPARK's outreach and enrollment efforts explored mental health and well-being in autistic adults, sensory sensitivities in autistic girls and women, problems with late diagnoses for Black autistic youths, differences in diagnosis based on gender identity, and inconsistencies between racial and ethnic groups in their use of autism support services, among other issues.

The massive size of the SPARK cohort and its ability to recruit new participants—18,000 more in 2024 alone—uniquely positions the project to address these challenges. Chung is especially interested in screening, early detection, and someday finding effective support systems for people with ASD. "This is about learning what to recognize and getting the right thing to the right person at the right time," she says. "That is why we strive for large and diverse sample sizes in our studies."

SPARK also made a significant technological leap in 2024. Previously, when SPARK researchers analyzed DNA samples from participants, they focused on sequencing only the scattered sequences in the chromosomes that encode information for making proteins, a mere two percent of the genome. Now, because of technological improvements in "whole-genome sequencing," it is practical to look at all the non-coding DNA too, which contains some crucial regulatory sequences. Research funded by SFI has already linked some mutations in this genomic "dark matter" to neurodevelopmental disorders, and further work on it will likely reveal new genetic pathways and risk factors for autism and other conditions.

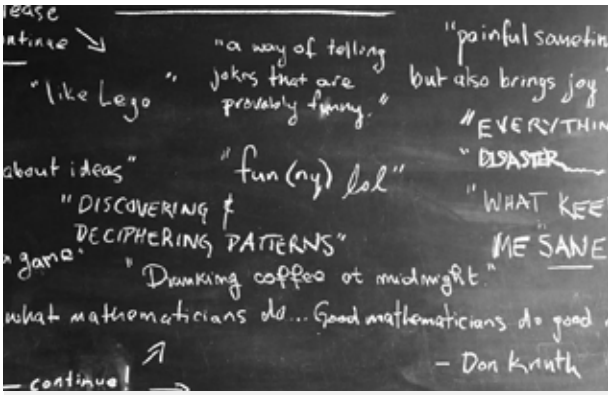
Studies like these are why Juricich jumped at the chance to join SPARK. "It just blows my mind to see how many advances are going through because of SPARK," she says. "They're giving support to autistic people and their families, but they're also making the world a better place that we can fit into." ▬

ENCOURAGING CREATIVE PARTNERSHIPS IN MATHEMATICS

The road to mathematical excellence can be lonely. The scholars of the Simons Laufer Mathematical Institute (SLMath) know better than most how true that may be—literally so, considering how its facilities sit atop a distant hill, a little north of University of California, Berkeley. For more than 40 years, some of the brightest mathematicians from across generations and the globe have chosen to climb that hill to become part of the creative, passionate community that is SLMath.

Established in 1982 as the Mathematical Sciences Research Institute, SLMath brings together established and upcoming researchers in mathematical sciences. Each year, much like a university, it organizes topic-focused programs and seminars over three semesters, including public outreach events and workshops open to non-member scholars. Sessions feature vibrant discussions among scholars specializing in every niche of mathematics imaginable, and those exchanges have frequently led to collaborations extending far beyond the program.

For decades, the Simons Laufer Mathematical Institute has been building lasting, meaningful connections across generations of mathematicians. Credit: SLMath



SLMath scholars share their answers to the prompt, "Math is..." during a session with Siobhan Roberts, journalist-in-residence at SLMath during the second half of 2024. Credit: Siobhan Roberts

SLMath is primarily a place of learning but also a place for scholars to bounce ideas off one another and to cultivate a taste for interdisciplinary mathematics. Younger mentees often return years later as team leaders and program organizers—including the current director, Tatiana Toro, whose first contact with SLMath was in the 1980s. Much has changed since then, but the essence of what the institute sets out to do has remained the same, Toro says.

In 2024, with help from Simons Foundation International and other private and public sponsors, SLMath celebrated another successful year of building meaningful, lasting relationships under the umbrella of mathematical science.

During fall 2024, Riccardo Caniato, an Italian analyst and postdoctoral researcher at the California Institute of Technology, took part in SLMath's Special Geometric Structures and Analysis group. Caniato's interests lay in the enigmatic manifolds of geometric analysis—a field that pulls together numerous disciplines across geometry and mathematical physics. Studies of the curvatures of multidimensional manifolds can deepen understanding of phenomena such as gravity and electromagnetic interactions.

"The idea for the program was to have all the different aspects of geometry," says Eleonora Di Nezza, program organizer and a professor of mathematics at the Mathematics Institute of Jussieu-Paris Rive Gauche in France. The goal was to introduce all the members to a variety of techniques and concepts that would serve as "tools" as they jumped on different problems in geometric analysis. Although the sheer volume of new ideas and perspectives felt overwhelming at times, Caniato says it was the refreshing experience he needed at that moment.

"One of the long-standing feelings of mathematicians is that we feel alone with our computations, especially when they don't come," says Caniato. "For me, [SLMath] was a playground."

The SLMath community is so open to the free exchange of math ideas, Caniato says, that even the contributions of non-members drawn to its programs are welcomed and treated as irreplaceable. Colleagues who visited for workshops and seminars during 2024 helped advance his own work during the semester and yielded two preprints addressing long-standing puzzles in geometric analysis.

The senior scientists' mentorship also contributed to the collaborative, inclusive environment. Much of Caniato's own experience of being mentored centered around human relations in mathematical academia as he prepared to enter the next phase of his career. "It brought a great insight on what it means ... to feel deeply about your [peers and mentees] and the responsibility to care for them,

always trying to keep humble, and to learn from your students as much as they are learning from you."

"The program is not just about the team," Di Nezza says. "It's also about bringing people together that can communicate, collaborate [and build] up a relationship." The young mentees will eventually become the mentors for the next generation, and the cycle will continue.

Providing "friendly" entry points is a key objective for public outreach at SLMath, Toro says. For example, in 2024 SLMath, in collaboration with Zala Films, premiered the two-part documentary series *Journeys of Black Mathematicians: Forging Resilience*. The series was broadcast nationwide on PBS, reaching millions of U.S. households.

Last year also marked the 10th anniversary of the Mathical Book Prize, which SLMath awards annually to an outstanding work of children's literature that inspires a love for math. Anyone can nominate a storybook "where math, or a character of math, plays an important role," Toro explains. In partnership with the Oakland school district, SLMath expanded the distribution program for the books to California schools to commemorate the program's 10th anniversary. The books were also shared with transitional centers for unhoused women.

> **"MATHEMATICS MOVES WAY FASTER AND IS WAY RICHER WHEN DIFFERENT PEOPLE BRING IDEAS."**
>
> **Tatiana Toro, director, SLMath**

"If you talk to a 5-or-6-year-old, they're not really afraid of math—they're usually very curious," says Juan Meza, associate director at SLMath and an applied mathematician at University of California, Merced. "They love doing puzzles, and all these activities that we associate with math." But at some point, students "start to really turn against math," he says.

Storybooks are a unique "ramp" up to a life-long engagement with math, says Toro. "Kids who love reading can get to math because the book was interesting. Kids who like art can get to art because math can have some beautiful symmetries [and] can be very artistic. Everything that a kid could find relevant [exists] in storybooks."

"By focusing on collaboration and the fact that people from different backgrounds can collaborate, this place has opened doors to many people," says Toro. "For everyone, I think, mathematics has evolved into a collaborative endeavor. Mathematics moves way faster and is way richer when different people bring ideas." ▬

Diverse mathematicians gathered for the Special Geometric Structures and Analysis program in fall 2024.

Every year, the Mathical Book Prize is awarded to exceptional children's literature that fosters young students' love for math. Credit: Kirsten Bohl

A SUNSHADE FOR EARTH? SCIENTISTS PROBE THE COMPLEXITIES OF GEOENGINEERING.

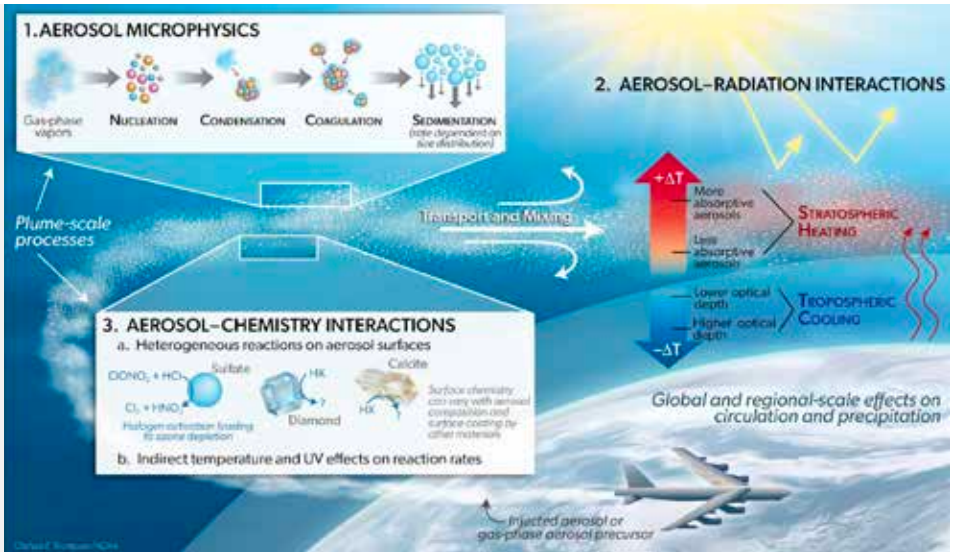
When Mount Pinatubo in the Philippines exploded in 1991, it became one of the largest volcanic eruptions of the 20th century. Beyond smoke and ash, it released at least 17 million tons of sulfur dioxide gas that spread throughout both the northern and southern hemispheres. Over the following year, the global temperature dropped up to a half-degree Celsius (nearly one degree Fahrenheit) because chemical processes in the stratosphere transformed the sulfur dioxide into aerosol suspensions of sulfate particles that reflected away sunlight.

That observation invigorated scientific interest into whether a speculative technology of 'geoengineering' Earth's atmosphere could someday mitigate global warming. Could there be a safe way to mimic the sun-screening volcanic effect to cool our ever-warming planet?

This question is what the new Solar Radiation Management program sponsored by Simons Foundation International seeks to answer. The program, which formally launched in 2024, funds studies into the feasibility and consequences of using aerosols to reflect away sunlight and offset global warming.

Recognizing the unparalleled stakes, the scientists exploring the subject approach it with the utmost caution. "The most complicated chemical reactor is the atmosphere," warns Rajan Chakrabarty, a professor of environmental and chemical engineering at Washington University in St. Louis. "You do not try to engineer a system without understanding it."

To understand the challenges of solar radiation management, researchers study a wide range of chemical and physical processes that occur in the atmosphere at various scales.



> **WITH THIS WORK, WE CAN RUN MODEL SIMULATIONS FOR PEOPLE THAT LOOK AT THOSE IMPACTS.**
>
> **Simone Tilmes, atmospheric researcher, National Center for Atmospheric Research**

In the early days of geoengineering ideas, some people thought it could be used to counter all anthropogenic emissions, says Simone Tilmes, an atmospheric scientist at the National Science Foundation's National Center for Atmospheric Research who has studied geoengineering for the past two decades. "It becomes more and more clear that it's not without side effects" on the ozone layer, precipitation and wind patterns, she adds. For that reason, any implementation of these ideas is still far from reality. "Research has already shown that geoengineering on its own cannot be a Plan B," Tilmes says. "It can only be combined with mitigation" by ending civilization's dependence on fossil fuels. But with this research, scientists can help shape what safe, effective and responsible solar radiation management could look like.

Sulfate particles like those from volcanic eruptions may be a poor choice for stratospheric aerosol injection (SAI), the equivalent geoengineering technique. For example, sulfates absorb heat and can interact with the atmosphere to thin or thicken the ozone layer. Tilmes and other scientists are investigating how various types of aerosolized nano-scale particles would behave in the stratosphere and what climate effects they might have.

Before pioneering research on other solid aerosols by SFI grantee Sandro Vattioni of ETH-Zurich, nobody had studied these effects from particles other than sulfate, Tilmes says. "With this work, we can run model simulations for people that look at those impacts," she adds.

To that end, Tilmes' team in Boulder, Colorado, is developing more accurate computer models for SAI. Their goal is to more precisely predict the complex

dynamics of both the particles and the atmosphere at all different scales. When aerosol particles cling together or combine with other chemicals, their shifting size and surface composition alters how they disperse and how they interact with sunlight. The impact of those changes on weather patterns can differ at the local or regional level. Consequently, injecting aerosols over one country to cool it, for example, could cause heavy rainfall or warming elsewhere.

It's a crucial ethical consideration, Tilmes says. Wealthier nations in the Global North are more likely to someday deploy geoengineering technologies, but Global South countries could be hardest hit by the unintended consequences, just as they already suffer disproportionately from climate change.

That's why Tilmes is collaborating with colleagues in Africa, such as Romaric Odoulami at the University of Cape Town, to prevent harmful effects on communities at risk. His team is finding that some of the particles most commonly proposed for SAI can reduce precipitation. That could be good for mitigating the extreme floods that damage property and take lives across parts of Africa, he says. But it could also be devastating for crops, food security, and the agriculture-dependent livelihoods of millions of Africans.

If geoengineering technologies are ever implemented, Africa and the rest of Global South will either be the "big winners" or the "big losers," Odoulami says. "When it comes to climate change, we are the most vulnerable because we have less capacity to adapt."

Geoengineering research in Africa is relatively new, he adds, and funding for climate science is slim. That's why support from the Simons Foundational International is so crucial for getting the data they need for analyses.

Meanwhile, scientists like Robert Wood, an atmospheric physicist at University of Washington in Seattle, are tackling practical questions about whether SAI is even feasible. The main focus of Wood's research is how rapidly plumes of particles spread once injected into the stratosphere from aircraft, balloons or other sources. Turbulence in the stratosphere is still poorly understood: The average airspeed is generally slow, but there can be strong, inconsistent gusts.

> **"RESEARCH HAS SHOWN THAT GEOENGINEERING ON ITS OWN CANNOT BE A PLAN B."**
>
> **Simone Tilmes, atmospheric researcher, National Center for Atmospheric Research**

"One of the things we would like to see is, if there's enough of that intermittent turbulence and you inject particles around it, would that make any difference in the plume?" he says.

Because air moves differently in the various layers of the atmosphere, aerosols can float in the stratosphere for months but will fall out within days at lower altitudes. That's why Tilmes' research integrating these properties in climate models comes in handy, Wood says. Pairing his turbulence and plume models with Tilmes' global models could help future developers of SAI technology determine which particles to inject and when and where to inject them.

These kinds of collaborations are essential because there's still so much relevant to SAI that scientists don't know, especially about different materials proposed for it. "We just don't really know what pitfalls there might be," Wood says. "The question is not simply 'Do you have the best particle?' but 'Can you distribute the particle?'"

Chakrabarty's laboratory is trying to find those answers for alumina (aluminum oxide) and calcite (calcium carbonate) by analyzing their optical properties. Alumina could be good for scattering sunlight because it is highly reflective and inexpensive to manufacture.

The catch, however, is that alumina also absorbs outgoing infrared radiation from the Earth's surface, and that trapped energy could warm the stratosphere. Moreover, during 2024, Chakrabarty's team found that alumina absorbs a small fraction of incoming solar radiation as well, contrary to assumptions that it reflects solar radiation perfectly.

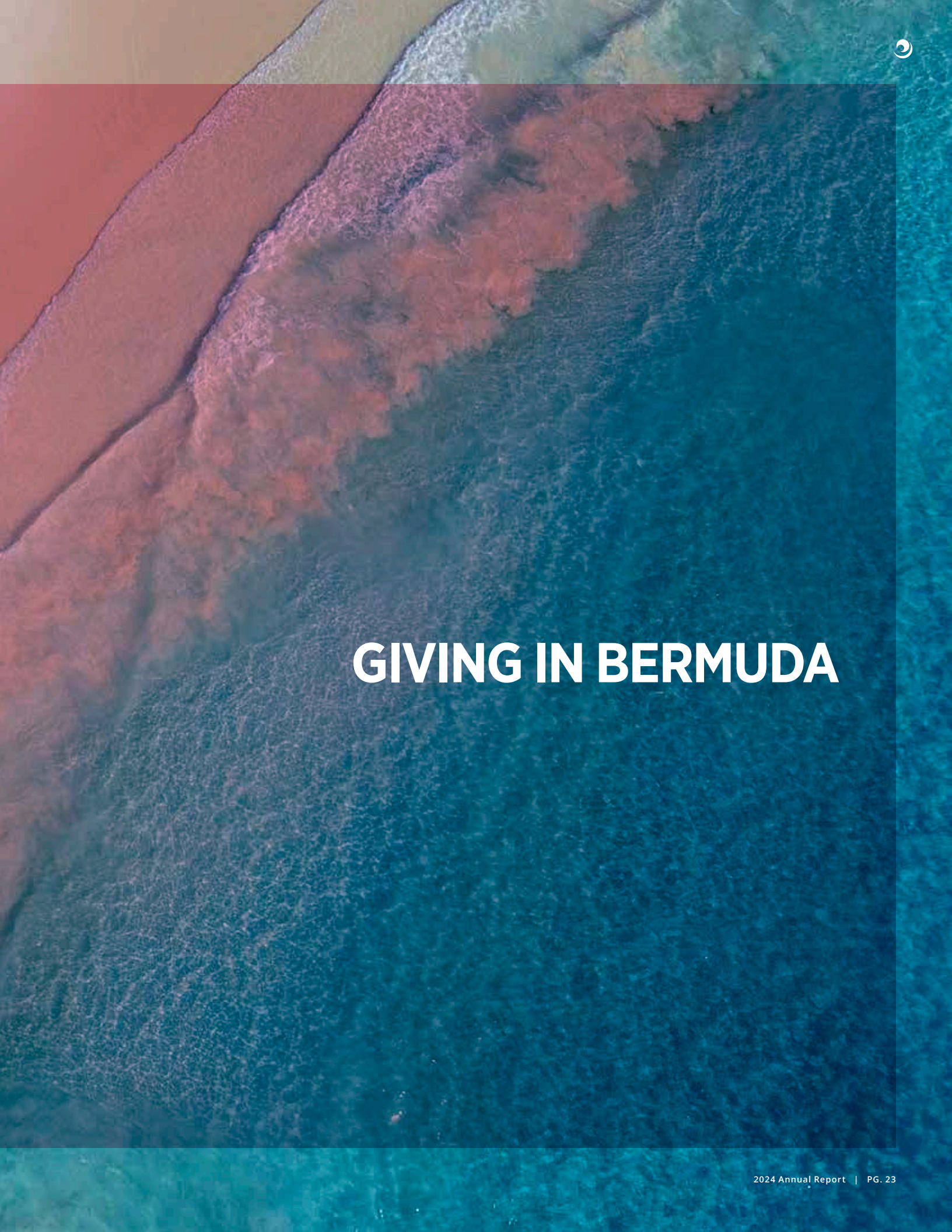
Even if alumina absorbs only one percent of solar radiation, for example, "this one percent could have a magnified 'blanket effect' when the heat is re-emitted back in the stratosphere," Chakrabarty says. An unexpected twist adds urgency to his research: Studies in recent years have shown that spacecraft already shed alumina particles into the atmosphere during both takeoff and reentry. A 250-kilogram satellite can release 30 kilograms of alumina when it returns from space, and those particles can hang in the stratosphere for half a year, Chakrabarty adds. "We do not have to wait for the SAI experiments to happen in the stratosphere to investigate alumina—the particles are already there," he says.

His lab has seen troubling signs that circulating alumina particles tend to end up over the poles, where they could accelerate the melting of snow and ice. "We have to rethink how realistic it is to spray these aerosols in the stratosphere for potential cooling because of our revised understanding," Chakrabarty says.

Although some countries have expressed interest in using geoengineering, Chakrabarty warns, scientists need to know more about chemistry, atmospheric science and physics to better inform those decisions. "As scientists, the onus is on us to give out the knowledge such that policymakers have the right information before executing any action," he says. "That's the best we can do." ▬

> **"YOU DO NOT TRY TO ENGINEER A SYSTEM WITHOUT UNDERSTANDING IT."**
>
> **Rajan Chakrabarty, atmospheric scientist, Washington University in St. Louis**

Rajan Chakrabarty



GIVING IN BERMUDA

SERVING THE AUTISM COMMUNITY WITH SCIENCE AND COMPASSION

Seventeen years ago, Tomorrow's Voices was launched as a temporary solution to a serious gap in autism services in Bermuda. Founded by parents who recognized an urgent need, the center has since evolved into a nationally and internationally recognized leader in autism intervention. Today, it is guided by science, sustained by compassion, and deeply connected to the community it serves.

"We were never meant to be permanent," says Jahnae Harvey, executive director of Tomorrow's Voices. "But now, we know we're here to stay. And we're ready to grow."

That growth was especially evident in 2024. The center, which supports individuals from age 2 through adulthood with autism and developmental disabilities, reached a record number of clients through its core offerings, including one-on-one early intervention therapy, adult services through the Thriving Beyond 21 program, Saturday social skills groups and a summer program. Every service is built on a form of individualized therapy called applied behavior analysis and guided by data collection and analysis that ensures interventions are grounded in research.

"THEIR SUPPORT HELPS US PROVIDE QUALITY SERVICES WITHOUT MAKING FAMILIES SHOULDER THE ENTIRE FINANCIAL BURDEN."

Jahnae Harvey, Executive Director, Tomorrow's Voices

"People often assume we're just a school," Harvey says. "But every decision we make is based on data. Each client's session is carefully tracked and analyzed to understand what is working and how we can improve."

The results go far beyond the numbers. For Gabrielle Cann, whose daughter Azori attends Tomorrow's Voices, the impact is deeply personal.

"Tomorrow's Voices really helped her develop confidence and fine-tune the skills she had," Cann says. "They gave her structured goals based on her age, what she should be able to do at 15, then at 17, and so on. It's been a great journey."

Even everyday tasks reflect the growth. "One small but significant example is washing dishes," Cann says. "She kept at it. Now she's proud of what she can do, and she asks me, 'Do I have to wash it again?' I say no, and that means the world to her."

Stories about Tomorrow's Voices like this one speak to more than clinical achievement. They reflect transformation in entire families and in the wider Bermuda community. Through workshops, training sessions and inclusive outreach programs, the center educates the public about autism and the importance of inclusion.

In 2024, Tomorrow's Voices deepened its capabilities by establishing the executive director role, creating more coordination across services and laying the groundwork for continued expansion. Even so, demand continues to outpace capacity. Long waitlists reflect both the trust that families place in the center and the growing need for autism services across the island.

Support from the Simons Foundation International plays a critical role in helping Tomorrow's Voices meet this demand. SFI funding subsidizes client fees by up to 80 percent, making medically necessary therapy affordable for families. It also supports staffing growth and professional development.

Practicing skills with clients one-on-one.

"SFI doesn't just fund us. They listen, they ask questions, and they understand what it takes to run a science-driven organization," Harvey says. "Their support helps us provide quality services without making families shoulder the entire financial burden."

The center's rigorous clinical approach even extends to its office culture, where interns routinely compare the center's results to recent peer-reviewed studies. That focus on evidence helps staff stay aligned with the latest in autism research.

Looking ahead, Harvey says the center's direction will remain grounded in evidence.

"You may think you know the path," she says. "But then the data shows you something else. That's when you adapt. That's when you grow."

BUILDING STRONGER NON-PROFITS FOR BERMUDA

What if the smartest giving was not just generous but strategic? That question sits at the heart of the work of the Bermuda Community Foundation. As a community foundation, it supports nonprofits across the island through grants, leadership development and infrastructure building. The goal is not only to meet today's needs but to ensure that Bermuda's nonprofit sector thrives well into the future. By combining local insight with data-driven philanthropy, it is helping to strengthen the island's social impact infrastructure from within.

> **"IT IS ABOUT LONG-TERM SUSTAINABILITY, NOT ONE-OFF GRANTS."**
>
> **Myra Virgil, CEO, Bermuda Community Foundation**

2024 Board - Bermuda Community Foundation

In 2024, to honor the tenth anniversary of the organization, Simons Foundation International made a three-year gift to the endowment of the Bermuda Community Foundation as a huge vote of confidence in the good work it does.

The Bermuda Community Foundation's approach is distinct from other philanthropic models on the island. Unlike corporate or family foundations, it blends several roles. It helps donors set up long-term charitable funds, distributes grants through an open application process and supports nonprofit development through platforms like GiveBermuda.org, a public website that connects donors to vetted community projects. In each case, the goal is the same: to make giving easier and more strategic.

The Bermuda Community Foundation's work is guided by a philosophy that prioritizes giving the community a voice. Annual gatherings and stakeholder meetings ensure that grantmaking reflects real needs. "It is about long-term sustainability, not one-off grants," says Myra Virgil, chief executive officer and managing director. In 2024, the Bermuda Community Foundation deepened its impact through partnerships with key nonprofits that illustrated its strategic focus on leadership development and science-informed initiatives.

One of its most significant investments for the year was in the Nonprofit Alliance of Bermuda, which offers professional training and voluntary accreditation to organizations across the island. From board governance and financial management to communications strategy, the Alliance helps nonprofits build the skills they need to improve performance and deliver stronger results.

"This is our flagship investment," says Virgil. "We're not just funding outcomes. We're building the ecosystem that makes those outcomes possible."

Sponsorship of PeerForward, meanwhile, has helped create a college-bound culture in Bermuda's public high schools. Through mentorship and peer support, PeerForward encourages youth to aim higher. Virgil describes it as "a game changer for students who might not have otherwise considered college."

Living Reefs, a marine conservation nonprofit, uses science-based strategies to restore Bermuda's coral ecosystems. Its profile on GiveBermuda.org has helped connect the group with new donors and partners, serving as a model for how visibility and digital tools can increase philanthropic impact. With support from the Bermuda Community Foundation, Living Reefs has expanded both its research and community outreach programs.

Science has played an increasingly important role in guiding the Bermuda Community Foundation's grantmaking. "Science led us toward greater collaboration with government and community partners," Virgil says. "It showed how evidence-based strategies can create systemic change beyond what we initially imagined."

One unexpected result of the leadership programs has been increased nonprofit engagement in policy and governance. "Our grantees are becoming more involved in community decision-making," Virgil says. "That is an exciting and unintended impact."

Looking ahead, the Bermuda Community Foundation plans to build on lessons learned in 2024 by continuing to prioritize flexibility, listening to the community and embracing science-driven approaches. Virgil says it aims to grow donor partnerships and strengthen leadership throughout Bermuda's nonprofit sector over the next five to ten years.

"Our work is about creating lasting change through partnerships, evidence and leadership," Virgil says. "Where science leads us next is a story still unfolding, but it is one full of promise." —

BERMUDA COLLEGE FOUNDATION BRINGS INNOVATION TO ISLAND STUDENTS

On a small island, big opportunities begin with access. For Bermuda, that access is made possible through the work of the Bermuda College Foundation, which exists solely to support Bermuda College through strategic fundraising, donor partnerships and capital improvements. Its mission is simple yet ambitious: to secure philanthropic partnerships that will ensure every Bermudian can receive a world-class education without having to leave home.

"We want Bermuda College to be the first choice," says Kerry Judd, executive director of the Bermuda College Foundation and an alumna of the college. "It should not be a backup plan. The quality of education that Bermuda College students receive rivals what's available overseas, and we are working every day to ensure that continues."

Bermuda College Foundation operates as an independent, community-driven nonprofit with a board made up of members from across Bermuda's private and civic sectors. While it works in strategic partnership with Bermuda College, its independence allows it to stay focused on fundraising, free from political pressure and agile in its decision-making.

This independence has proven critical as Bermuda College Foundation has scaled its impact. In the 2024–2025 fiscal year, it awarded over $900,000 in

Environmental studies gather on a farm.

Nursing graduates at their pinning ceremony.

Nursing trainees use modern clinical simulators.

Biology students get laboratory experience.

grants to the college. That included approximately $400,000 in new equipment, such as $200,000 in state-of-the-art training simulators for the nursing program. High-tech SimMom and SimDad manikins, for example, allow students to safely practice complex scenarios in clinical settings.

“The Nursing Simulation Lab is remarkable,” says Pahn-ya Ratteray, development director of the Bermuda College Foundation and an alumna. “These tools give students a chance to train with the same kinds of resources they would find in major hospitals overseas. It elevates the learning experience and the confidence of our future health professionals.”

Beyond equipment, Bermuda College Foundation has transformed spaces on campus. One of the signature projects for 2024 was the half-million-dollar conversion of the college’s former cafeteria into a conference center that is available and suitable for use by both the college and the wider community.

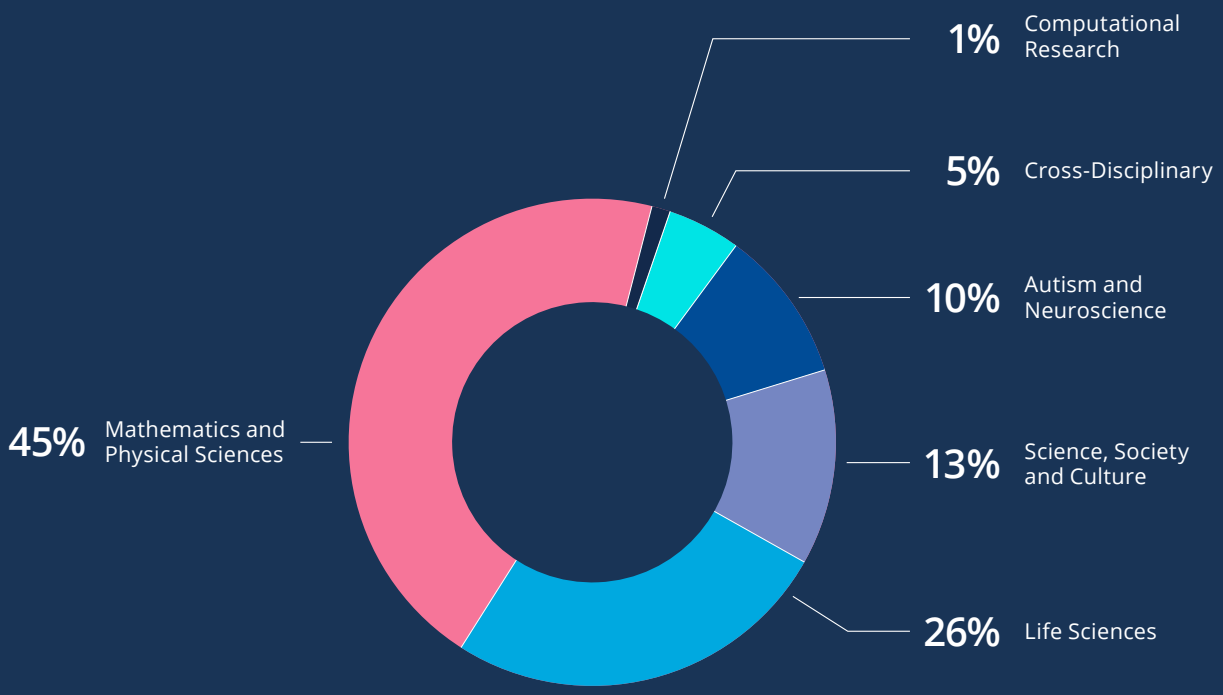
Student financial assistance and scholarship support is a key pillar of the Bermuda College Foundation’s work. Of the more than 164 scholarships and student financial aid awards disbursed for the 2024–2025 academic year, 83 of those were made possible by funding from Simons Foundation International: 32 in the fall semester and 51 in the spring.

Scholarship and student financial assistance recipients pursue a range of degrees in science, technology, engineering, mathematics, nursing and allied health, culinary arts and other fields. The STEM fields in particular were beneficiaries of early funding from Simons Foundation International, but the foundation’s support has since expanded to include students in all disciplines, as well as a variety of special community interests, including actuarial science and computer information systems.

“When you give students access to the same tools and training available globally, it changes what they believe they can achieve,” Judd says. “We have faculty members with doctorate degrees and a curriculum that’s preparing students for high-impact careers in Bermuda and beyond.”

Bermuda College Foundation’s long-term vision is ambitious. It aims to fully fund a state-of-the-art Bermuda College capable of providing student financial assistance or scholarships to any resident in need. “We want every resident who wants to pursue post-secondary education to be able to do so without financial hardship,” Ratteray says. “We are blessed to have partnerships such as the one we have with Simons Foundation International.”

2024 SPENDING BY INTELLECTUAL AREA



Bermuda's beauty arises out of the elegant patterns set down by the laws of nature, from the pink sand beaches to the ocean waves to the sun in the sky. The new logo of Simons Foundation International embodies its Bermudian setting and its mission to advance the frontiers of research in mathematics and the basic sciences for the benefit of humanity.

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