IT STARTS HERE.

Caltech

2014 Annual Report

It starts here. At Caltech.

Year after year, research gets its start at Caltech. In telling the story of 2014, we decided to look back at how some of today's most exciting work came to be. Read on to learn—from our people, in their words—how our faculty and students turn ideas into discoveries, and how those discoveries are transforming the world we live in.

Table of Contents

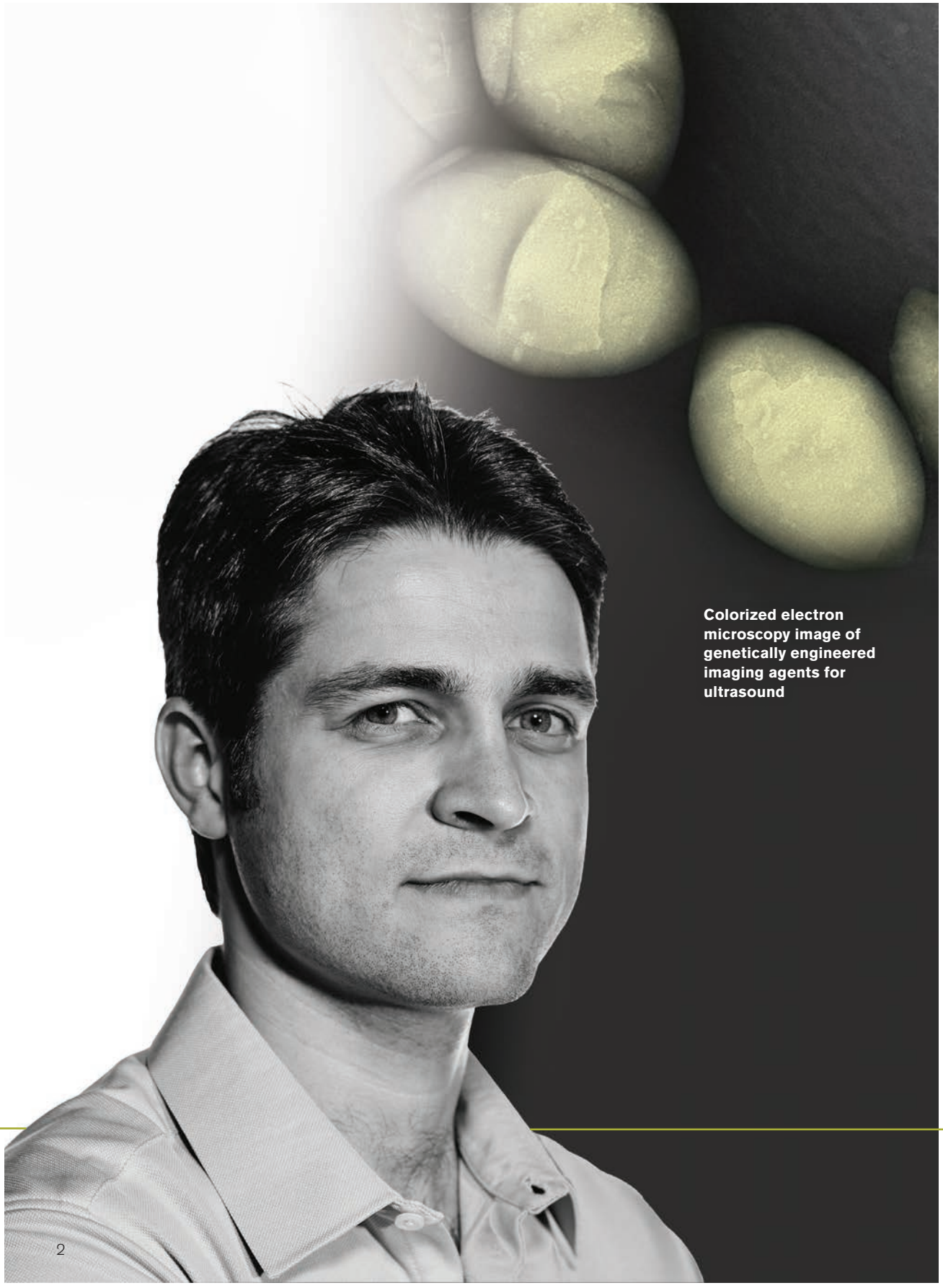
Caltech is a jewel of American higher education, a source of transformative discovery for the world. But what motivates our researchers to tackle the most difficult problems and create new fields of inquiry? To engineer technologies to probe the human brain, to understand the basis of consciousness and the neural circuitry underlying human emotion? To imagine implantable devices that can cure blindness and epilepsy?

What spurs a theoretician to send robots along the ocean floor? A historian to elucidate artistic representations of human life? Undergraduates to lead laboratory projects and author articles in top journals?

This year's report provides snapshots of extraordinary individuals and in so doing illustrates the dynamic environment at Caltech. We hope that you enjoy these stories of inspiration, intellectual adventure, and achievement.

Thomas F. Rosenbaum
President, Caltech
Sonja and William Davidow Presidential Chair and Professor of Physics

David L. Lee
Chair, Caltech Board of Trustees



Colorized electron microscopy image of genetically engineered imaging agents for ultrasound

"I started out in neuroscience in college, and I really wanted to learn how the brain works, how consciousness works, and these are still the questions that ultimately drive what my lab is interested in. But I realized at the time that we didn't have the right technologies to really probe the brain in the way I wanted to; most of its information is hidden in chemical signals deep inside the skull. So I decided to become an engineer in order to create those technologies to help us observe the brain's chemical signals from the outside without having to open it up."

That charge—which Shapiro says he's pursued with single-minded intensity ever since—has led him to explore the use of magnetic fields and sound waves to penetrate deeply yet noninvasively into the body. His research has resulted in the first biomolecular sensors that can be imaged with MRI and ultrasound. And he credits the environment at Caltech for making it possible.

"In a lot of places, if I were in a chemical engineering department, people might ask, 'Why aren't you working on a pipeline or in a refinery?' But at Caltech, working across disciplines is totally normal. And without this kind of collaboration, our vision never would have gotten off the ground. I can't imagine this happening so quickly and naturally anywhere else in the world."

Mikhail Shapiro
Assistant Professor of Chemical Engineering

When Dehn Gilmore was finishing up her first book—*The Victorian Novel and the Space of Art: Fictional Form on Display* (Cambridge, 2013)—she came across a collection of miniatures during a house tour in England. The questions of scale that the encounter brought up have resulted in her current research project, a book tentatively titled "*Large as Life": The Victorians' Disproportionate Reality*.

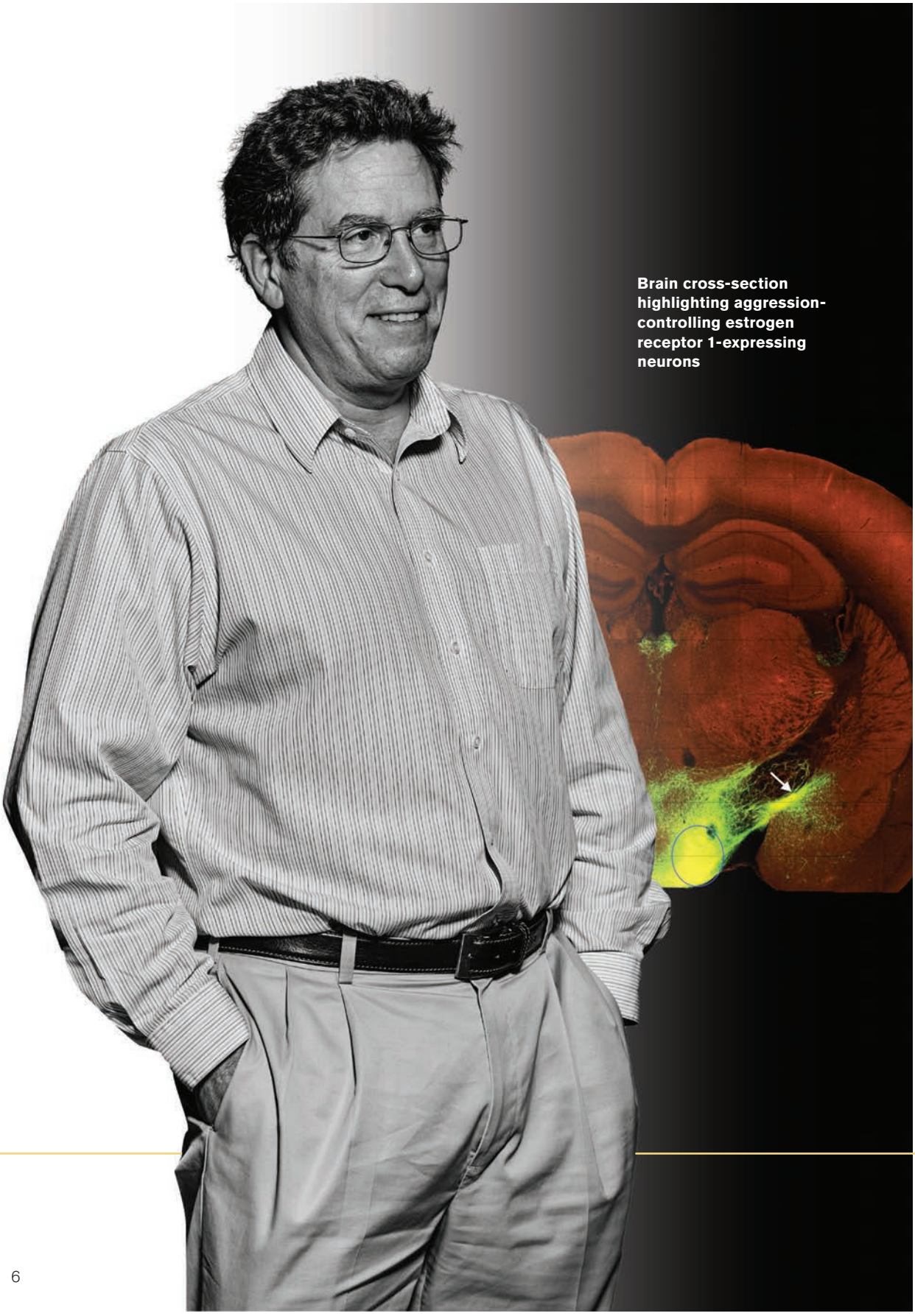
"The Victorians were obsessed in ways that we have not necessarily realized before with life-sized representation, whether that's the wax models at Madame Tussaud's, anatomical models, or even the life-size statue made out of sugar that somebody put together for Queen Victoria.

"The phrase 'large as life' actually comes to its modern meaning in the Victorian period, but it starts more as a classification of size. As the project is shaping up, it's also starting to become about 'history of science' things—like automata and anatomical models—and a lot of the questions I'm thinking about are questions of objectivity versus subjectivity.

"As somebody whose work is half history and half literature, it was really exciting to join a department that's genuinely interdisciplinary, and that fosters conversations across fields—across English, across history, across the history of science. Being around people who are so engaged by their research is very inspiring. In moments when you're full of doubt or exhaustion, it makes you want to get back into it."

Dehn Gilmore
Professor of English

Victorian-era mechanical toy carousel



Brain cross-section highlighting aggression-controlling estrogen receptor 1-expressing neurons

"I like to get into a field at the beginning, when there aren't too many people thinking about it and working on it. Staying focused on a topic within a mature field can be rewarding, but the downside is that your contributions tend to become more and more incremental and it's harder to make big discoveries."

In the 1990s, David Anderson—already renowned for his work on the development and function of the nervous system—began refocusing his research and exploring the neural circuits underlying emotional behavior. Anderson helped bring to his new field of study a transformative molecular biological toolkit that provided unprecedented ways to determine which neural circuits provoke specific emotions, such as fear or anger.

"The change in field has been very productive: we've gotten fairly sophisticated in our ability to mark, map, measure, and manipulate neuronal activity in a way that will ultimately allow us to construct an integrated picture of what is happening in the brain when an animal is afraid or angry—and where that is encoded. Which could eventually lead us to a better understanding of forms of aggression like impulsive violence."

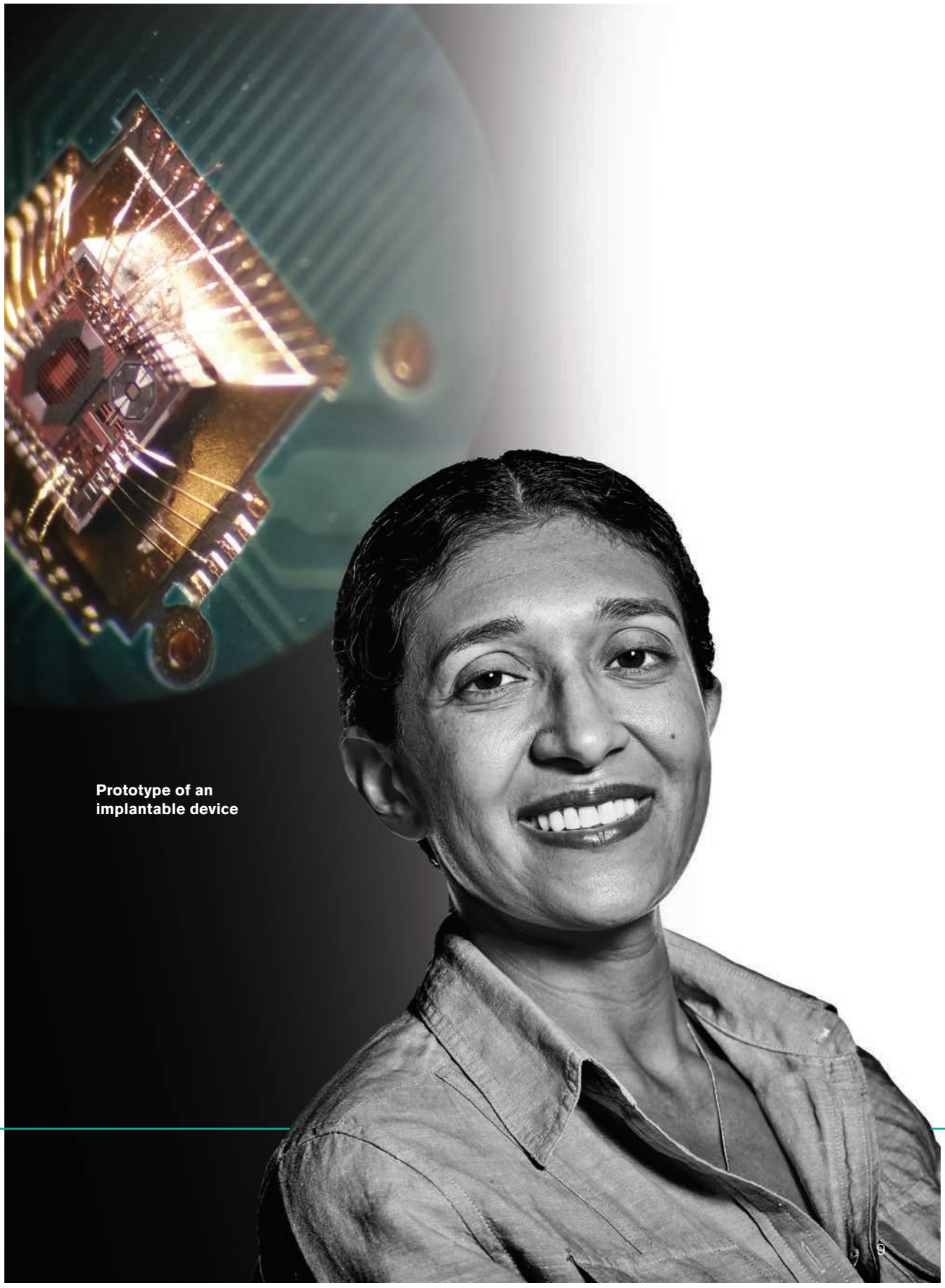
David Anderson
Seymour Benzer Professor of Biology

"I have a sister who suffers from epilepsy, and there is evidence that neurostimulation—the therapeutic activation of part of the nervous system using microelectrodes—can help minimize the symptoms. This is one of my inspirations for directing part of my research team's efforts towards neural interfaces."

When she joined the Caltech faculty in 2007, Azita Emami added her expertise in implantable devices to a research collaboration involving electrical engineer Yu-Chong Tai and other Caltech researchers. This group is developing a tiny retinal implant that fits within the eye and allows blind people to recognize faces as well as read. The current prototype of the implant supports 512 stimulation channels and features wireless power delivery and data transmission.

"Although my current research—creating a new retinal implant that allows people to see efficiently and do everyday tasks without assistance—isn't going to affect my sister directly, it is moving the field forward and we are learning more about the brain. For instance we are learning how to use its power to fix what has gone wrong. This will ultimately help many people."

Azita Emami
Professor of Electrical Engineering



Prototype of an implantable device

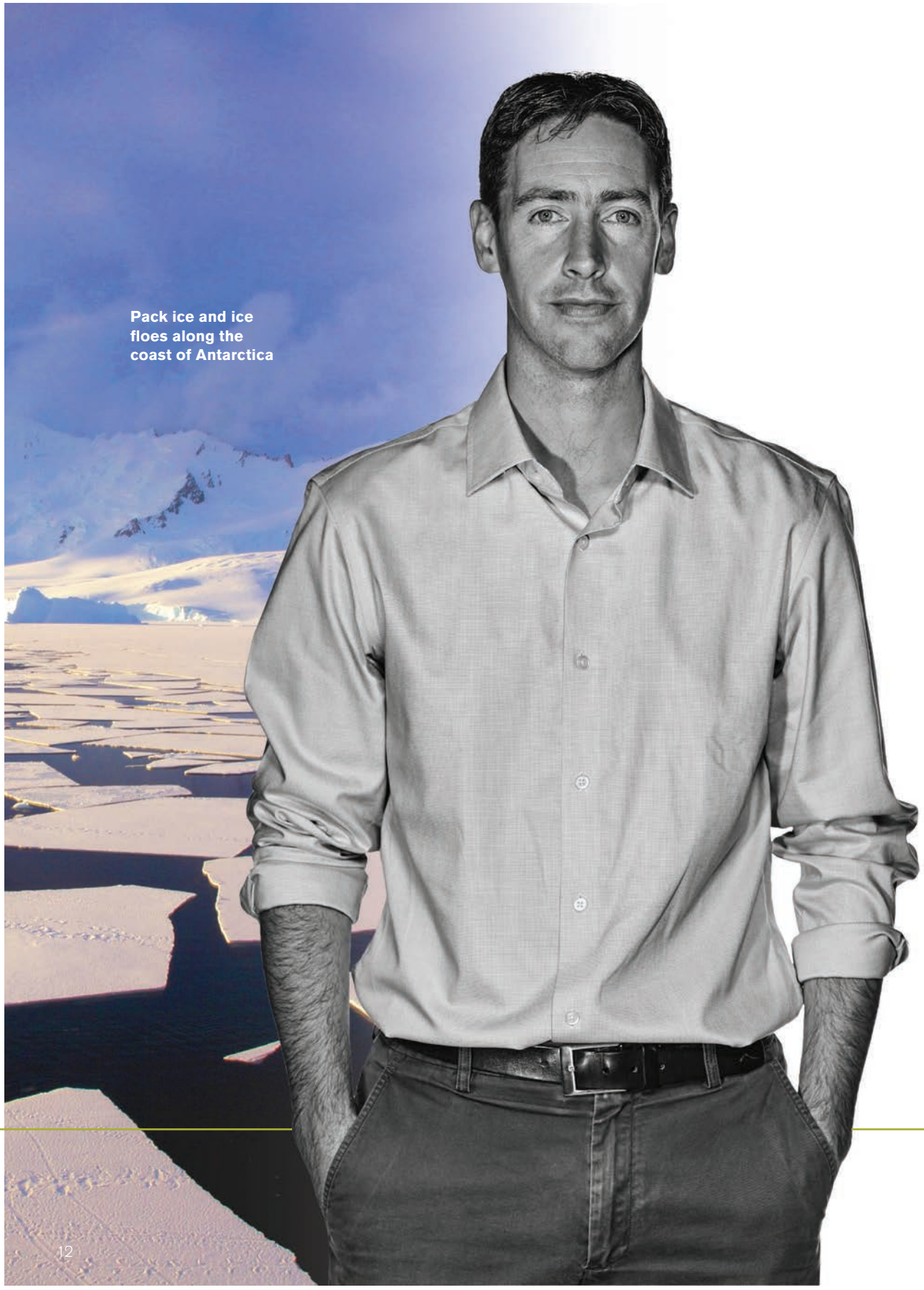
In October, Caltech inaugurated Thomas Rosenbaum as the Institute's ninth president in a ceremony that brought students, faculty, and staff together with local community members, elected officials, and academic leadership. More than just an opportunity to celebrate the beginning of a new presidency, the inauguration was an occasion to recall—and reconnect with—the values that have animated Caltech since its founding more than a century ago.

As Rosenbaum remarked in his inaugural address, "Caltech researchers . . . have contributed in considerable part the quintessential new knowledge that makes our society worth defending. But I would argue that Caltech's most formidable contribution has been in introducing a novel approach to discovery, a conception of research that has permitted the Institute to found new schools of thought. This approach derives from the Institute's origins . . . and it continues to provide a wealth of cultural capital. As the inheritors of this cultural capital, we must be attentive to its worth, defending our values in a sometimes indifferent and even hostile world, while at the same time seeking to hone Caltech's distinctive identity.

"It is a time to ensure that Caltech's fundamental identity comes from within and that it is never imposed from without. It is an opportunity for us to distill the hard-won experience of the past so that we may create a sense of magic and wholeness for the future."

New Beginnings


CALIFORNIA INSTITUTE OF TECHNOLOGY
1891



Pack ice and ice floes along the coast of Antarctica

Andrew Thompson had always assumed he would join a traditional oceanography institute—somewhere he could carve out a niche and pursue his research into how ocean eddies redistribute heat and nutrients.

But when Thompson began looking for a home for himself and his research, he began hearing about Caltech's interest in expanding work in the area of climate science. And then there were the robots: autonomous vehicles that glide through the ocean, measuring everything from polar ice melt to ocean levels. Thompson wanted them, and Caltech was ready and able to hand them over to him.

"Caltech was willing to give someone who had mostly done theory on numerical models the keys to these ocean gliders. They basically said, 'We believe in the work you're doing—even though you haven't done it before—so go and do it, and if it doesn't work out, don't worry about it. You have to try things that are a bit crazy.'

"The gliders are at a stage now where less of the effort is on the engineering side of getting them ready; now, they are tools that we can use to actually get at the science we want to do. We're getting observational data back from them that we can use to increase our understanding of ocean circulation."

Andrew Thompson
Assistant Professor of Environmental Science and Engineering

High-energy X-ray mapping of the Cassiopeia A supernova remnant

"When I started on the faculty at Caltech, in 1995, I had this idea that I wanted to focus high-energy X-rays with a space telescope for the first time. But we didn't yet have the technologies—the mirrors, the detectors—to do this. So I joined the Institute's Space Radiation Lab, which allowed me the opportunity to work with excellent, experienced engineers who designed electronics and detectors. Also, with JPL being so close and supportive, Caltech provided a uniquely encouraging environment for me."

Fiona Harrison's idea—an expansion of work she had done as a graduate student to build a balloon-borne X-ray telescope—came to fruition and worldwide attention in June 2012 with the launch of the Nuclear Spectroscopic Telescope Array (NuSTAR), which has been exploring the heavens ever since. This year alone, NuSTAR's explorations have yielded information about a pulsating dead star that beams with the energy of about 10 million suns, and a map of the radioactive material from the core of a supernova explosion.

"There's a certain amount of risk associated with starting as a junior faculty member trying to work on something that has to go into space to get results. But Caltech is a place that truly believes that if something is hard and worthwhile, you should do it. And that has really paid off."

Fiona Harrison
Benjamin M. Rosen Professor of Physics

Ellen Price has been the lead author on two astronomy research papers—and she hasn't even received her undergraduate degree. This Caltech senior grew up with two scientist parents and an innate interest in the sciences that was carefully cultivated throughout high school. But it wasn't until she got to Caltech that she was able to carve out her path for the future.

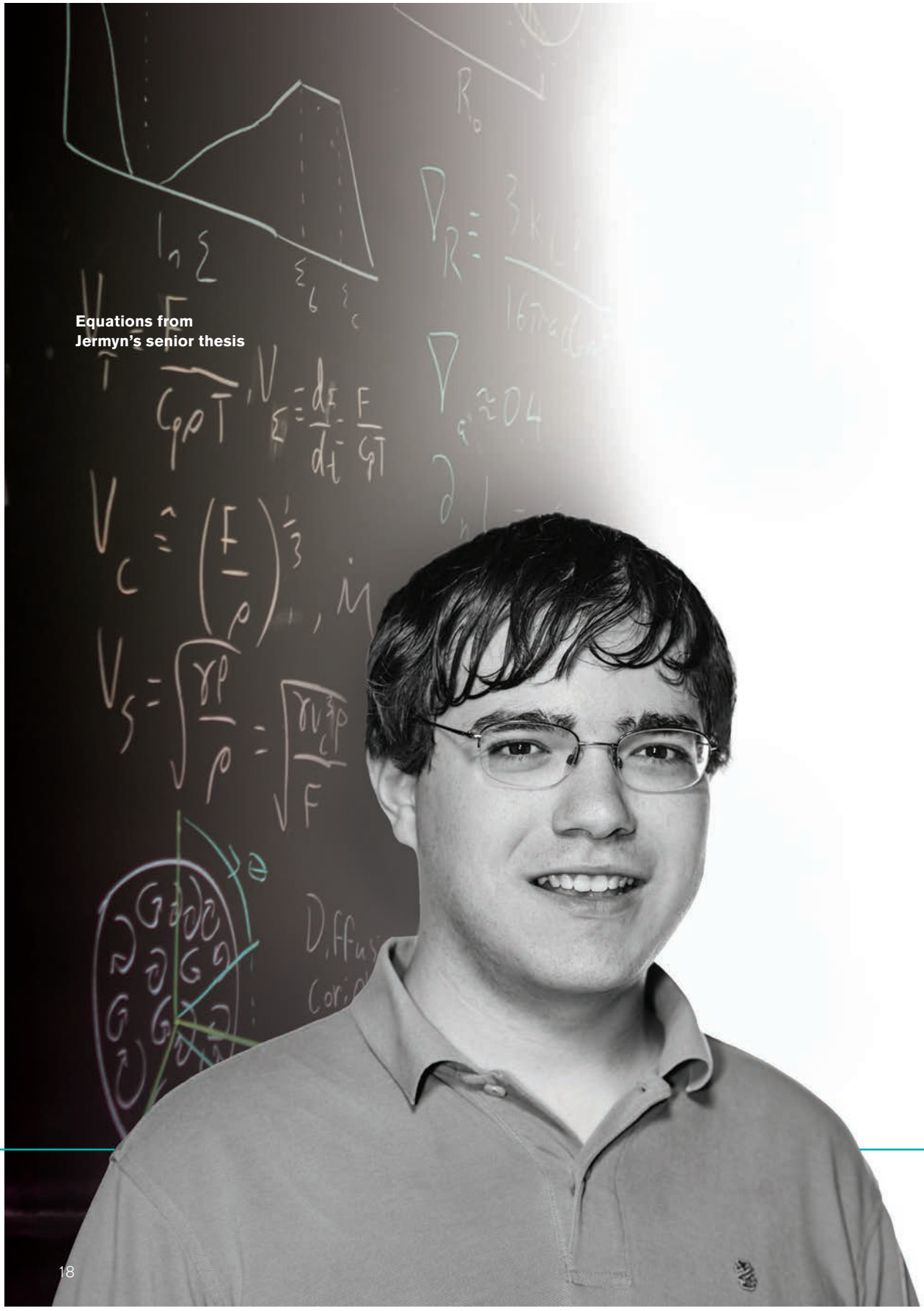
"As a sophomore, I enrolled in Astronomy 20 with John Johnson, who approached me to work on a project with him—even though I didn't know anything about exoplanets! Over the three years I've worked with the exoplanet team at Caltech, I feel like I've contributed significantly to the project."

Those contributions led to a paper on transit light curves with finite integration time published in 2014, and another on the photoeccentric effect for planets of various sizes, set to be published in 2015.

"One of the best parts of my time here at Caltech has been being able to do so much hands-on research; I never imagined I would be able to go so far. The professors here have had such an impact on me, and it's because I want to be able to do that for future students that I am planning to pursue a career in academia."

Ellen Price
Caltech Senior

Artist's conception of a newly discovered exoplanet



Equations from Jermyn's senior thesis

For senior Adam Jermyn, studying science in college was a no-brainer. The tricky part was focusing on just one area. As a freshman, he came to Caltech to study physics; later, he changed his focus to study biology after his grandfather was diagnosed with Alzheimer's. Then, as a sophomore, he was encouraged by his statistical physics professor, Jason Alicea, to study condensed-matter physics; a graduate student invited him to do research on solar energy with Harry Atwater; and he took his first trip to the Palomar Observatory with Nick Scoville, which helped reignite a passion he has always had for astronomy. Jermyn will graduate this June with a degree in physics, and as both a Marshall Scholar and a Goldwater Scholar.

"I never had room in my schedule to take the intro astronomy course that Dr. Scoville taught, but every year I would email him and ask him if I could tag along with that class to Palomar. It eventually dawned on me: If I'm this interested in astronomy, then why am I not doing it?

"I've taken a strange path through this place. I've been distracted by all the shiny course offerings, but ultimately I'm here to do research, to be challenged. Amazingly, Caltech let me find my own challenges, and that helped me find my own way."

Adam Jermyn
Caltech Senior

Awards

NATIONAL AWARDS AND HONORS

AMERICAN ASTRONAUTICAL SOCIETY, Lifetime Achievement Award:
Edward C. Stone
David Morrisroe Professor of Physics; Vice Provost for Special Projects

2014 PRESIDENTIAL EARLY CAREER AWARD FOR SCIENTISTS AND ENGINEERS, Recipient:
Theodor Agapie
Professor of Chemistry

NATIONAL ACADEMY OF INVENTORS, Fellow:
Frances H. Arnold
Dick and Barbara Dickinson Professor of Chemical Engineering, Bioengineering and Biochemistry; Director, Donna and Benjamin M. Rosen Bioengineering Center

David Baltimore
President Emeritus; Robert Andrews Millikan Professor of Biology

Carver Mead
Gordon and Betty Moore Professor of Engineering and Applied Science, Emeritus

Axel Scherer
Bernard Neches Professor of Electrical Engineering, Applied Physics and Physics

NATIONAL INVENTORS HALL OF FAME, Inducted:
Frances H. Arnold
Dick and Barbara Dickinson Professor of Chemical Engineering, Bioengineering and Biochemistry; Director, Donna and Benjamin M. Rosen Bioengineering Center

NATIONAL ACADEMY OF SCIENCES, Member:
Gregory C. Fu
Altair Professor of Chemistry

Fiona A. Harrison
Benjamin M. Rosen Professor of Physics

John P. Preskill
Richard P. Feynman Professor of Theoretical Physics

NATIONAL INSTITUTES OF HEALTH, 2014 BRAIN Award:
David J. Anderson
Seymour Benzer Professor of Biology; Investigator, Howard Hughes Medical Institute

Michael H. Dickinson
Esther M. and Abe M. Zarem Professor of Bioengineering

Viviana Gradinaru
Assistant Professor of Biology

Markus Meister
Anne P. and Benjamin F. Biaggini Professor of Biological Sciences

Michael L. Roukes
Robert M. Abbey Professor of Physics, Applied Physics, and Bioengineering

Mikhail G. Shapiro
Assistant Professor of Chemical Engineering

Thanos G. Siapas
Professor of Computation and Neural Systems

Doris Y. Tsao
Professor of Biology

Changhuei Yang
Professor of Electrical Engineering, Bioengineering, and Medical Engineering

NASA HONOR AWARDS:
James J. (Jamie) Bock
Professor of Physics; Jet Propulsion Laboratory Senior Research Scientist

Christopher Martin
Professor of Physics

INTERNATIONAL AWARDS AND HONORS

2014 PRINCE OF ASTURIAS AWARD FOR TECHNICAL AND SCIENTIFIC RESEARCH, Recipient:
Mark E. Davis
Warren and Katharine Schlinger Professor of Chemical Engineering

2014 SPIE, George W. Goddard Award, Recipient:
James J. (Jamie) Bock
Professor of Physics; Jet Propulsion Laboratory Senior Research Scientist

ORDER OF THE SACRED TREASURE GOLD AND SILVER STAR, JAPAN, Recipient:
Hiroo Kanamori
John E. and Hazel S. Smits Professor of Geophysics, Emeritus

THE ROYAL SOCIETY, Fellow:
Vladimir Markovic
John D. MacArthur Professor of Mathematics

SOCIETY OF SYNTHETIC ORGANIC CHEMISTRY, JAPAN, 2015 Mukaiyama Award:
Brian Stoltz
Professor of Chemistry

KODANSHA PRIZE FOR SCIENCE BOOKS, JAPAN, Recipient:
Hirosi Ooguri
Fred Kavli Professor of Theoretical Physics and Mathematics; Deputy Chair of Physics, Mathematics and Astronomy

AWARDS AND HONORS FROM PROFESSIONAL SOCIETIES

2014 ALBANY MEDICAL CENTER PRIZE IN MEDICINE AND BIOMEDICAL RESEARCH, Recipient:
Alexander J. Varshavsky
Howard and Gwen Laurie Smits Professor of Cell Biology

AMERICAN ACADEMY OF ARTS AND SCIENCES, Fellow:
John F. Brady
Chevron Professor of Chemical Engineering and Mechanical Engineering; Executive Officer for Chemical Engineering

Katherine T. Faber
Simon Ramo Professor of Materials Science

Kenneth A. Farley
W. M. Keck Foundation Professor of Geochemistry

Fiona A. Harrison
Benjamin M. Rosen Professor of Physics

AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, Wallace E. Pratt Memorial Award, Recipient:
Michael Gurnis
John E. and Hazel S. Smits Professor of Geophysics; Director, Seismological Laboratory

AMERICAN CHEMICAL SOCIETY, 2015 Priestley Medal, Recipient:
Jacqueline K. Barton
Arthur and Marian Hanisch Memorial Professor of Chemistry; Chair, Division of Chemistry and Chemical Engineering

AMERICAN INSTITUTE OF PHYSICS, 2014 Andrew Gemant Award, Recipient:
Sean Carroll
Research Professor of Physics

AMERICAN GEOPHYSICAL UNION, the William Bowie Medal, Recipient:
Hiroo Kanamori
John E. and Hazel S. Smits Professor of Geophysics, Emeritus

AWARDS AND HONORS FROM FOUNDATIONS AND ORGANIZATIONS

SPRINGER SCIENCE + BUSINESS MEDIA, Julius Springer Prize for Applied Physics, Recipient:
Harry A. Atwater
Howard Hughes Professor of Applied Physics and Materials Science; Director, Resnick Sustainability Institute

DAVID AND LUCILE PACKARD FOUNDATION, Packard Fellowship, Fellow:
Andrew Thompson
Assistant Professor of Environmental Science and Engineering

SOCIETY FOR EXPERIMENTAL MECHANICS, 2014 William M. Murray Award, Recipient:
Guruswami (Ravi) Ravichandran
John E. Goode, Jr., Professor of Aerospace and Professor of Mechanical Engineering; Director, Graduate Aerospace Laboratories

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John G Braun Professor of Applied Physics

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Simon Ramo Professor of Materials Science

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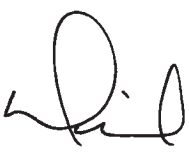
RICHARD P. FEYNMAN PRIZE FOR EXCELLENCE IN TEACHING, Recipient:
Steven C. Frautschi
Professor of Theoretical Physics, Emeritus

Financial Summary

For the fiscal years ended on September 30, 2014 and 2013 (in thousands)

LETTER FROM DEAN CURRIE, VICE PRESIDENT FOR BUSINESS AND FINANCE

I am happy to report that fiscal 2014 was another positive year for Caltech. Net assets increased by 6.6 percent and topped $2.5 billion on the strength of investment returns, the generosity of our donors, and careful management of operating expenses. The Institute's endowment rose to $2.1 billion due to investment returns and new contributions to the endowment, and provided more than $108 million in support to campus programs. Our visionary donors continue not only to increase Caltech's financial strength but also to provide the flexibility to determine the best use of funds in pursuing exciting opportunities. Similarly, increases in JPL funding and continued strength in funding of new campus research awards reveal the support for the ideas generated at Caltech. Overall expenses remained virtually unchanged, reflecting the Institute's continuing commitment to administrative efficiency. In particular, innovative efforts in the structure of health benefits will moderate costs in the years to come while maintaining accessible benefits for faculty, staff, and retirees, and providing upgraded benefits administration systems. As we usher in a new era of leadership under Thomas F. Rosenbaum, I am confident that the Institute's strong financial foundation, and its focus on flexibility and careful administration, will allow the Institute to maintain its commitment to scientific leadership as well as its ability to attract the world's most creative, insightful, and impactful scholars.

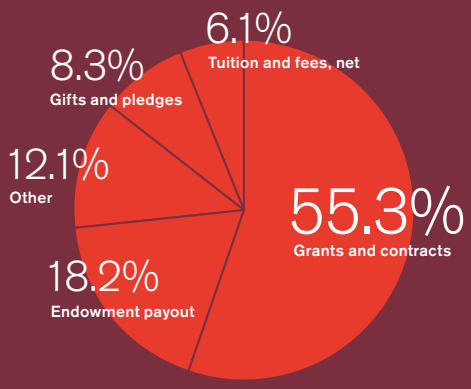


Operating Revenues (excluding JPL)	2014	2013
Tuition and fees, net	$ 36,307	$ 35,216
Endowment payout	108,086	102,162
Gifts and pledges	49,523	46,174
Grants and contracts	327,744	342,279
Other	72,022	80,476
Operating revenues	$ 593,682	$ 606,307

Operating Expenses (excluding JPL)		
Compensation and benefits	$ 351,490	$ 349,643
Supplies and services	122,759	144,882
Subcontracts	38,355	32,798
Graduate fellowships	17,202	17,720
Depreciation, accretion, & amortization	67,170	67,406
Utilities	18,040	16,170
Interest	16,788	16,400
Operating expenses	$ 631,804	$ 645,019

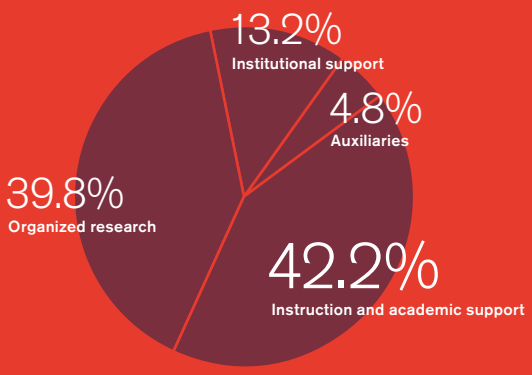
Asset, Liability, and Net Assets Summary		
Cash and cash equivalents	$ 10,092	$ 10,209
Accounts receivable, net	239,130	216,290
Investments	2,501,865	2,392,563
Other assets	202,451	181,367
Deferred United States government billings	346,160	456,917
Property, plant and equipment, net	866,706	874,288
Total assets	$ 4,166,404	$ 4,131,634
Accounts payable and accrued expenses	$ 462,540	$ 408,913
Other liabilities	134,876	118,155
Bonds and notes payable	682,362	726,970
Accumulated postretirement benefit obligation	369,244	515,032
Total net assets	2,517,382	2,362,564
Total liabilities and net assets	$ 4,166,404	$ 4,131,634
Increase in net assets	$ 154,818	$ 182,125

Note: The figures that appear in the financial summary shown are derived from the financial statements for the years ended September 30, 2014 and 2013, that have been audited and have received an unmodified opinion. The complete, audited financial statements for the Institute can be seen at www.businessandfinance.caltech.edu.



2014 Operating Revenues (excluding JPL)

Grants and contracts	$	327,744	%	55.3
Endowment payout		108,086		18.2
Other		72,022		12.1
Gifts and pledges		49,523		8.3
Tuition and fees, net		36,307		6.1
Operating revenues	$	**593,682**	%	**100.0**



2014 Operating Expenses (excluding JPL)

Instruction and academic support	$	266,766	%	42.2
Organized research		251,374		39.8
Institutional support		83,198		13.2
Auxiliaries		30,466		4.8
Operating expenses	$	**631,804**	%	**100.0**

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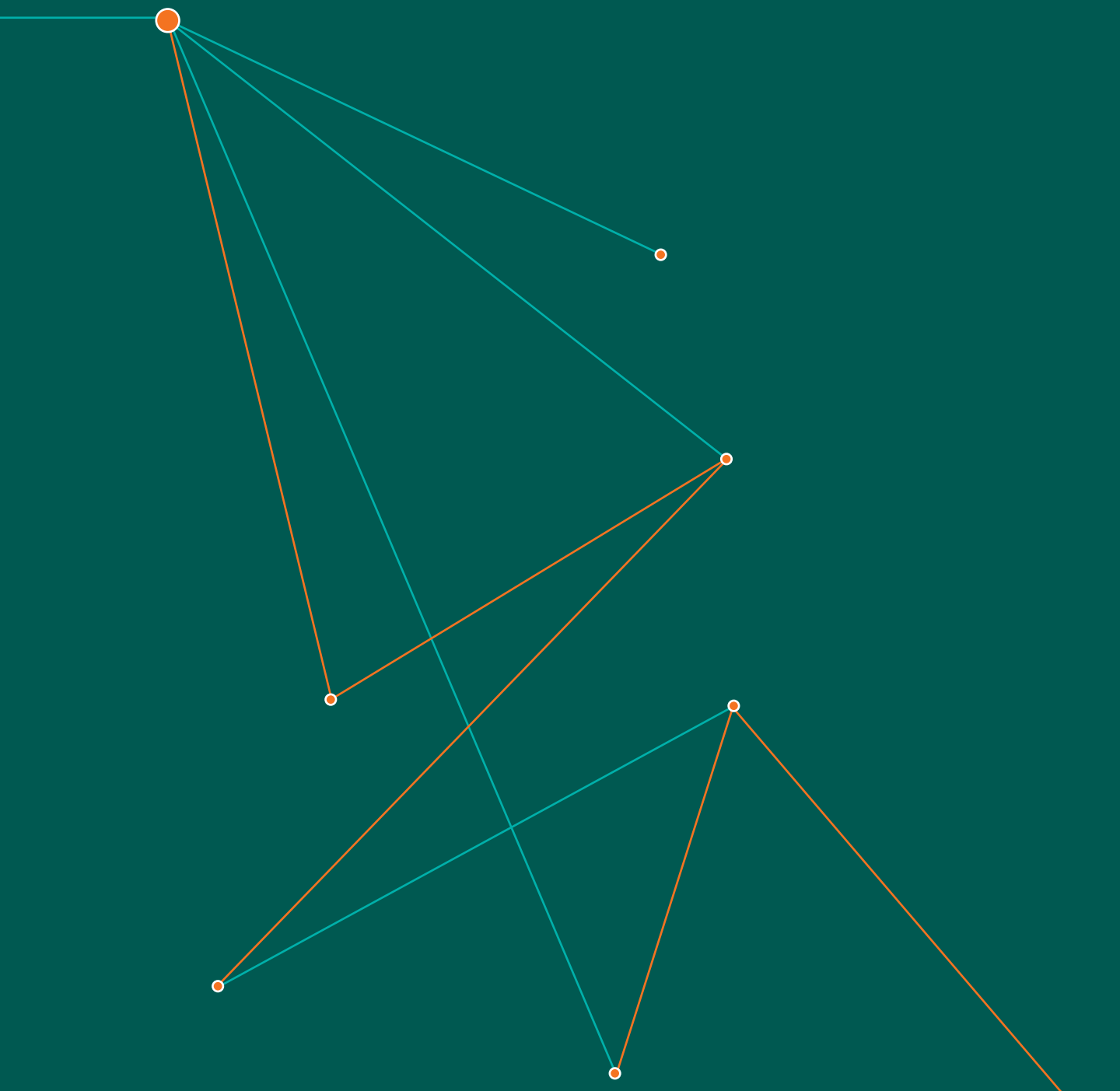

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