SoCaltech

- Commencement returns to Beckman Mall
- CE10 plots an ambitious sustainability roadmap
- A superposition snapshot; and more

A Lonely Off-Road

Up until this year, no one had ever hiked the entirety of Death Valley National Park from north to south in less than a week. In February, however, Caltech postdoctoral fellow Cameron Hummels covered the 170-mile route in four days—with six minutes to spare.

Death Valley, one of the hottest, driest, and least hospitable places in the world, is an unusual setting for a long-distance backpacking trip. But Hummels, a senior postdoctoral scholar in theoretical astrophysics, is part of the Fastest Known Time (FKT) movement, in which outdoor adventurers seek to traverse remote and difficult terrain as quickly as possible. Their efforts are authenticated using GPS records on exercise-tracking websites like Strava, leading to fierce but friendly competition with other athletes.

Hummels, abiding by the official FKT rules, traveled solo and unsupported, did not follow any trails or roads, and carried all of his food and equipment on his back. For water, Hummels relied on a few natural springs and seeps, some little more than mud puddles, which he had identified along the route and tested as part of his two-year preparation. Over the course of these four days in Death Valley, he experienced 60 mph winds, a haboob (an airborne wall of sand), temperatures higher than 100 degrees Fahrenheit, a salt swamp, arsenic- and uranium-laden water sources, a poisonous gas vent, and devastating fatigue resulting in visual, auditory, and olfactory hallucinations.

Why would anyone do this? “I think it makes the highs higher to have the lows lower, but it hurt a lot and was probably one of the hardest things I’ve ever put my body and mind through,” Hummels said. “It made for quite an adventure, but I hope to never do it again.”

CE10: Roadmap to Reduction

The Caltech Energy 10 project (CE10) is working to define the ambitious but achievable solutions needed to cut U.S. global warming gas emissions in half by the end of the decade. The CE10 public program, which took place on June 14 and 15, included livestreamed talks from Steven Chu, former U.S. secretary of energy; Sally Benson, current White House deputy director for energy; Kristen Siemen, chief sustainability officer at General Motors; and other experts in the energy and government sectors. The CE10 workshops on June 15 and 16 brought together key leaders to create a strategic roadmap for reducing global warming gas emissions that can realistically enlist broad public support.

“If you’re really optimizing economy-wide, you’re better off allowing that little bit of carbon to remain at the wholesale level and instead investing those dollars in reducing carbon emissions that may have a bigger impact in other sectors.”

Caltech trustee Pedro J. Pizarro (PhD ’94)
President and CEO of Edison International, speaking at CE10

For more information, visit: **ce10.caltech.edu**

Thanks to the Boss

Jean Somalwar, a graduate student in astronomy at Caltech, studies the stars in our galaxy and beyond. But she points to a different kind of star as one of her main inspirations: Bruce Springsteen. In fact, she says, the musician is the reason she got into college. A New Jersey native like the Boss, she has attended five Springsteen concerts (including three of his Broadway performances in New York) and has been a fan since she was 14. Somalwar even wrote her college application essay to Princeton University about meeting Springsteen at a 2016 book signing for his autobiography *Born to Run*.

“When I heard the emotional howls at the beginning of ‘Something in the Night,’ I had to stop working and just listen,” the essay reads. “Every line reflected my exact feelings, and for five minutes and fourteen seconds, the world disappeared.”

Somalwar began to collect Springsteen-related memorabilia when she was 16. The items, which include newspapers, magazines, concert tickets, and a poster, now fill up most of a wall in her home. “I’m under the impression that such displays are quite common among Springsteen fans,” she says.

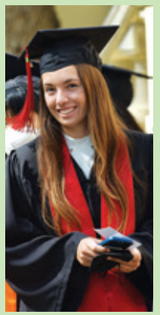
A Human Wave
In quantum superposition, subatomic particles can act like waves and occupy many places at once—a little like how Caltech graduate student Piero Chiappina can be seen here performing every stage of a backflip at once. In reality, large, or macroscopic, objects like people cannot be in many places simultaneously, at least not without the help of photography. But researchers, including physicists like Chiappina, are working to scale up bizarre quantum effects such as superposition and entanglement so they can be used in quantum computers and other future technologies. (See page 11 for more.)

A Day for Degrees

On Friday, June 10, 2022, Caltech held its 128th Commencement with a ceremony on campus, marking the first in-person commencement since 2019. Hundreds of graduates processed in front of a crowd of cheering friends and family on Beckman Mall. The Institute honored graduates with **560** degrees: **218** bachelor's degrees, **139** master's degrees, and **203** doctoral degrees.

Additional commencement photos can be found on Caltech's Instagram and Flickr accounts.

Watch a recording of the ceremony here:



History in Space

Jessica Watkins, formerly a Chair's Postdoctoral Scholar in the Division of Geological and Planetary Sciences (GPS) and a California Alliance for Graduate Education and the Professoriate (AGEP) Fellow, launched to space aboard a SpaceX Crew-4 mission from NASA's Kennedy Space Center on April 27, 2022. She then made history as the first Black woman to serve aboard the International Space Station, where her work involves making geological observations. Watkins received training from Lauren Edgar (MS '09, PhD '13), now a research geologist at the USGS Astrogeology Science Center.

Watkins spent two years working at Caltech on the Mars Science Laboratory mission's *Curiosity* rover with John Grotzinger, the Harold Brown Professor of Geology and Ted and Ginger Jenkins Leadership Chair for GPS. While a graduate student at UCLA, she worked at Caltech with Bethany Ehlmann, professor of planetary science and associate director of the Keck Institute for Space Studies. Both Grotzinger and Ehlmann traveled to Florida to wish Watkins good luck and watch the launch.

A New Hub for Math

Caltech trustee Richard N. Merkin, MD, founder and CEO of the Heritage Provider Network, will fund the Institute's new Richard N. Merkin Center for Pure and Applied Mathematics. As a hub for mathematical research on campus, the center will bridge disciplines and connect research in disparate areas that focus on the development of mathematical ideas and foundations in fields such as pure mathematics, computational biology, and quantum sciences.

Merkin and the Merkin Family Foundation have also provided funds to renovate the eighth floor of Caltech Hall. The reconfigured space, scheduled to open in early 2023, will provide a home for the Merkin Center as well as a base of operations for the American Institute of Mathematics (AIM), which will relocate from its current headquarters in San Jose, California. Sergei G. Gukov, Caltech's John D. MacArthur Professor of Theoretical Physics and Mathematics, has been named director of the Merkin Center. A member of the Caltech faculty since 2005, Gukov is known for important concepts relevant to string theory, quantum field theory, and pure mathematics.

Disco is Back

The Caltech student experience is unlike any other. From the House System to SURF to JPL, there is a lot for admitted students to consider and process as they make their decision about where to enroll as undergraduates. That is why the Caltech Undergraduate Admissions Office hosts Discover Caltech. The two-day event, also known as DiscoTech, made its return to campus in April 2022 alongside ecosySTEMs, a one-day pre-program that offers historically marginalized and underrepresented students the chance to experience the new community they will be joining.

Formally called the Pre-Frosh Experience, DiscoTech drew 433 attendees in 2022, including 222 who also joined ecosySTEMs. They heard from current students, faculty members, administrators, alumni, and others about not only Caltech's research, campus life, and commitment to diversity, but also what to expect after commencement. Nobel Laureate Frances H. Arnold, the Linus Pauling Professor of Chemical Engineering, Bioengineering and Biochemistry; and director of the Donna and Benjamin M. Rosen Bioengineering Center, welcomed the crowd with a keynote address about her lab's efforts to engineer enzymes using directed evolution.

EARTHQUAKE SCIENCE ON THE BIG SCREEN

For more than a century, Caltech's Seismological Laboratory has transformed society's understanding of earthquakes and geophysics through advanced instrumentation, data science, experimentation, engineering, and public outreach.

To celebrate the Seismo Lab's centennial, the Caltech Science Exchange, in collaboration with the Dr. Lucy Jones Center for Science and Society, will host a public event in Beckman Auditorium in November called "Shaking in our Seats: Earthquake Science on the Big Screen," to explores the science behind earthquakes in films such as 1974's *Earthquake* and 2015's *San Andreas.* Moderated by seismologist Lucy Jones, a panel of scientists, engineers, and disaster-response professionals will provide insight into what happens during and after earthquakes, how scientists and government officials interact, and the future of the field. Audience members will hear what Hollywood has done right and what it has done wrong, and will have the opportunity to ask questions.

The event is scheduled for ***Saturday, November 12,*** *at* ***1 p.m.***
For more information, visit: ***scienceexchange.caltech.edu/shaking***

Origins

The Institute for Quantum Information and Matter (IQIM)

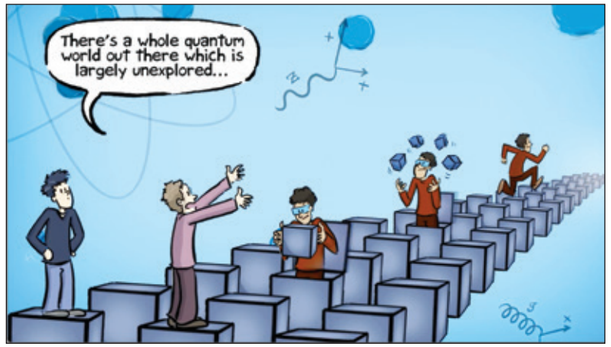
When John Preskill, now the Richard P. Feynman Professor of Theoretical Physics, came to Caltech in 1983, he planned to continue his work in particle physics and quantum field theory. By the mid-1990s, however, Preskill had switched his focus to a field that owes its existence to ideas posed by Nobel laureate and Caltech professor of physics Richard Feynman two decades earlier: quantum information theory. It was a career change that eventually led to the creation of what is now called the Institute for Quantum Information and Matter (IQIM), Caltech's long-standing home for cutting-edge quantum research.

Quantum information theory is the study of information processing on the quantum level. One of its primary aims is to guide the development of quantum computers, machines capable of far surpassing even classical supercomputers on certain problems of fundamental importance.

In the late 1990s, Preskill and H. J. "Jeff" Kimble, now the William L. Valentine Professor of Physics, Emeritus, received a grant from the Defense Advanced Research Projects Agency (DARPA), which was interested in quantum computing's potential applications in cryptography. Preskill and Kimble then hired Alexei Kitaev, now the Ronald and Maxine Linde Professor of Theoretical Physics and Mathematics, as a yearlong visitor.

Then, in 2000, Preskill and Kimble received a grant from the National Science Foundation, which they used to form the Institute for Quantum Information (IQI) that same year.

"NSF got a surge of funding for a program they called Information Technology Research, which included a lot of practical things, but also sort of a lunatic fringe of blue-sky research. And that's what we were part of," Preskill noted in an oral history for the American Institute of Physics conducted by science historian David Zierler, who now serves as director of the Caltech Heritage Project.



Guifre Vidal (Postdoc '01–'05), now a senior staff research scientist at Google, recalled those early days as a Caltech postdoc during a Heritage Project interview: "John had the vision ... to hire interesting young people for [IQI], then apply a hands-off approach. He's not the type of person who needs to control everything and everyone."

Liang Jiang (BS '04), a former IQI postdoc and current professor at the University of Chicago, told Zierler during a Heritage Project interview that weekly meetings were so full of discussion and questions that Preskill had to impose a time limit: "You could only talk for one minute because some group members would get really excited with the results and would talk a lot about their research."

By 2011, advances in quantum computing hardware, such as superconducting circuits and qubits (the quantum mechanical analogue of a classical bit), gave Preskill and Kimble the impetus to apply for more NSF funding as a means to broaden the IQI's scope to include experimental work. They received that funding and, in 2011, changed its name to the Institute for Quantum Information and Matter, for which Preskill serves as the Allen V. C. Davis and Lenabelle Davis Leadership Chair of the Institute for Quantum Science and Technology.

Spiros Michalakis, staff researcher and manager of outreach at IQIM, described this name change in a recent Heritage Project interview as a "visionary move," one that is still paying off: "We attach 'M'—matter—and it really mattered because … we started to have conversations with how you can implement certain things, and how you can convert some of the theories into experiments. … I didn't know many physicists or many people who were part of physics or even mathematical physics … who were not, basically, in one way or another, associated with IQIM. … If you look at the roster even now, for the second iteration of IQIM, the second cycle we have, there's a pretty cool medley of people."

Above: Still image from the 2013 video "Quantum Computers Animated" produced by IQIM in partnership with PhD Comics. The video features IQIM's **John Preskill** and **Spiros Michalakis.** Watch the video:

For more on the history of IQIM, visit:
magazine.caltech.edu/post/iqim-quantum-john-preskill

A Spotlight on STEM in Rural Areas

From left to right: Arjuna Subramanian, Elle Chimiak, Mike O'Connell, and Steven Bulfer at the 29 Palms Farmers Market.

On a sunny Saturday in April, in a stall sandwiched between lemonade and cotton candy stands at the 29 Palms Farmers Market, chemistry graduate student Andrea Stegner shows 10-year-old Kira Collins how copper film can be stretched, broken, and repaired thanks to the metal's atomic structure.

Since November 2021, Stegner and other Caltech grad students and postdocs have driven to the market on the first Saturday of nearly every month to showcase the wonders of science to the community. Unusual specimens from Caltech's extensive geology collection, such as augen gneiss and a meteorite, are often big hits in this 28,000-person rural community in the California desert. "Because of the area, people just love rocks," says Elle Chimiak (MS '19, PhD '21), a visitor in geochemistry, as scents from the Mine Train Smokery barbecue stall waft by. Nearby, the local junior high school concert band plays "Twinkle Twinkle Little Star." At a previous market, one mom even asked Chimiak if the group could come to her child's birthday party.

"I had to sadly decline," she says. "But I thought that was great."

Chimiak, who came up with the STEM Stall idea, works in the lab of John Eiler, the Robert P. Sharp Professor of Geology and Geochemistry. She receives some funding from the American Geophysical Union's Voices for Science program to cover gas and food expenses. While the science experiments wow the young visitors, the group has loftier aims.

"We want to let people know if you want to be a scientist, there is not one route to this, and you do not have to be a perfect student to get there," Chimiak says. As kids stop by to draw flowers and write their names on small sheets of copper film, the Caltech students also hand out postcards to adults that are addressed to area state and federal representatives, encouraging guests to ask their politicians for more broadband internet access and greater investment in STEM education.

"In rural areas like this, the broadband is terrible. We'll be your science Google. If you have a question we can't answer, we'll return next month with an answer," Chimiak says, wearing a tag that reads, "Ask me, I'm a scientist!"

According to a 2019 report from The Rural School and Community Trust, more than 9.3 million American students, or nearly one in five, attend a rural school. A particular focus of Chimiak and company's attention is the Rural STEM Education Act, which was passed by the U.S. House of Representatives in May 2021 and is now under consideration in the Senate. The legislation would provide research grants to fund teaching STEM in rural schools and fund broadband expansion.

Steven Bulfer, a grad student studying electrical engineering, has a personal connection to the group's mission having grown up on a farm in rural Minnesota.

"I didn't have a lot of science mentorship growing up, but I noticed when going to college that a lot of my colleagues had people who pushed them toward science," Bulfer says, noting he would like to help make kids aware of what science has to offer. "STEM was really quite a useful vector for me to do the things I'm doing today."

Sandy Smith, who has owned the Farmers Market with her husband Roger Thomas for four years, loves having members of the Caltech community come by.

"They're so patient, and they're good one-on-one with the kids and answering questions," Smith says. "Our kids need to know that these options are out there. We have a national park, but I don't think they realize, besides climbing on the rocks, what it all entails."

—Omar Shamout