

- Alumni Association changes
- “Before I was a scientist ...”
- Teaching philosophy via sci-fi
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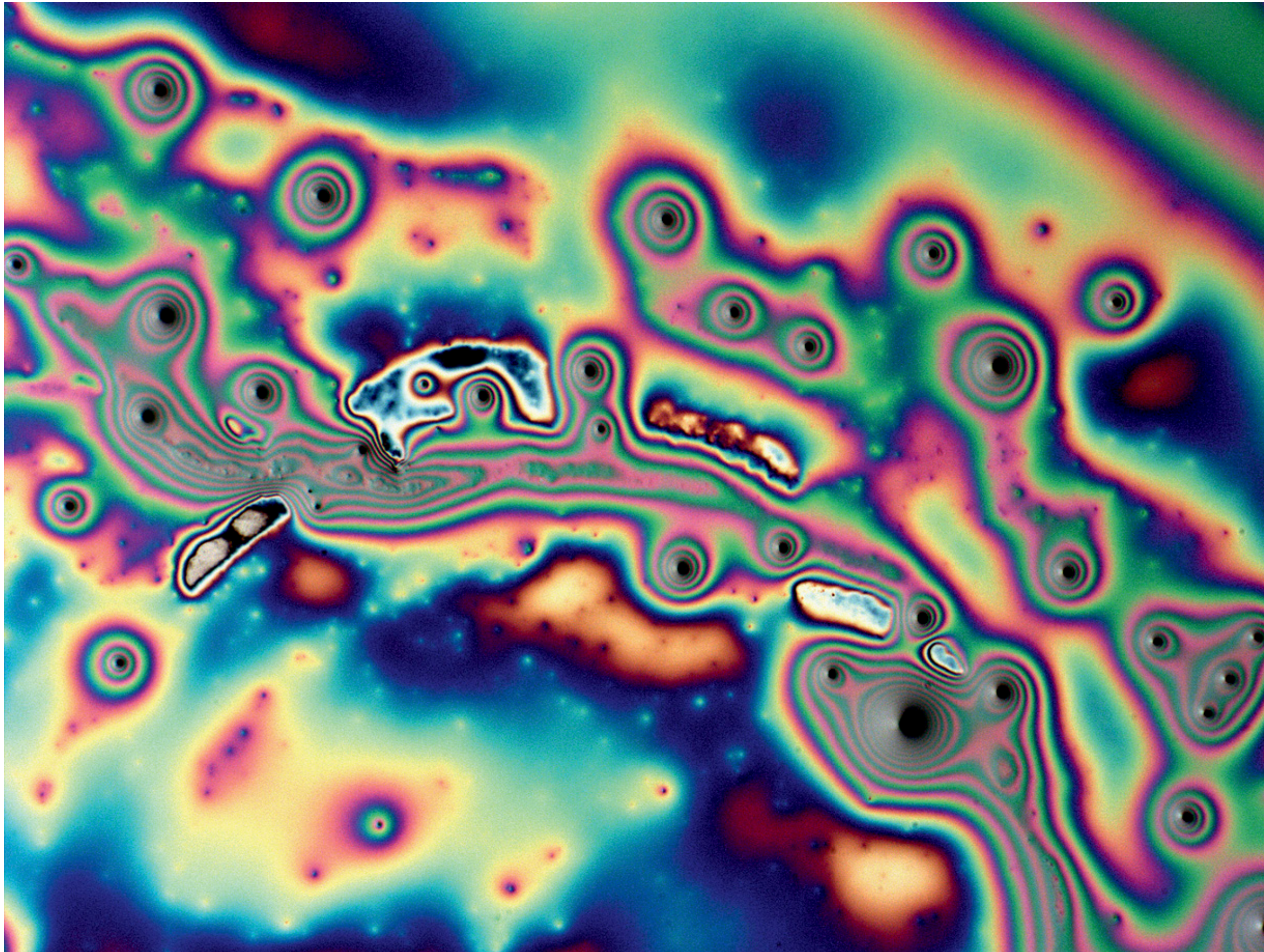
The Art of Failure

“I was producing miniature optical components by sculpting very thin films. These films love to detach themselves from surfaces, so in this experiment I was investigating if an adhesive layer would help to hold them down. This process involved a heating step, and to avoid destructive surface tension effects one first had to dry the sample. I forgot to perform this step and watched in horror as my perfect sample tore itself apart on the hot plate. While taking pictures of the sample under the microscope, I was struck by the beautiful iridescent patterns and agglomerates that formed. It was reminiscent of a false-color topographic map of island groups, but these colors were real and breathtaking! I kept this image to remind myself that often failure in one domain can reveal insight or beauty in another. Experiments tend to be rather boring when they work precisely as expected. Mistakes and failure, though, are typically nothing short of spectacular: organic and fractal Rorschach blobs form when nature finds a way to defeat the well-controlled experiment.”

Soon Wei Daniel Lim (BS '17), reflecting on the experience that led to the creation of this image while he was a student at Caltech. Lim is currently working towards a PhD in applied physics at Harvard University.

See more artwork created by Caltech students
at www.artofscience.caltech.edu

Micro-archipelago
Polymer on silicon, light microscope



Four Questions for : Chris Bryant

A senior software engineer at the Walt Disney Studios in Burbank, Chris Bryant has been president of the Caltech Alumni Association since 2018. Recently, Bryant oversaw a significant change to the Alumni Association structure whereby all Caltech alums are now members of the CAA; previously membership dues were required. *Caltech* magazine caught up with Bryant to talk about this change and what he hopes to accomplish during the last few months of his term, which comes to an end in June 2020.

1. How did this recent change come about?

The push to make every alum automatically a member of the Alumni Association had been in the works for more than a decade. The CAA was funded by dues, so the majority of our program resources came from members. But, even though our events were open to all alumni, we knew that having dues as part of membership was creating a barrier to people participating, and it was a lot of work to solicit membership to fund our programs. When President Rosenbaum came to Caltech, he put the issue of alumni engagement front and center and, with Brian Lee (then vice president for Advancement and Alumni Relations), partnered with us to create a more permanent funding model that didn't require dues.

2. What do you see as the main benefits?

With the dues barrier removed and dramatically increased membership, we expect alumni to feel the benefit of a stronger, more engaged network. Whether it's via returning to campus, connecting at regional events, or participating in online virtual programs, we expect to see higher engagement levels and more value to alumni from those connections.

3. What do you find most rewarding about working with Caltech alums?

Caltech students and alumni are some of the most collaborative people I've interacted with through my life and career. Working with fellow alumni as CAA president has been extremely rewarding because of that culture of collaboration.

4. What are some goals you have for the Alumni Association?

As long as I've been a part of the board, there has been a consistent desire to have the caliber and strength of alumni programming and engagement be on par with the overall caliber of the Institute in all the things it does. We aim for the equivalent groundbreaking, prizewinning, societally advancing impact in alumni relations and alumni engagement that Caltech has achieved in science and engineering. It is definitely a journey and one that all of the presidents I've been fortunate to work with have each contributed their best efforts to.



Artist Jennifer E. Padilla explains her painting, *XOR Logic* (acrylic on canvas), at right, this way:

"Pick a tile and look at the tile below and the tile to the left. Are they both light blue or both dark blue? If so, then the tile you are looking at should be light blue. If instead there is one light blue and one dark blue tile in the positions below and to the left, then the tile you are looking at should be dark blue.

"From this rule, a fractal pattern begins to emerge. It is a manifestation of the 'Exclusive OR' (XOR) logic gate, an element of the computer circuits operating in your laptop or your phone. The pattern is known as the Sierpinski triangle.

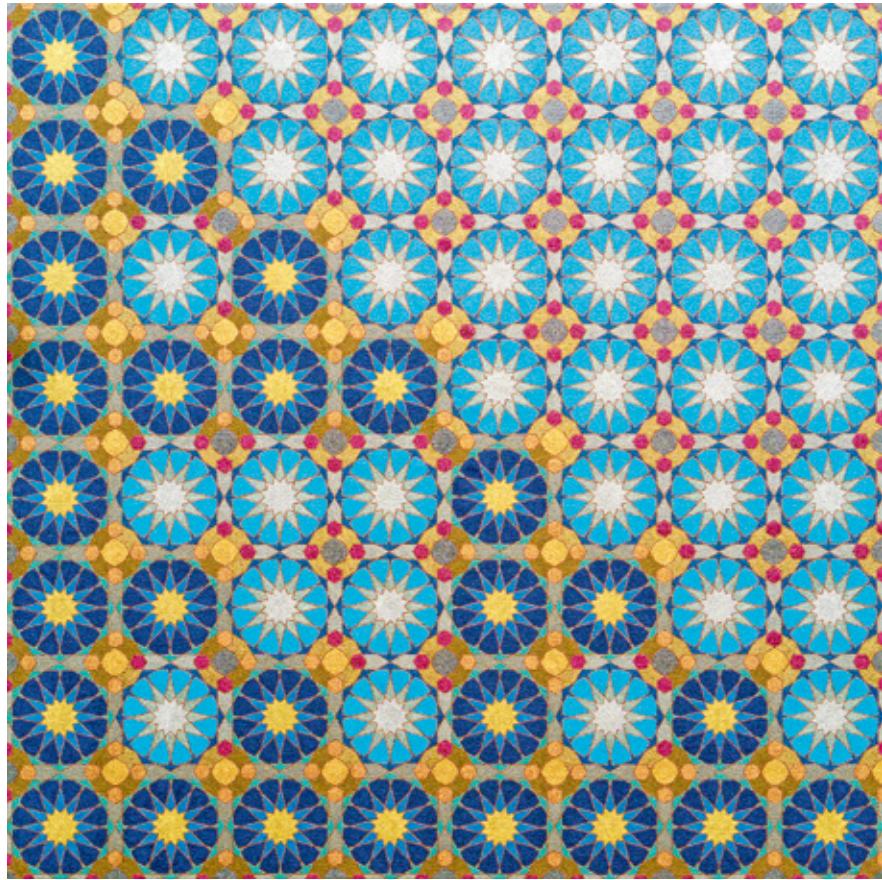
"This work explores the early moments of that progression where one can observe the logical XOR rule while just beginning to perceive the triangular Sierpinski fractal pattern."

Jennifer E. Padilla:

A LOGICAL STEP

With a master's degree in mathematics and a PhD in biochemistry, Jennifer Padilla seemed set on the scientific path. She continued that journey as a postdoc at Caltech, studying DNA nanotechnology in the lab of Applied and Computational Mathematics and Bioengineering Professor Niles Pierce and in a second postdoc at New York University. Later, after two years as a research professor at Boise State University, Padilla realized that her passion was for art, not science. Or, rather, the intersection of art and science.

Now based in Altadena, Padilla has been working primarily as an artist for the last three years, exploring the connection between Islamic geometric art and mathematical topics such as Euclidean geometry, algorithmic assembly, and quasiperiodic order. "Much of my research focused on the self-assembly of molecules, how the assembly process could be guided by symmetry, and how it could relate to computation," says Padilla. "The precision and intricacy of the patterns found in Islamic geometric art converse easily with the logic of mathematics."



The Dictionary Definition of Cal·tech

Caltech magazine uses *Merriam-Webster* as its go-to dictionary, its arbiter of spelling and usage. Recently, it became obvious that M-W returns at least some of that regard, given the number of times it uses Caltech references in its usage examples. Here are a few of those instances.

aero·dy·nam·i·cist *noun*

aero·dy·nam·i·cist | \ er-ō-dī-na-mə-sist \

Definition:

one who specializes in [aerodynamics](#)

Recent Examples on the Web:

[The Rocket Boys' audacity caught the attention of aerodynamicist Theodore von Kármán, who already worked with two of them at Caltech.](#)

— Corey S. Powell, *Discover* magazine, "These New Technologies Could Make Interstellar Travel Real," 13 March 2019

drawstring *noun*

'draw·string | \ 'drō-strīŋ \

Definition:

a string, cord, or tape inserted into hems or casings or laced through eyelets for use in closing a bag or controlling fullness in garments or curtains

Recent Examples on the Web:

[In 2012, a Caltech paper detailed a procedure for harnessing an asteroid—proposing a plan for lassoing a valuable asteroid by catching it in a giant drawstring bag.](#) — Rachel Riederer, *The New Yorker*, "A New Space Race, for Lawyers," 18 June 2019

minor planet *noun*

Definition:

asteroid

Recent Examples on the Web:

[Caltech's Konstantin Batygin, for one, does not think the Kuiper Belt objects have enough mass to pull minor planets and asteroid out of their orbit.](#) — Jason Daley, *Smithsonian*, "Is the Mysterious Planet Nine Just a Swarm of Asteroids?" 6 June 2018

“Before I Was a Scientist”

There is no single path to becoming a scientist ... just ask Caltech’s faculty. Here are some of the varied experiences they had on the road to their current careers.

Jean Paul (Pablo) Ampuero Saenz

Professor of Seismology

- T-shirt graphic artist
- Bass player in punk/metal bands
- Translator at a trade fair
- Jeep chauffeur in Cuba
- Indian food delivery guy



Frances Arnold

Nobel Laureate; Linus Pauling Professor of Chemical Engineering, Bioengineering and Biochemistry; Director, Donna and Benjamin M. Rosen Bioengineering Center

- Jazz club cocktail waitress
- Taxi driver
- Worker in a factory building nuclear reactor parts



Rob Phillips

Fred and Nancy Morris Professor of Biophysics, Biology, and Physics

- [Left high school at 17]
- Computer store clerk
- Electrician
- Surfboard shaper



Dean Mobbs

Assistant Professor of Cognitive Neuroscience

- [Left high school at 15]
- Part-time garbage man
- House painter
- Amateur boxer



Turn to page 40 to read about the circuitous paths of other alumni.

“Some people are surprised when they learn I got my undergraduate degree in English. Your focus can change as your horizons broaden, but it is focus that lets you know when that change is important, it’s focus that lets you dream new concepts that will surprise you, focus that ultimately sets your imagination free.”

France Córdova (PhD '79), NSF Director, at Caltech Commencement 2019



Did you find your focus by following a winding path? Tell us about it! Tweet using #BeforeIWasAScientist

Class Act Philosophy Through Science Fiction

Watching science fiction movies and shows such as *The Matrix*, *Doctor Who*, and *Black Mirror* may not seem like homework, but such was the case in a new class taught last spring by Caltech assistant professor of philosophy Charles (Chip) Sebens. The goal of Philosophy Through Science Fiction is to introduce students to important philosophical questions using themes such as teleportation, parallel universes, and time travel.

“When students start learning philosophy, they often feel like the scenarios that philosophers discuss are outlandish and not worth taking seriously,” says Sebens. “Framing the course as an analysis of science fiction allows students to put these concerns aside and ultimately realize that philosophy is relevant to their lives and to other fields of academic inquiry.”

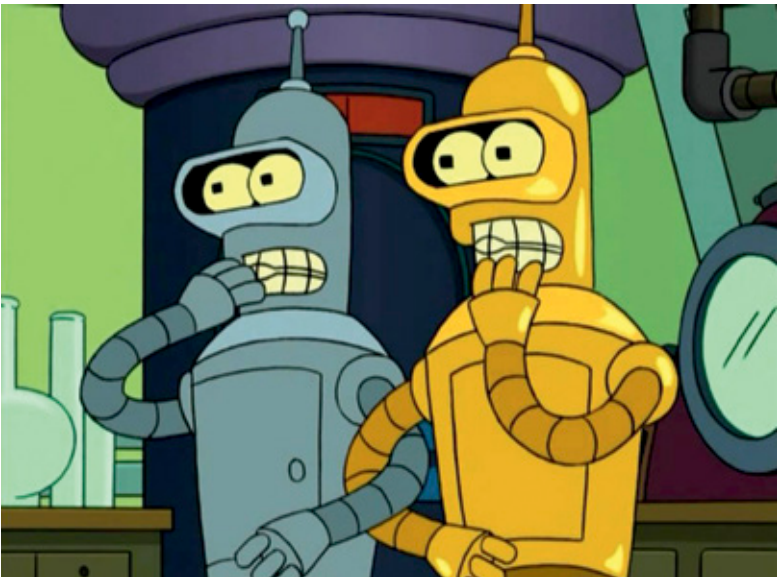
Multiple Universes, Multiple Robots

In an episode of the TV series *Futurama*, called “The Farnsworth Parabox,” a character named Professor Farnsworth discovers a way to travel between parallel universes. He soon learns that there are

alternate versions of the main characters in each universe, including the robot named Bender (see image below), whose color, gray in one universe and gold in another, had been determined by the flip of a coin. The idea of people or robots living in multiple universes may indeed seem outlandish, but this is a real theme that comes up in quantum physics.

“In the many-worlds interpretation of quantum physics, measurements of a quantum particle can split one universe into many, just as coin tosses split Bender’s universe in the *Futurama* episode,” says Sebens.

In addition to quantum physics, the class also talked about the concept of identity. “Is the Bender that existed before the coin toss the same robot as either the gray or the gold Bender after the coin toss?” asks Sebens.



Beauty is in the Eye of Science

In another section of the class, the students studied a short story by Ted Chiang called “Liking What You See: A Documentary” about a time in the future when scientists have figured out how to render people insensitive to physical beauty. This technology is used to fight “lookism,” a phenomenon where people are discriminated against based on their looks. In the class, the students debated the strengths and weaknesses of the futuristic technology.

“Discussing this piece of science fiction helped them to better understand various kinds of discrimination and the ways we might address them,” Sebens says. “I hope my students will read and watch science fiction differently after taking this class, noticing when philosophical questions come up and being ready to tackle them.”

Sebens will teach the class again in spring 2020.

“The media attention relaxes after a few hours or days, but I’m going to be looking at the data we gathered from these quakes for a long time. It could take months or even years for our group to process all the data. These quakes in particular were interesting, as two perpendicular faults were involved. We can study the rupture dynamics, which you can’t resolve in smaller quakes. Also, having two strong quakes caused variations in fault slip and ground motion that will be important to study and understand.”

— Caltech staff seismologist **Jen Andrews** on her work as part of the Seismo Lab team to analyze the two large Ridgecrest earthquakes on July 4 and 5, 2019

Siobhán MacArdle (fifth-year graduate student)

#SoCaltech is an occasional series celebrating the diverse individuals who give Caltech its spirit of excellence, ambition, and ingenuity. Know someone we should profile? Send nominations to magazine@caltech.edu.

Siobhán MacArdle is a Caltech chemistry graduate student working in the lab of Jackie Barton, the John G. Kirkwood and Arthur A. Noyes Professor of Chemistry.

"I've been interested in the chemistry of wine and alcohol for a long time. As an undergrad, I started getting obsessed with fermentation and distillation. I worked at a distillery in Brooklyn, and I was just blown away by how it's all chemistry and biology. More recently, I had been reading academic papers on the

science of wine and whiskey, and I felt like I needed an outlet for it, so I created an Instagram account called @PeriodicallyDrinkingChemicals.

It's been so fun for me, and it's reigniting my love of chemistry. When I'm in the lab, I'm making a lot of electrochemistry measurements, looking for peaks in cyclic voltammograms. When you're smelling a wine, you're also detecting some sort of chemical reaction or chemical change but with your nose or your mouth."

For more #SoCaltech, and to hear more from MacArdle go to tinyurl.com/MagSoCaltech

The Science of Wine Tasting

Tropical flavors like pineapple and guava come from thiols (compounds with a sulfur bound to a hydrogen, SH).

When the grapes are allowed to ferment with their skins *and* their stems, the stems can impart vegetal or herbaceous notes, like cucumber, to the wine from compounds called methoxypyrazines.

Though the minerality of some wine is so dominant it can taste like granite, the chemical basis of the sensation remains a mystery. It likely has more to do with how human brains perceive bitterness and acidity than with any actual metal compounds in the wine.

Strawberry aromas can arise from a variety of chemicals including ethyl esters, which are made in fermenting yeast cells by enzymes that break down acyl-CoA.

The buttery tones of chardonnay derive from lactic acid, which is the product of malolactic fermentation, a process that converts malic acid (a tart, citrusy acid) into lactic acid (more buttery and less sour).

"I look at the rovers on Mars. When we landed Spirit and Opportunity, they were supposed to work only for 90 days, because we were concerned that the dust on Mars would cover the solar panels and we wouldn't get enough power. Well, they worked for almost 14 years, continuously. I wonder how many people have a car—that they cannot bring back to the garage to fix it and repair it—that can work for 14 years."

— Charles Elachi, former director of the Jet Propulsion Laboratory, on KTLA's "Frank Buckley Interviews" podcast, July 10, 2019



Summer visitors

Every summer, labs across campus and at JPL (as well as farther afield) host undergraduates eager to hone their research skills. One such avenue for growth is the 10-week program known as SURF (Summer Undergraduate Research Fellowships). While most SURFers are Caltech students, almost a quarter of the participants visit campus for the summer from other colleges across the U.S.



Mahlet Shiferaw
Harvard University
LIGO

Mentor: Physics Professor Alan Weinstein
Research focus: Shiferaw studied the harmonics of gravitational waves: ripples in space-time produced by cosmic events such as the collisions of black holes. These waves have been detected regularly by LIGO (the Laser-Interferometer Gravitational-wave Observatory) since 2015. Shiferaw wants to know more about higher-order modes of gravitational waves, which are similar to musical overtones. In the same way that the overtones of a piano can sound different from those of a plucked violin string, these higher-order gravitational-wave modes can reveal unique information about their sources: black holes and other objects in space. While LIGO cannot detect these higher-order modes at its current sensitivity, it should be able to do so in the coming years after planned upgrades to its instruments.
Highlight: “The campus is so beautiful,” says Shiferaw. “Sometimes it feels like walking around in a huge botanical garden.”
Takeaway: “My research will pave the way for future tests of the general theory of relativity under extreme conditions: near black holes, where gravity is strong and the speeds of particles are close to that of light,” she says. “It’s mind-blowingly cool.”



Amy Windham
Pasadena City College
Division of Humanities & Social Sciences

Mentor: History Professor Jennifer Jahner
Research focus: Windham explored *The Book of Margery Kempe*, which is considered the first autobiography in the English language. The fascinating part, says Windham, is that it was written by a woman who lacked formal training in reading or writing. Kempe, a mystic and pilgrim who lived at the turn of the 15th century, dictated her story to two scribes. Windham is intrigued by what the work reveals about both female literacy and how books developed in medieval times.
Highlight: Jahner and Windham visited the Special Collections at the UCLA Library to look at manuscripts from the period that Windham has been exploring. “Nothing replaces the experience of actually being in the presence of a 700- or 800-year-old book,” says Jahner.
Takeaway: “I’ve become so fascinated with medieval studies,” says Windham. “This has definitely helped me shape the direction that I want to move and opened my eyes to a whole other world of how books came to be and even how the English language evolved.”

SURF STATS 2019
414 students • 313 Caltech students; 101 visiting students • 292 doing research at Caltech; 65 at JPL; 57 off-campus • SURF stipend: \$6,350 per student; total stipend payroll of \$2.655M • 414 students = 828 written interim reports, 414 abstracts and final papers, 71 final poster presentations, 343 final oral presentations • 241 faculty mentors and 278 graduate student, postdoc, or research staff co-mentors

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