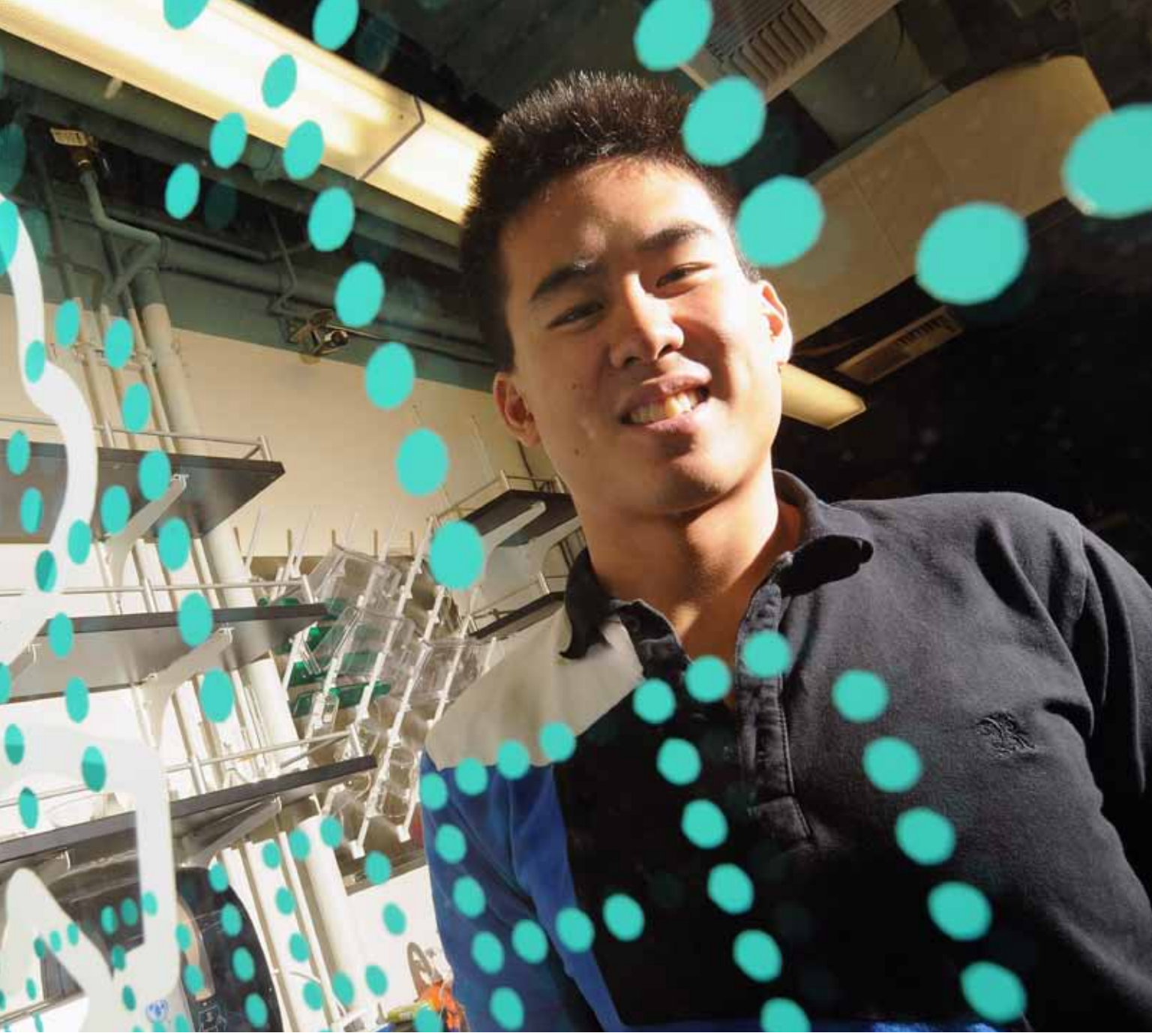


SURF

Summer Undergraduate Research Fellowships
California Institute of Technology

2011 and 2012 Report

SHAUNAK AND BEN

It certainly is a small world. When Shaunak Kar came to Caltech as a participant in the SURF exchange program with the Indian Institute of Technology at Gandhinagar, he was looking forward to a summer of exciting research, travel throughout California, and making new friends. What he didn't expect was to meet his American step-cousin, Ben Lieber, also a SURFer. Ben came into the family when his mother married Shaunak's mother's mother's brother's son. Shaunak had often heard of his American cousin from his relatives back home in India, but it wasn't until Shaunak arrived in Pasadena that his great uncle (and Ben's step-grandfather) mentioned that Ben was a student at Caltech. Excited at the surprising coincidence, Shaunak contacted Ben and the two finally met in person. When Ben went to see Shaunak at his Caltech summer house, Ben didn't have to travel far. It turns out that Ben was living next door!

Dear SURF Friends,

Before joining the Caltech community, I had already heard of the Summer Undergraduate Research Fellowships (SURF) program. SURF's reputation for providing extraordinary research experiences for young students is well known among faculty and administrators across the country, and in fact across the world. I have personally witnessed the lasting impact of the SURF program in the lives of students, as they learn from world-renowned faculty and research teams throughout campus, at the Jet Propulsion Laboratory, and at universities around the globe.

Their experiences as SURFers are bolstered by the collaboration among faculty, students, alumni, donors, and staff who join together to advance one goal—to impact the world through science and engineering.

Since 1979, each SURF session has produced many inspirational stories, some of discovery, others of innovation, all of them representing unique educational experiences. This past summer, students were once again involved in some of the most exciting research happening at Caltech and JPL: the search for the Higgs Boson; the development of fuel cells through artificial photosynthesis; the exploration of new antibodies that target HIV and cancer; and the observation and discovery of planets beyond our solar system. Whether it is helping the Curiosity rover quickly visualize and analyze mobility sequences or using mice models to better understand the neural circuitry involved in autism and schizophrenia, SURFers are being trained through research to become the next generation of mathematicians, scientists, and engineers.

With your support, the SURF program has maintained a strong reputation as a unique education and research opportunity for the world's most talented students. I would like to extend my gratitude to all of the donors, faculty mentors, co-mentors, staff, alumni, and students who contribute to this great experience.

Yours in discovery,

Jean-Lou Chameau
President, California Institute of Technology

Report from **THE LORD OF MANY SURFS** and **THE MAN OF MANY MISSIONS**

by Hillary Bhaskaran

With the election-year behind us, we can now sit back, relax, and enjoy a fireside chat with two key leaders of SURF. To my right we have Caltech's Beckman Professor of Chemistry Harry Gray, who chairs the SURF Administrative Committee. The sign on Harry's meeting-room door welcomes visitors to the realm of "Lord Gray." Indeed, Harry's realm has included the 107 SURF fellows that he has mentored since 1981. To my left we have JPL's Kent Frewing ('61 EAS), a soft-spoken engineer-turned-administrator. Kent shares a strong commitment to education and volunteerism with his wife, Judy, a retired schoolteacher. He chairs the SURF Board, on which he has served since 2006. The two chairs are here to tell us what's up in their respective realms and beyond.

Mr. H. Kent Frewing
Chair, SURF Board

Dr. Harry B. Gray
Chair, SURF Adminstrative Committee

Moderator: Is it my imagination, or are student researchers getting younger each year?
Harry: It's true. We've made a lot of progress recruiting freshmen and getting them into the labs.

Moderator: Why freshmen?
Harry: It's important for our kids to get involved in research right away. Their courses are technically very good, but—this is certainly true in chemistry—regular courses can no longer keep up with what's happening at the frontiers of science. If our students are making decisions about which path is best for them, they need to have more of a connection to what's happening in the field. In my talks to high school students, I tell them that SURF gives them a big reason to select Caltech. This is probably the only small school where undergraduate students can do world-class research. At a big school, they can get involved if they're lucky and hopefully don't get lost in the crowd. But with the help of SURF, students can have a big impact on the world stage.

Kent: At age 17 or 18, this is an opportunity that few people have. They're doing real research; they're not just lab helpers. In just ten weeks, they complete the full cycle of a research project—from writing a proposal to presenting their final results. I find that amazing.

Moderator: Are they up to the challenge?
Kent: I think these students are so capable, but they have a range of reactions when they take on a SURF project. Some of them have never had to organize their lives. Now they're getting a job, doing research, and presenting findings. Yes, they have guidance, but their SURF responsibility is part of what builds independence. If they're chafing at the bit in high school—to get beyond learning, to doing, to tackling problems on the frontier where there are no known answers—then they are the kind who welcome this. They can handle it.

Harry: Some of them even change the course of research in a mentor's group. They've made discoveries that greatly influence the work of faculty PIs, postdocs, and graduate students.

Moderator: Can you give us an example?
Harry: In my own lab, Megan Jackson recently helped chemistry graduate student Alec Durrell turn palladium chemistry into palladium catalytic chemistry. She figured out how to make the palladium catalysts work. Megan's success began when she secured her first SURF as a freshman. She has worked in our lab for three years and has done well.

Moderator: Can students apply for a SURF without previous research experience or related coursework?
Harry: Yes. My main focus as chair of the Administrative Committee is to not have to turn away any student because of a lack of experience or funding. They often won't have the experience unless we help them get it. To this end, we are always seeking mentors who can provide research opportunities at every level.

Here I want to give a shout out to JPL, which has been really helpful in making opportunities available to our students. Last year we almost doubled the number of JPL SURFs from the previous year. We helped make this happen by offering JPL colleagues the same cost-sharing financial package that SURF offers to Caltech faculty. For Caltech students SURFing on campus, we've always picked up half of the cost, but JPL mentors needed to pay the full award amount. Since Caltech and JPL are one community, we should all be playing by the same rules. Now we've fixed this and it's an achievement that I'm very proud of.

Moderator: Kent, did you do a SURF as a Caltech undergrad?
Kent: No, I'm too old! I graduated 18 years before the modern SURF program at Caltech was started.

Moderator: Did you feel less connected to research opportunities?
Kent: I think I did feel less connected. I knew I'd be an engineer, so I just took the normal courses. Then I started applying the techniques I'd learned to my graduate school education and my jobs at Hewlett Packard and JPL. Especially at JPL, I've been able to apply engineering principles to spacecraft system engineering. I found, and I think SURF students find, that applying what we learn provides motivation to learn more. I think it's important for students to take advantage of the rare opportunity that SURF offers.

Moderator: How do Board members benefit from participating in SURF?
Kent: I think the Board finds the annual student-donor dinners to be very inspirational because of the competence of the students and the hope that that engenders. These young students are imaginative, and they're uninhibited by the roadblocks that more experienced people have hit. During the Doris S. Perpall Speaking Competitions, which my peers and I have had the privilege of judging, we see that the students are not only competent in breadth and depth, but they are also able to communicate work that is very difficult and esoteric for the layperson to understand.

Harry: Those are the ones who win. Actually, all the finalists have come up with such great talks that it's hard to judge which is best. They're all spectacular.

Kent: When we see them, we see that the future will be in the hands of people who are very talented. To support these talented students we have a very dedicated Board and AdComm who work hard to ensure that the SURF program remains strong.
I'd like to welcome the Board's newest members: Melissa Conn (SURF '00, '01, '02, '03), Joe Cheng (SURF '83), Mike Stefanko (BS '70 EC), and Professor Jonas Zmuidzinas (BS '81 Ph). And, I'd like to thank our outgoing members, Bill Deverell and Paula Grunthaner, for all of their support and dedication.

Moderator: What parting words do you have for folks interested in the activities of the SURF Board and AdComm?
Harry: Our fabulous SURF supporters can be proud. We could not have increased the number of SURF opportunities so dramatically without tremendous support from our alumni and friends. I want to acknowledge our two anonymous donors who provided matching grants during the campaign to increase the SURF endowment. Just recently the last of those matches was used. That gift helped increase the SURF endowment by $10M. With the help of donors such as Dan and Sally Harris, who have funded four SURF endowments in recent years, SURF is in good hands. Thanks to all who have supported this important program.

DEDICATION

2011

John Gee (BS '53 ME) (Fleming) served as chair of the SURF Board (2003-2007), and under his strong leadership nearly 30 new student endowments were created. Barbara has always been interested in supporting students' academic and professional growth. In 2007 they created the John and Barbara Gee SURF Endowment, which provides support for one SURF student each year in perpetuity. In 2009, they established the Gee Family Prize for Effective Posters.

2012

Carol Casey started her career with SURF in January 1994. Over the years she has worked unbelievably hard on behalf of our students, faculty, donors, and alumni to ensure that they receive the best of experiences through SURF, MURF, and our other undergraduate research programs. Her creativity, thoughtfulness, depth of experience, robust intellect, and attention to detail has improved SURF in both apparent and subtle ways. In 2007 she was awarded the inaugural Thomas W. Schmitt Annual Staff Prize for embodying the values and spirit that enable the Institute to achieve excellence in research and education. Carol is also an honorary alumna and a Gnome.

Selected by the SURF Administrative Committee and SURF Board, dedicatees are chosen on the basis of the extraordinary support they provide to the program, our students, and the Institute.

SURF Dedicatees

1985	Dr. Ernest Swift
1986	Dr. Lee A. DuBridge
1987	Dr. Robert P. Sharp
1988	Dr. Ray D. Owen
1989	Dr. Hans W. Liepmann
1990	Dr. Fredrick H. Shair
1991	Dr. Lew Allen, Jr.
1992	Dr. John D. Roberts
1993	Dr. Robert E. Bacher
1994	Dr. Edward C. Posner
1995	Mr. Samuel P. Krown
1996	Dr. Edward B. Lewis
1997	Dr. Harold Brown
1998	Dr. Thomas E. Everhart
1999	Dr. Ward Whaling
2000	Dr. Terry Cole
2001	Dr. William M. Whitney
2002	Dr. Edward C. Stone
2003	Dr. Thomas A. Tombrello, Jr.
2004	Dr. Harry B. Gray
2005	Paul K. Richter and Evalyn E. Cook Richter Memorial Funds
2006	Lew and Edie Wasserman
2007	Ms. Carolyn A. Ash
2008	Dr. David L. Goodstein
2009	Carl and Shirley Larson
2010	Bob and Toni Perpall

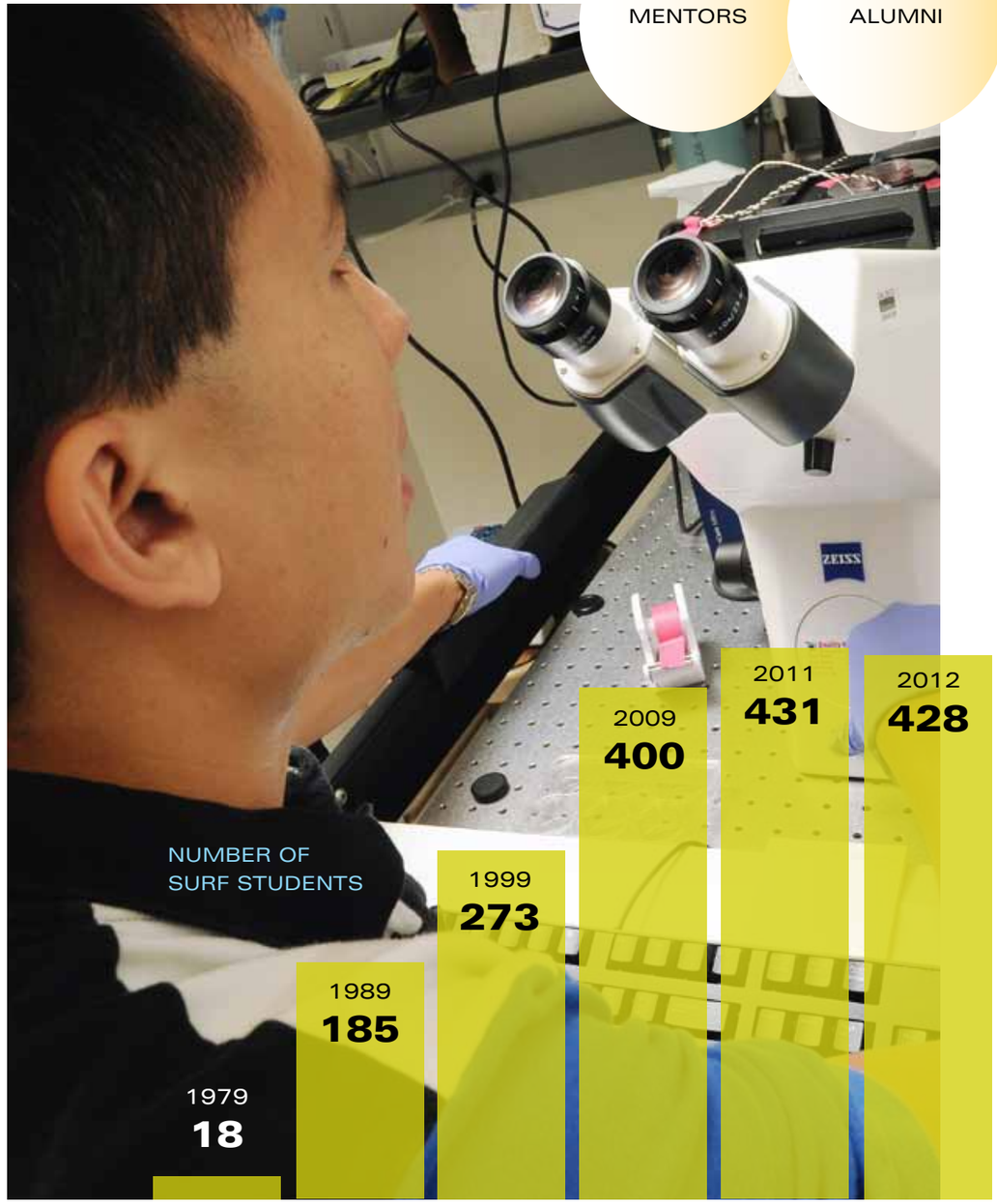
DEVELOPING **SCHOLARS**

from one generation to the next

STUDENTS

MENTORS

ALUMNI



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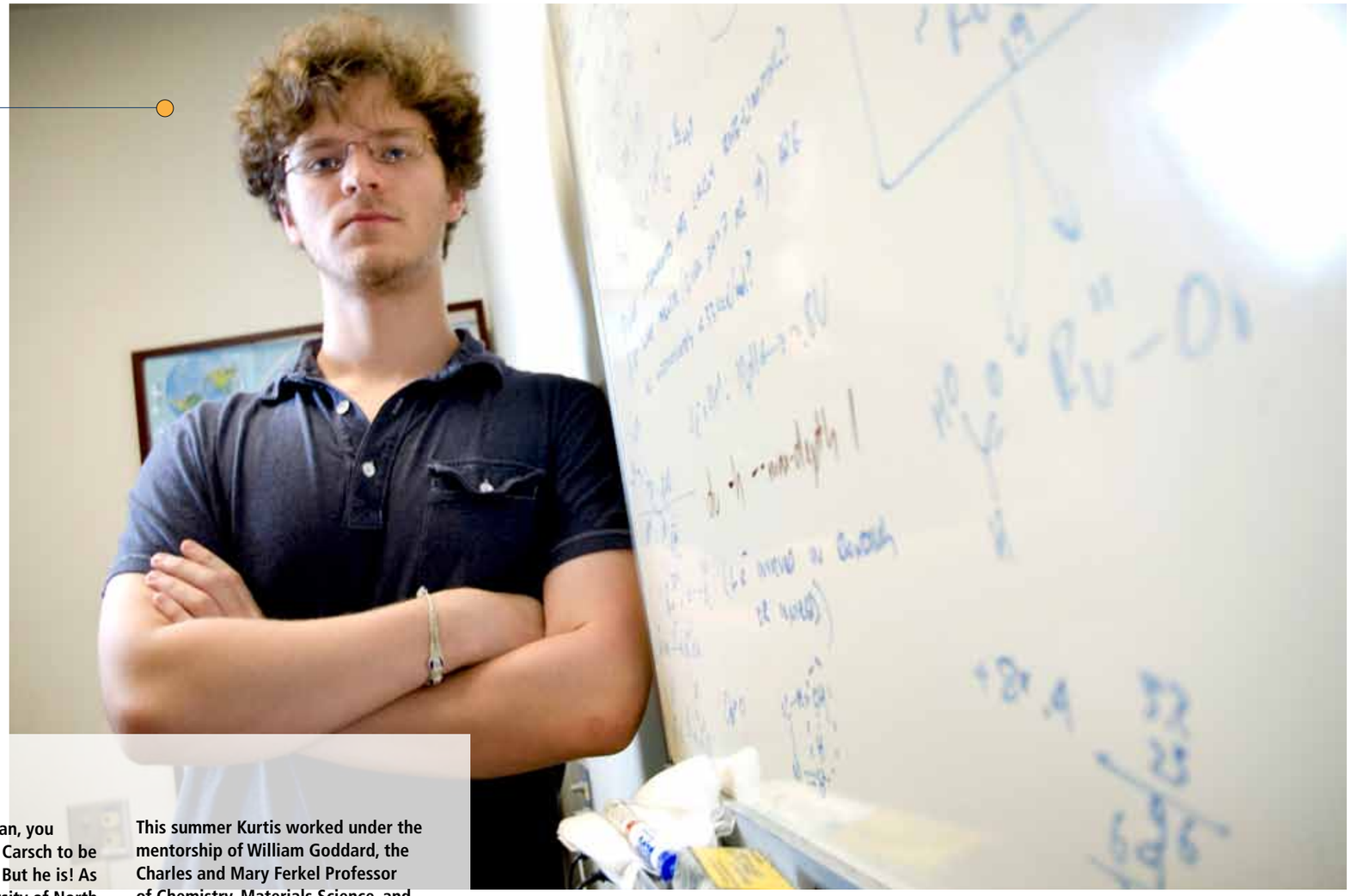


Kurtis Carsch

As an incoming freshman, you wouldn't expect Kurtis Carsch to be a seasoned researcher. But he is! As a student at the University of North Texas' Texas Academy of Mathematics and Science (TAMS), Kurtis worked with Dr. Tom Cundari researching catalyst molecules that would more efficiently convert methane gas into methanol. His work landed him in the finals of the prestigious Intel Science Talent Search; a lead authorship in *Computational and Theoretical Chemistry*; and a spot as the only Caltech pre-frosh in the 2012 SURF class.

This summer Kurtis worked under the mentorship of William Goddard, the Charles and Mary Ferkel Professor of Chemistry, Materials Science, and Applied Physics, and Robert Nielsen, scientific researcher in the Goddard group. Continuing his focus on methane oxidation, he spent his summer working on C-H activation applied to electrochemical alkane oxidation. Through a computational modelling of natural gas utilization via addition of a metal-based catalyst, the group identified energy barriers that appear economically accessible and thus demonstrate viability for methane fuel cells.

BILL WAS A WONDERFUL PERSON TO WORK WITH AS AN UNDERGRADUATE BECAUSE HE HAD SUCH A BIG CHARACTER BUT WAS ALWAYS WILLING TO TALK, ESPECIALLY IF IT WAS ABOUT RESEARCH...

— Andrew Gellman (BS '81)

Since 1980, Dr. Goddard has mentored sixty-five SURF and MURF students. His first two students have become professors, no doubt with undergraduate mentoring experience of their own.

Andrew Gellman
(BS '81, CH; SURF '80)

Carnegie Mellon University
Head of Chemical Engineering and
Lord Professor of Chemical Engineering, Chemistry, Materials Science, and Engineering

"As an undergraduate in the late 1970s, I was asked to work on a project to develop a means of calculating 'effective potentials' to represent the core electrons of atoms in Hartree Fock calculations. I learned early on from the other students that the rest of the world referred to these as pseudo-potentials, but Bill hated the 'pseudo-nym' and insisted on calling them effective potentials. At the time no one had managed to get this to work right, so this was a fairly big challenge to hand to an undergrad but in blissful ignorance I managed to make some progress."

Susan Gardner
(BS '82, PH; SURF '80)

University of Kentucky
Professor of Physics and Astronomy

"I fondly recall that I began my research career as a ``Weenie"—I was a SURF student in Bill Goddard's molecular quantum mechanics group. We all referred to Bill as WAG, and we played softball as "WAG's Weenies," the phrase being loosely evocative of the generalized valence bond orbitals that the group computed. WAG was a wonderful mentor, and I enjoyed my summer immensely. I had my very own project to compute, on the molecular states of PdO, which was a great thrill, and the group atmosphere was lively and supportive. I have no doubt that my SURF experience was an important impetus to my choice of a research career."

2

SURF is one of several summer undergraduate research programs affiliated with the Student-Faculty Programs office. Over 300 students conducted research as part of these allied programs:

Caltech Amgen Scholars Program

Caltech-Cambridge Exchange

Caltech-IIT Gandhinagar Exchange

Caltech-Gwangju Institute of Science and Technology Exchange

Caltech-University of Iceland Exchange

Howard Hughes Medical Institute EXROP

JPL Student Internship Program

Laser Interferometer Gravitational-Wave Observatory (LIGO)

MURF

NASA Planetary Geology and Geophysics Undergraduate Research Program

NASA Space Grant

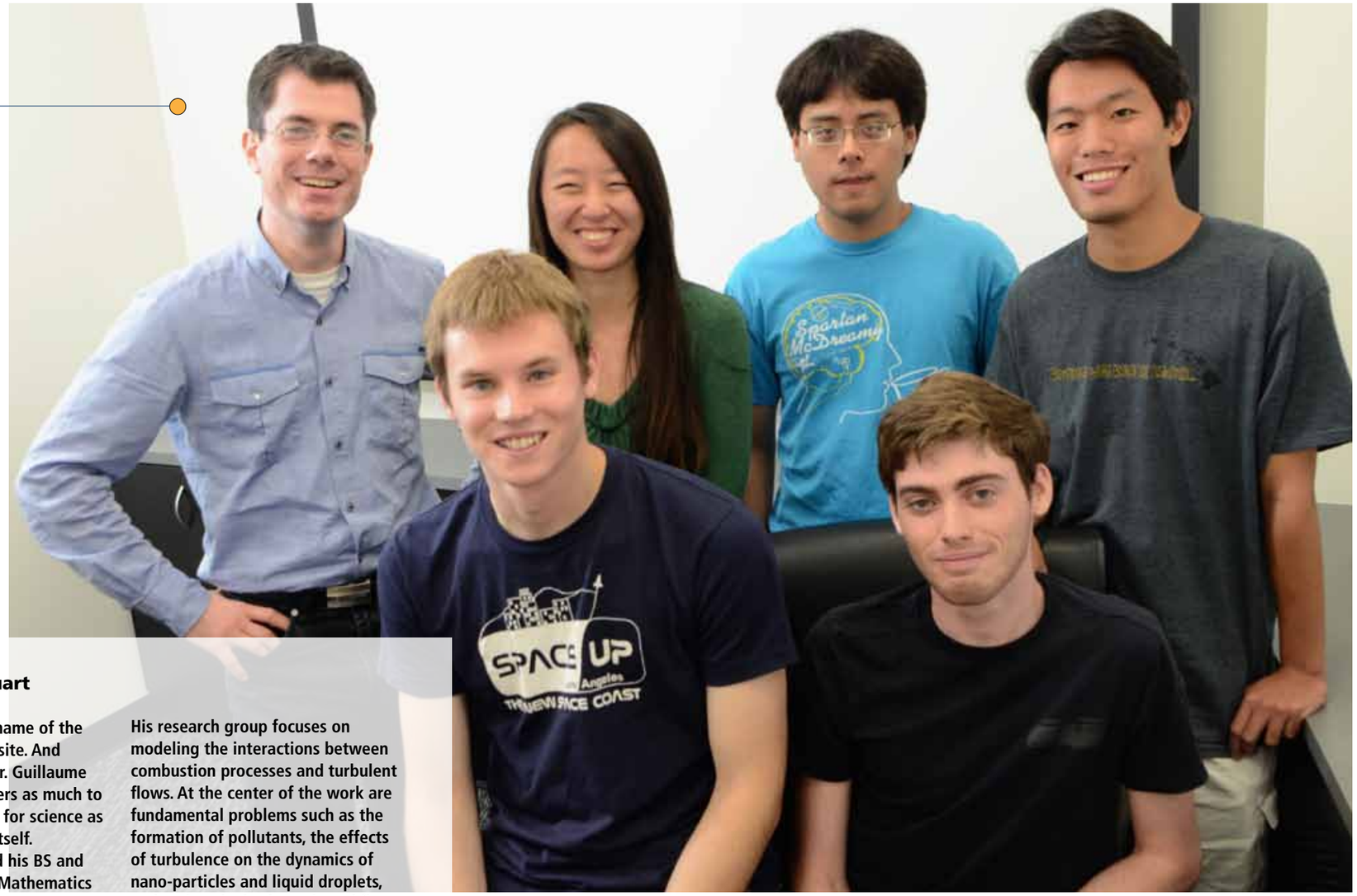
NASA Undergraduate Student Research Program

MURF SUPPORTS CALTECH'S COMMITMENT TO TRAINING A DIVERSE SET OF SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH LEADERS.

Arturo Mateos

In November 2011, Arturo Mateos, a junior from Texas A&M University, visited Caltech as part of GradPreview. The GradPreview program aims to increase the representation of underrepresented students in Caltech's doctoral programs and make Caltech's programs more visible to additional students not traditionally exposed to Caltech. During that visit he met Michael Ortiz, the Dotty and Dick Hayman Professor of Aeronautics and Mechanical Engineering. The research of the Ortiz group on modeling and simulating the response of materials from hypervelocity impact was of immediate interest. As a high school student at The Awty International School of Houston, Arturo became interested in space debris and its effect on spacecrafts. This summer as a MURF Fellow, Arturo worked with Dr. Ortiz on a project entitled A Multivariate Piecewise-Linear Interpolation Approach for Solid Mechanics Simulations. This year Arturo will be applying to Ph.D. programs. We hope to see him back at Caltech!

3



Guillaume Blanquart

The FORCE. That's the name of the Blanquart group's website. And anyone who has met Dr. Guillaume Blanquart knows it refers as much to his energy and passion for science as it does to the science itself.

Blanquart received his BS and his first MS in Applied Mathematics from École Polytechnique in France in 2002. He received a second MS in Aeronautics and Astronautics in 2004 and his PhD in Mechanical Engineering in 2008, both from Stanford University. He continued as a Postdoctoral Scholar under the supervision of Professor Heinz Pitsch at Stanford University before joining Caltech in 2009. In 2011 he received both the U.S. Department of Energy Office of Science Early Career Research Award and the National Science Foundation's Faculty Early Career Development Award.

His research group focuses on modeling the interactions between combustion processes and turbulent flows. At the center of the work are fundamental problems such as the formation of pollutants, the effects of turbulence on the dynamics of nano-particles and liquid droplets, and various hydrodynamic and flame instabilities.

In three short summers, Blanquart has already served as a SURF mentor to thirteen students. His students describe him as a committed teacher and mentor and as someone who likes to have fun. This includes playing practical jokes and pranks in the lab! But most importantly, working in the Blanquart group has helped students understand the research process and as a result better understand their own passion for science.

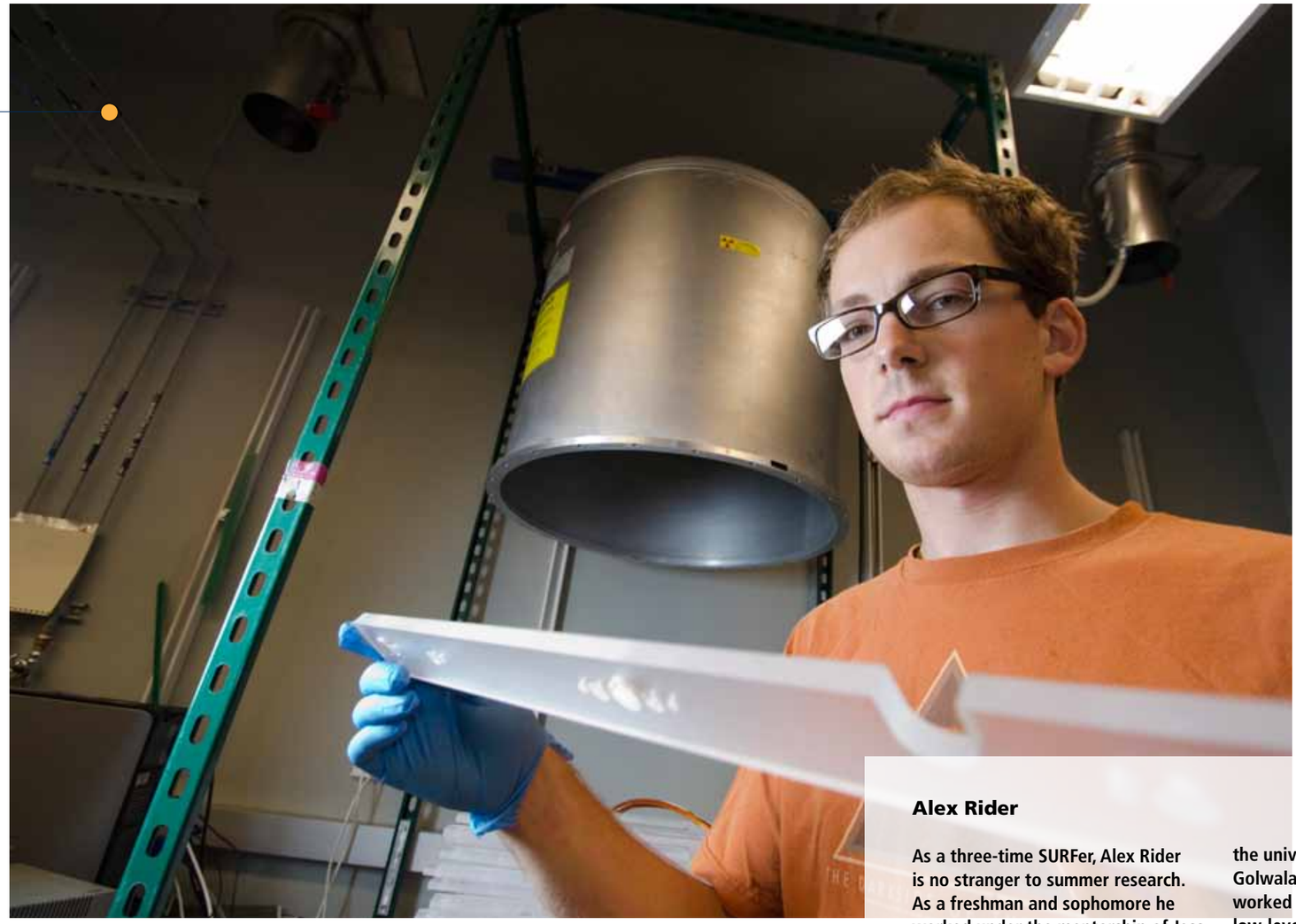
"Working in the Blanquart group was an incredibly fun and rewarding experience. The group is small, the people are close, and the informal working environment influenced us to be open-minded and creative when we approached problems. The size also meant that we SURF students were able to work closely with the professor, and we discussed our projects with him at least once a week. It's surprising how quickly I learned under the guidance of the professor and my graduate student mentor."
Yifei Huang, Class of '13

MY SUMMER RESEARCH…ALLOWED ME TO LEARN THINGS THAT I WOULDN'T HAVE LEARNED IN ANY CLASS. IT ALSO HAS LET ME APPLY MY CLASSROOM KNOWLEDGE TO A REAL-WORLD APPLICATION.

— David Choy (BS '12 ME)

4

Alex was a Rose Hills Foundation SURF Fellow this summer. The Rose Hills Foundation is a legacy created by the founders of the Rose Hills Memorial Park, which is the largest cemetery in North America and is located in the city of Whittier. The Foundation supports organizations in Southern California, with an emphasis on programs that benefit the people of Southern California. In 2007, the Rose Hills Foundation generously committed to support fifteen SURF students each year, for five years. These students must demonstrate a strong academic record and be from Southern California.



I LEARNED THAT THEY CALL HARDWARE HARD FOR A REASON. I LOVED THE CHALLENGE.

— Alex Rider, Class of '13

Alex Rider

As a three-time SURFer, Alex Rider is no stranger to summer research. As a freshman and sophomore he worked under the mentorship of Jess Adkins, Professor of Geochemistry and Global Environmental Science. During those two summers and the academic year in between, Alex explored the geochemistry of the Buda Cave system, using the isotopes of the uranium decay series as a way to better understand past climates. This summer he turned his attention away from the dark matter of caves towards the dark matter of the universe. Working with Dr. Sunil Golwala, Professor of Physics, Alex worked to characterize a device for low-level radiation screening called a BetaCage. According to Alex, this type of detector uses gas as a detection medium, which has a very low mass and therefore an inherently low background. This allows for less contamination and better measurements. This year, as a senior, Alex is continuing his project for his senior thesis. His plans after graduation: take a job for a year and then head to graduate school.

5

In general 20 – 25% of SURF students become a co-author on a peer-reviewed journal article as a result of their summer work. This is usually not the case in math, however, where it can be more difficult for an undergraduate to make such a contribution. In just three years, seven of the Marcolli SURFers have seen their name in print.

Boundary conditions of the RGE flow in the noncommutative geometry approach to particle physics and cosmology (Daniel Kolodrubetz and Matilde Marcolli) *Physics Letters* B 693 (2010) 166-174

Spin foams and noncommutative geometry (Domenic Denicola, Matilde Marcolli, and Ahmad Zainy al-Yasry) *Classical and Quantum Gravity* 27 (2010) 205025 (53pp)

The Ricci flow on noncommutative two-tori (Tanvir Ahamed Bhuyain and Matilde Marcolli) *Letters in Mathematical Physics* Vol.101 (2012) N.2, 173-194

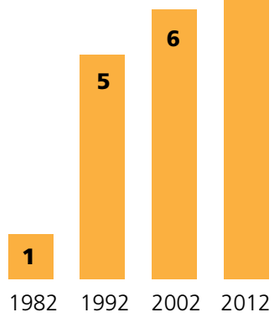
Noncommutative mixmaster cosmologies (Christopher Estrada and Matilde Marcolli) to appear in *International Journal of Geometric Methods in Modern Physics*

Codes as fractals and noncommutative spaces (Matilde Marcolli and Christopher Perez) to appear in *Mathematics in Computer Science*

Arithmetic of Potts model hypersurfaces (Matilde Marcolli and Jessica Su) to appear in *International Journal of Geometric Methods in Modern Physics*

Thermodynamic semirings (Matilde Marcolli and Ryan Thorngren) to appear in *Journal of Noncommutative Geometry*

Number of math SURFs by decade



Matilde Marcolli

Over the years Math SURFs have been a rarity. This is due partly to the independent nature of mathematicians' research and in part to limited funding to support such efforts. However in recent years the faculty in Mathematics, along with the SURF office, has worked to increase the number of SURF opportunities and funding. And, with the commitment and enthusiasm of mentors such as Dr. Matilde Marcolli, this may just be the beginning of a growth spurt!

In 2009, Dr. Matilde Marcolli, Professor of Mathematics, mentored her first two SURF students. In 2010, she mentored 3; 2011, 4; and 2012, 5. Even with this writer's limited understanding of mathematics, I can spot a pattern. Marcolli's research reaches across disciplines in various areas of mathematics and theoretical physics. In particular, her research interests span from gauge theory and low-dimensional topology and algebraic-geometric structures in quantum field theory to noncommutative geometry with applications to number theory and to physical models. Her teaching interests are even more varied. Recent courses include Ordinary Differential Equations to Sanskrit for Modern Scientists to The (Martial) Art of Giving Talks.

ALUMNI SPOTLIGHT

Tina Dwyer '06 is fascinated with the moon. The former Caltech undergrad has been interested in astronomy and science ever since she was a kid, she says. But it wasn't until she did a Summer Undergraduate Research Fellowship (SURF) project at Caltech that her passion for the moon and planetary science ignited. "My SURF project kicked my interest in the moon to high gear," she says. She worked with professor of geobiology Joe Kirschvink and then-postdoc Ben Weiss on mapping the magnetic fields of tiny moon rocks—glass beads found in the lunar soil. "I spent two summers on that project, and it was awesome."

Then, in the spring of 2005, she took a planetary-interiors course taught by professor of planetary science Dave Stevenson. For the class, students had to do a small research project, and one of the suggested topics was about solving a decades-long lunar mystery: how did the ancient moon power its now-defunct magnetic field? "I grabbed onto that idea," she says.

Earth's magnetic field is powered by energy from its core, which causes the molten outer core to churn. Because the liquid outer core is primarily made out of electrically conductive iron, the fluid motions generate electric currents, which then produce a global magnetic field. The moon, however, is too small, so it doesn't have enough energy in its core to sustain a magnetic field. Scientists were puzzled, then, when the Apollo astronauts brought back magnetic moon rocks, which could only arise in the presence of an ambient magnetic field. Since then, researchers have been trying to come up with a satisfying explanation.

"For 40 years, people have been sitting there, scratching their heads, going, how do we do this?" Dwyer says. For her research project, she proposed that instead of being powered by heat—like in the Earth—the moon's magnetic field could have been driven by the physical stirring of its liquid core. After graduating from Caltech in 2006, she went to graduate school at the University of Washington, where she studied experimental geochemistry. Now she's pursuing her PhD at UC Santa Cruz, where she's returned to planetary science—and the research project she started at Caltech. With Stevenson and Francis Nimmo of UCSC, Dwyer refined her earlier work, and the team has published their findings in the November 10 issue of the journal Nature.

THE MAGNETIC MOON

Researchers propose new theory for the moon's ancient magnetic field

by Marcus Woo

"Our story ties in with ideas of how the moon formed and evolved in its orbit," Stevenson says. Earth's gravity pulls on the moon in a way that causes the moon's liquid core and mantle to spin around axes that are at a slight angle with respect to each other. As a result, instead of spinning as a single object, the core and mantle rotate separately. The differences in their motions are small today, but the moon—which is currently moving away from Earth at a rate of a few centimeters per year—was much closer to Earth when the lunar magnetic field existed a few billion years ago. Because of its closer distance, the gravitational interactions were more powerful, leading to a bigger difference in rotation between the core and mantle. Dwyer and her colleagues calculated that, in the past, the difference was pronounced enough to generate a magnetic field.

Over time, as the moon drifted farther away, the difference in motion lessened, and the magnetic field eventually died. "The fact that we have a way to turn off the magnetic field is a very exciting aspect of this model," Dwyer says, although she stresses that more research—including the development of computer models to study the mechanism in detail—is necessary to show that the theory is viable.

HIGHLIGHTS OF **SUMMER**

Wednesday Seminar Series

Providing students an opportunity to learn about research across campus

2011

David Prober
Assistant Professor of Biology
Genes, Drugs, and Neurons that Regulate Zebrafish Sleep

Guillaume Blanquart
Assistant Professor of Mechanical Engineering
Old and New Concepts: The Challenges of Combustion

John Grotzinger
Fletcher Jones Professor of Geology
Mars Science Laboratory: The Search for Habitable Environments

K. Mani Chandy
Simon Ramo Professor and Professor of Computer Science
SURF, Engineering, and Science for Society

Christian Ott
Assistant Professor of Theoretical Astrophysics
Listening to the Sound of Cosmic Explosions

Nicolas Wey-Gomez
Professor of History
Columbus and the Conquest of the Tropics: Tracking the Early History of Globalization (1434-1529)

Dianne Newman
Professor of Biology and Geo-biology; Investigator, Howard Hughes Medical Institute
From Iron Oxides to Infections: Roles of Redox Active 'Antibiotics' in Microbial Survival and Development

2012

Richard Murray
Thomas E. and Doris Everhart Professor of Control and Dynamical Systems and Bioengineering
Synthetic Biology and Molecular Programming

Glenn Orton
Senior Research Scientist, JPL
Jupiter and Saturn: Battered From the Outside, Turmoil From Within!

Erik Snowberg
Professor of Economics and Political Science
Predicting Stuff (Mostly Politics)

Lea Goentoro
Assistant Professor of Biology
Systems Biology, Evo-Devo, and the Flamingo's Smile

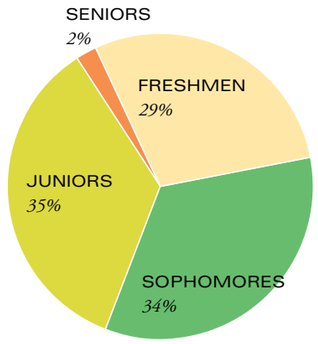
Victor Tsai (SURF '01, '02)
Assistant Professor of Geophysics
Physical Modeling Inspired by Earth Observations

Michael Brown
Richard and Barbara Rosenberg Professor and Professor of Planetary Astronomy
Pluto Is Still Dead and Other Good News

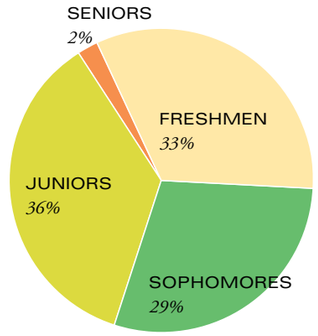
Heather Knutson
Assistant Professor of Planetary Science
The Grand Tour: Planetary Atmospheres Outside the Solar System

José Andrade
Associate Professor of Civil and Mechanical Engineering
Granular Mechanics Models for Enhanced Planetary Science

2011 SURFers



2012 SURFers



Jet Propulsion Lab Seminar Series

Providing students an opportunity to learn about the variety of research at JPL

2011

Randii Wessen
Project Formulation Support Office

Marc Rayman
Systems and Software

Sami Asmar
Radio Science Systems

Charles D. Norton
Instrument Software and Science Data Systems

Paulo Younse
Robotic Platforms

Angela Capece
Electric Propulsion

Rosaly Lopes
Geophysics and Planetary Geosciences

Tom Soderstrom and Gabriel Rangel
IT Chief Technology Office

2012

Charles Elachi
JPL Director

Charles Norton
CubeSats

Khawaja Shams and Tom Soderstrom
Computer Science

Joy Crisp
MSL Science

Gregory Villar
MSL & Systems Engineering

Eric De Jong
Computer Visualization

Lauren White
Astrobiology

Nick Gautier
Exoplanets/Kepler

The William Whitney Workshops on Professional Development

Helping students make short-term career decisions in the context of long-term life and career goals

2011

Academic and Career Planning
Courtney Hunter, *Career Counselor*

Creating, Building, and Sustaining Effective Teams
Dr. Steve Matousek, *Advanced Concepts and Concurrent Engineering Methods Manager, Jet Propulsion Laboratory*

Networking: How to Make it Work for You
Caltech alumni, faculty, and friends

How an Idea Becomes a Business
Dr. Ken Pickar, *Visiting Professor of Mechanical Engineering,* and Fred Farina, *Assistant Vice President, Office of Technology Transfer*

2012

Making the Most of Your Summer, and Beyond
Dr. Varoujan Gorjian, *Research Scientist, JPL (SURF '89, '90, '91)*
Dr. Blythe Towal, *Postdoctoral Scholar in Biology (SURF '02)*
James Berk, *Career Counselor/Pre-Health Advisor, Career Development Center*

Decisions, Decisions!
Crystal Dilworth, *Graduate Student in Chemistry and Chemical Engineering*
Ben Sveinbjornsson, *Graduate Student in Chemistry (SURF '08)*
Melissa Tanner, *Graduate Student in Mechanical Engineering (SURF '08)*
Mark Goldberg, *Graduate Student in Biology (MURF '08)*

Applying to Graduate School
Mandy Casani, *Assistant Director, Career Development Center*
Dr. Melany Hunt, *William R. Kenan, Jr., Professor of Mechanical Engineering; Vice Provost*
Dr. Joseph Shepherd, *C. L. Kelly Johnson Professor of Aeronautics and Professor of Mechanical Engineering; Dean of Graduate Studies*

Letters of Recommendation and Essays: An In-Depth Look
Lauren Stolper, *Director, Fellowships Advising and Study Abroad and Career Development Center*
Mandy Casani, *Assistant Director, Career Development Center*

More Graduate School Decisions?!
Dr. Felicia Hunt, *Associate Dean of Graduate Studies*

Networking for the Introvert
James Berk, *Career Counselor/Pre-Health Advisor, Career Development Center*

The PHD Movie
Piled Higher and Deeper, The PHD Movie

Graduate School Tuesdays 2011

Helping students think about and plan for graduate school

Decisions, Decisions!
Is graduate school for me? How do I choose a program? What school should I go to? What about funding? A panel of graduate students spoke about their own graduate school decision-making process.

Building a Foundation for Strong Letters of Recommendation
Letters of recommendation are perhaps the most important part of your graduate school application. Getting a strong letter of recommendation takes relationship building and it's never too early or late to start cultivating relationships with key faculty.

Unraveling the Mysteries Behind the GRE
Guest speaker Tom Stern from The Princeton Review shared with us how and why the GRE is structured the way it is, updated us on the new revised GRE that will be offered starting August 2011, and shared his thoughts on how to best prepare for taking the test.

The Dos and Don'ts of Graduate School Essays
Whether it is a personal statement or statement of purpose, graduate school essays are a core part of your application process. Dr. Felicia Hunt, Associate Dean of Graduate Studies, reviewed the dos and don'ts for preparing a strong essay.

Surviving and Mastering Grad School Visits
Campus visits are an important part of the application and admissions process. Dr. Felicia Hunt, Associate Dean of Graduate Studies, discussed how you can prepare for and make the most of these visits.

Becoming a Grad Student
Although it seems like a far way off, understanding what to expect during one's first year of graduate school can help students make important decisions now. This panel of first-year graduate students shared their personal stories.

SURFers 2011

Division	*Total # of Students*	*CIT Students*	*Non-CIT Students*	*Mentors*
Biology	65	62	3	28
Chemistry and Chemical Engineering	78	67	11	27
Engineering and Applied Science	126	115	11	44
Geological and Planetary Sciences	19	16	3	13
Humanities and Social Sciences	15	10	5	11
Physics, Mathematics, and Astronomy	68	61	7	35
Jet Propulsion Laboratory	30	14	16	23
Off Campus	25	25	0	24
International	5	5	0	4
Total	431*	375	56	209

SURFers 2012

Division	*Total # of Students*	*CIT Students*	*Non-CIT Students*	*Mentors*
Biology	56	47	9	27
Chemistry and Chemical Engineering	66	51	15	25
Engineering and Applied Science	116	87	29	44
Geological and Planetary Sciences	24	19	5	17
Humanities and Social Sciences	11	5	6	6
Physics, Mathematics, and Astronomy	67	62	5	35
Jet Propulsion Laboratory	44	24	20	36
Off Campus	37	37	0	37
International	7	7	0	4
Total	428*	339	89	231

**this includes LIGO and exchange SURF students*

Strengthening Effective Communication Skills

Throughout the year, SURF students are encouraged and provided opportunities to develop effective communication skills. This process begins with the research proposal which is submitted as part of the application and continues long after students give their final talk at Seminar Day. Here are just some of the ways in which students' oral and written communication skills are supported.

Prizes—The Doris S. Perpall Speaking Competition was endowed by Robert C. Perpall (BS '52, MS '56) in memory of his late wife, Doris Perpall. The prize encourages students to prepare excellent SURF presentations. The competition is a three-round event. The best SURF Seminar Day presenters, as evaluated by the session chair and a judge from the discipline, advance to a semifinal round held in November. Six to eight finalists advance to a final round held in January. The 2012 Perpall finals will be held on January 24, 2013.

2010 Winners: James Li, Michelle Jiang, Deboki Chakravarti
2011 Winners: Kevin Gu, Anum Jang Sher, Matthew Mayers

The Gee Family Poster Competition was created by Barbara and John Gee to encourage and support excellence in scientific communication. Students delivering a research poster are encouraged to learn how to present highly technical information to a general, yet educated, audience. Posters are judged on content, visual organization, and verbal presentation.

2010 Winners: Elisa Walsh, Stephanie Wuerth
2011 Winners: Angie Wang, Eli Alster, Alex Jose

CURJ—*The Caltech Undergraduate Research Journal* is an award-winning publication, dedicated to highlighting the accomplishments of the numerous undergraduates conducting research during the SURF program and throughout the academic year. CURJ is edited, designed, and published entirely by students. CURJ has repeatedly won the National Pacemaker Award, administered by the Associated Collegiate Press and widely considered to be the Pulitzer Prize of student journalism. Entries are judged on content, quality of writing and editing, art and graphics, layout and design, and theme.

Winter 2010-2011, Vol. 11 No. 1
Editors-in-Chief: Elizabeth Mak and Cindy You
Student authors: Neha Samdaria, Joe Funke, Daniel Obenshain, Eric Chang

Winter 2011-2012, Vol. 12 No. 1
Editors- in-Chief: Granton Jindal and Marvin Gee
Student authors: Zhaoying Xian, Suhail Dhawan, Diana Liskovich, Jonathan King

To view the 2011 and 2012 issues, please visit http://curj.caltech.edu/

SURFers 2011-12

	2011	*2012*
Women	43%	44%
Minorities	10%	10%
Average GPA*	3.49	3.46

** Caltech students only, excluding freshmen*

FUNDING **SURF**

Each SURF student receives an award of $6000 for the ten-week summer period, a total budget of over $2 million. Funds are raised annually from a variety of sources including gifts from individuals, foundations, and corporations. Typically mentors pay half the award, and funds raised are used as matching funds.

SURF depends upon the generosity of its many friends for annual gifts or for contributions to the SURF endowment. A robust financial base ensures that Caltech students continue to have the opportunities to engage in research with faculty.

We thank the many donors who have supported SURF 2011 and 2012, and beyond!

We are delighted to announce the establishment of four new endowments:

Samuel N. Vodopia and Carol J. Hasson SURF Endowment
Sam Vodopia, BS '54, Ricketts House, has been a long-time supporter of Caltech and the SURF program. Memories of his summer jobs while at Caltech sparked his interest in SURF. He once commented: "What better way for students to earn a stipend over the summer and have an opportunity to see first-hand what research is all about and the cooperative efforts involved." After Caltech, Sam worked at both Bell Labs and Hughes Aircraft. Carol attended Reed College and graduated in 1949 with a BS in Political Science. She is retired from the Hughes Aircraft Company, where she was a systems engineer and did real-time software programming. Over the 50+ years that she and Sam have been together, she has come to love and support Caltech and our students.

Sam Vodopia and Carol Hasson at the 2011 SURF Kickoff Dinner

Bill Davis SURF Endowment
Dr. Bill Davis was a Caltech alum who earned his Master's '50, and Ph.D. '55, in physics at Caltech. He funded this SURF endowment through his estate.

Eric T. Fung and Julie A. Buckley SURF Endowment
Eric Fung completed his BS Biology from Caltech in 1990. He completed two SURF projects under the mentorship of David Van Essen. Dr. Fung was a Howard Hughes researcher at Stanford University before joining Vermillion in 2000. He currently serves as the Senior Vice President and Chief Medical Officer. Dr. Julie A. Buckley is a board certified radiologist for the Palo Alto Medical Foundation. She earned her MD at The Johns Hopkins School of Medicine in 1995. Dr. Buckley's professional interests include cross-sectional body imaging with CT, MR, and ultrasound, as well as women's imaging.

David G. Goodwin SURF Endowment
Daniel, Ph.D. '73, and Sally Harris created this SURF endowment to honor Dr. Goodwin, Professor of Mechanical Engineering and Applied Physics, Emeritus, at Caltech. Dr. Goodwin passed away on November 11, 2012. Goodwin was best known for developing ways to grow thin films of high-purity diamond. Diamond films—transparent, scratch-resistant, and efficient dissipaters of the heat generated by high-powered computer chips—are now routinely used to protect electronic and optical components, and diamond-coated drill bits.

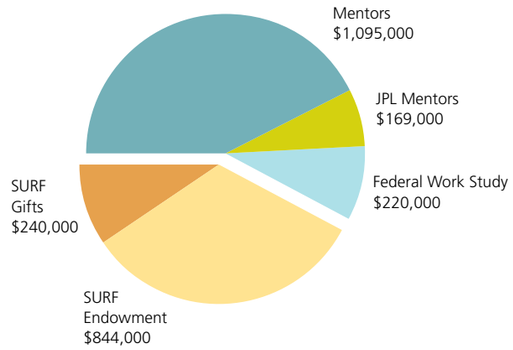
Annual Gifts
We deeply appreciate the gifts from the friends of SURF who have made contributions in all amounts to support our students in the undergraduate research enterprise. Each gift is important!

We especially thank the SURF parents and alumni contributors to the program. Their gifts are a strong testimony to the value they place on the SURF experience in the undergraduate curriculum. Through their donations Caltech alumni recognize the remarkable advantages students receive from engaging in research. Gifts may be given to SURF online at: giving.caltech.edu/CF.

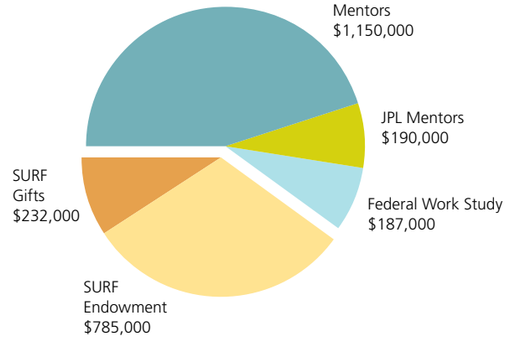
You may also mail contributions to the SURF Office, California Institute of Technology, Mail Code 330-87, Pasadena, CA 91125.

The End of the Matching Campaign
In 2005, to help meet the goal of the SURF endowment campaign, a very supportive alumnus and his wife offered $2 million as a matching challenge to other SURF donors. This fund matched up to $50,000 for those donors who contributed $75,000 towards the establishment of a SURF endowment. The result of this amazing gift was the establishment of 48 new SURF endowments and was instrumental in increasing the SURF general endowment of $10 million! The last of the matching funds was used in 2011. Ketaki Panse, a student who benefitted from one of these endowments, said it best: "We all come to Caltech, starry-eyed and with big dreams of changing the world through science and research. Your generosity makes those dreams possible." Thank you.

2011 SURF Award Funding
$2,568,000



2012 SURF Award Funding
$2,544,000



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Thanks to the generosity of many committed donors, gifts to the SURF endowment will ensure students the opportunity to conduct research for generations to come. Scholar endowments provide support for five students annually in perpetuity. Fellow endowments provide support for one student annually in perpetuity.

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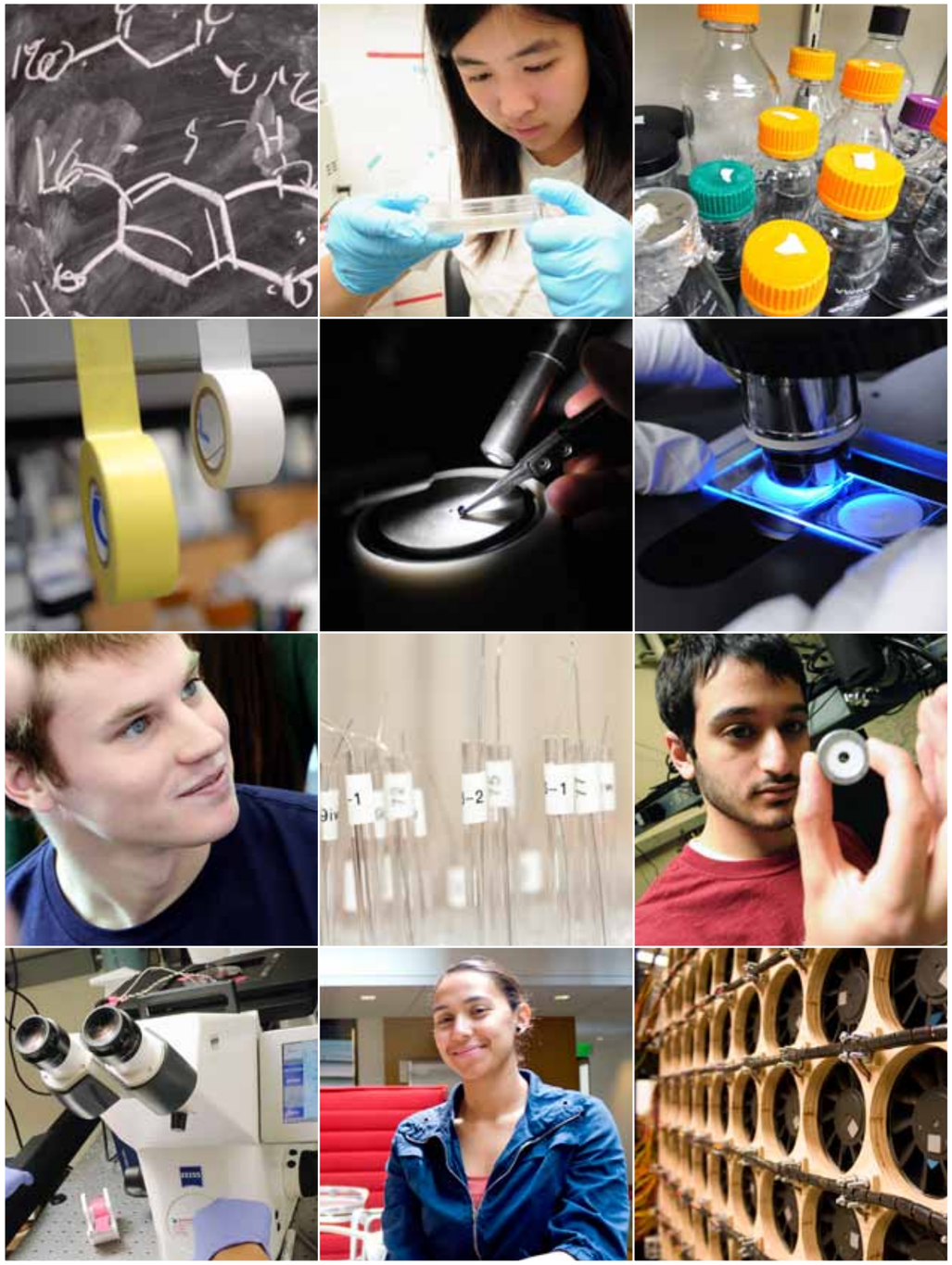

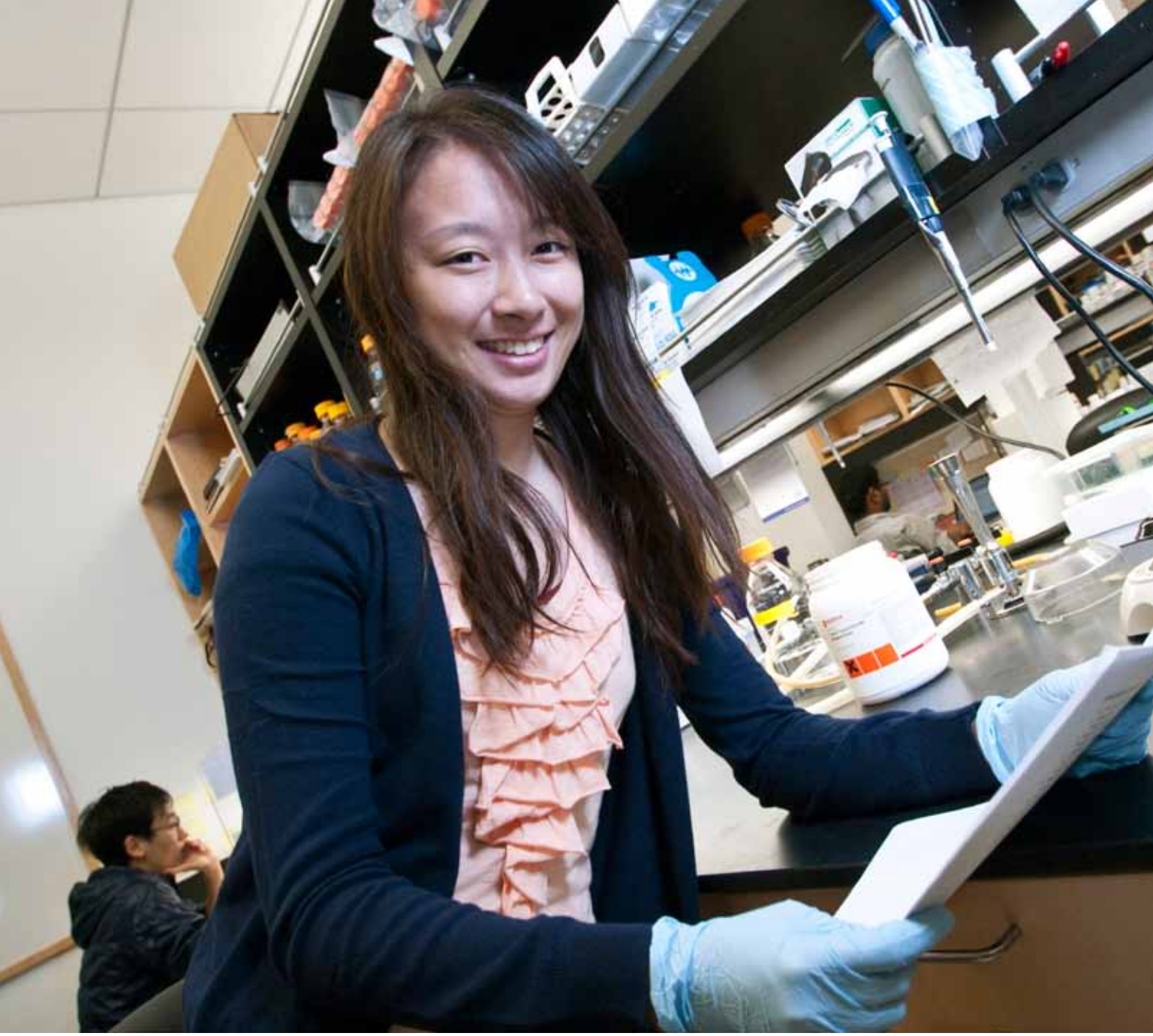

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