SFI External Professor Elizabeth "Liz" Bradley (second from front), a new SFI Science Board member, researches nonlinear dynamics and artificial intelligence at the University of Colorado at Boulder's Department of Computer Science. She rowed in the Four With Coxswain in the 1988 Olympic Games.

SUSAN E. R. STEIN

TRANSITIONS

BOARD OF TRUSTEES

SFI's trustees are drawn from leaders in business and finance, the academic world, and the public sector. Here are the newest additions to an accomplished roster:

The chairman and former CEO of DivX Inc., **Jordan Greenhall** co-founded the San Diego company behind the digital data compression application DivX that enables reasonable quality video transmission over the Internet. Before DivX, Greenhall was vice president at MP3.com, where he developed and implemented the company's business and content development model.

He currently invests in start-up technology companies such as Musinaut, Takelessons, OneRecovery, SparkWords (née SpinSpotter) and OpenCandy. Greenhall is actively interested in questions surrounding Transmedia, culture production, and the singularity and frontiers of science and philosophy.

Mari Kooi founded and currently serves as CEO of Wolf Asset Management International LLC, which manages over a billion dollars in assets for institutional clients around the world. Her career began in physical commodity trading, and she gained experience in alternative markets during her 18 years as a trader, trading manager, and president of Cargill Asset Management. Kooi also founded and presides over the New Mexico Financial Services Task Force, a not-for-profit group dedicated to improving New Mexico's financial services industry.

Several art organizations have benefited from Kooi's governance, including the Minnesota Museum of American Art. Kooi is known to many as the author of the "Sopa Piranha," a market commentary which reaches thousands of people quarterly in the hedge fund industry.

SCIENCE BOARD

This group of scientists and educators, drawn from a wide variety of fields, oversees the general direction, integration, and quality of the Institute's research. These are the newest members:

Elizabeth "Liz" Bradley, a member of the SFI External Faculty, researches nonlinear (chaotic) dynamics and artificial intelligence at the University of Colorado at Boulder's Department of Computer Science.

Her nonlinear dynamics projects range from handling Internet attacks to controlling vortex formation in fluid flows. In her artificial intelligence work, she has built systems that help engineers make mathematical models and geologists deduce the age of landforms. Bradley has also combined artificial intelligence and nonlinear dynamics to generate human movement sequences through chaos and machine learning. She has received a National Science Foundation National Young Investigator award, a Packard Fellowship, a Radcliffe Fellowship, and the 1999 student-voted University of Colorado College of Engineering teaching award. Bradley also rowed in the Four With Coxswain in the 1988 Olympic Games.

Distinguished Professor Donald Saari, a new SFI Science Board member, directs the Institute for Mathematical Behavioral Science at the University of California, Irvine. In his spare time, he cruises local beaches in his buggy and plays Santa Claus for department Christmas parties.

the Department of Statistics, Kansas State University; served as director of the statistical design and analysis unit for the Kansas State University Institute of Social and Behavioral Research; and was an adjunct professor in the Computer and Information Sciences Department. She is a former program director for statistics and probability in the Division of Mathematical Sciences at the National Science Foundation.

She is fellow and past president of the American Statistical Society, fellow of the American Association for the Advancement of Science, and a National Associate of the National Academy of Sciences.

In her research and leadership positions, Keller-McNulty has developed a great appreciation for the need for interdisciplinary research to find solutions for today's complex problems.

Arthur Lander directs the University of California at Irvine's Center for Complex Biological Systems, where he researches the strategies that organisms use to control fundamental processes of growth and pattern formation. Combining mathematical modeling, live cell imaging, and experimental genetics, his laboratory investigates how layers of complex molecular and genetic circuitry enable the major events of development and regeneration to proceed robustly in the face of internal noise and external uncertainty. Projects in the lab focus on morphogens—secreted molecules that form gradients in space from which cells obtain positional cues—and feedback regulators of cell growth and differentiation, and make use of a variety of model organisms including mice, fruit flies, and zebrafish.

Initially trained as a molecular biologist and physician, Lander relishes the diversity of perspectives that comes from collaborating with mathematicians, engineers, and physicists, and is passionate about drawing biology students into such work. His other passions include playing jazz and cooking—he can frequently be found teaching a course on the chemistry and biology of food and cooking.

Richard Lenski's long-term evolution experiment with *E. coli* has provided experimental evidence for many of the central concepts of evolutionary biology. Twelve populations, initially identical, have been evolving in his Michigan State University laboratory since 1988, where Lenski and his students have observed the dynamics of their phenotypic and genomic change for over 45,000 generations. The cultures have demonstrated adaptation, diversification, and the origin of new functions. Lenski also studies evolution in action using digital organisms—computer programs that replicate, mutate, compete, and evolve

David Gross, the director of the Kavli Institute for Theoretical Physics at the University of California, Santa Barbara, won the 2004 Nobel Prize in Physics for discovering asymptotic freedom. Gross, along with Frank Wilczek and H. David Politzer, showed that the nucleus of an atom can never be broken into its quark constituents because the attraction between quarks grows stronger as they are pulled away from each other. This asymptotic freedom is essential to understanding the nuclear strong force, one of the four basic forces of nature, which Gross has also played a central role in defining.

In addition to work with asymptotic freedom and the strong force, Gross has significantly contributed to superstring theory. With collaborators, he originated "Heterotic String Theory," the prime candidate for a unified theory of all the forces of nature.

One of the nation's experts in applied and theoretical statistics, **Sallie Keller-McNulty** teaches at Rice University where she is the William and Stephanie Sick Dean of the George R. Brown School of Engineering. She researches uncertainty quantification, computational and graphical statistics and related software and modeling techniques, and data access and confidentiality.

Prior to joining Rice in 2005, Keller-McNulty led the Statistical Sciences Group at Los Alamos National Laboratory for seven years. She was also professor and director of graduate studies in

a computational metabolism.

Lenski was a National Science Foundation Presidential Young Investigator. He has held fellowships from the John Simon Guggenheim Memorial Foundation and the John D. and Catherine T. MacArthur Foundation. He is a fellow of the American Academy of Arts and Sciences and a member of the National Academy of Sciences.

Eric Maskin shared the 2007 Nobel Prize in Economics for developing the theory of mechanism design. Given particular social or economic goals, mechanism design examines whether or not it is possible to construct institutions (mechanisms) that attain those goals.

Maskin has contributed to many other areas of economics as well, including game theory, general equilibrium theory, social choice theory, and contract theory.

He is married with two children and lives in Princeton, New Jersey, where he works as a professor of social science at the Institute for Advanced Study.

A former SFI resident professor, **Melanie Mitchell** now works for the Computer Science Department at Portland State University, where she teaches and researches computation in complex systems. She has also held faculty and professional positions at the University of Michigan, Los Alamos National Laboratory, and the OGI School of Science and Engineering at Oregon Health & Science University.

Mitchell's first introduction to the field of complex systems came in 1989 when, as a graduate student, she participated in a conference on emergent computation. There she met a group of like-minded scientists who saw the need to move beyond traditional, reductionist science in order to understand irreducibly complicated natural phenomena. Many of those scientists were affiliated with the Santa Fe Institute.

Like others in the complex systems community, Mitchell is fascinated with commonalities across systems such as brains, insect colonies, the immune system, cells, the global economy, and biological evolution. Her work aims to understand how natural systems perform computation, and how to use ideas from natural systems to develop new kinds of computational systems.

Mark Newman's research focuses on networked systems such as computer networks and social networks. He has covered topics as diverse as the spread of computer viruses on the Internet, the spread of human diseases over social networks, the pattern of collaborations between scientists in different fields, and the networks formed by committees in the U.S. House of Representatives.

Newman received a Ph.D. in physics from the University of Oxford in 1991 and conducted postdoctoral research at Cornell University before coming to the Santa Fe Institute in 1996, first as a postdoctoral fellow and later as a member of the resident faculty. In 2002 he left Santa Fe for the University of Michigan, where he is currently Paul Dirac Collegiate Professor of Physics and a professor in the Center for the Study of Complex Systems.

Newman is known for co-authoring the widely acclaimed *Atlas of the Real World*, in which the sizes of states and countries are pictured in proportion to their population, health, wealth, resource consumption, exports, and other variables. To read more, see "Mark Newman: Exploring the Physics of Connection" earlier in this issue.

Martin Rees teaches cosmology and astrophysics at the University of Cambridge, where he serves as Master of Trinity College. He holds the honorary title of Astronomer Royal and also Visiting Professor at Imperial College London and at Leicester University. His current research interests are high energy astrophysics, cosmic structure formation, and general cosmological issues.

Rees's awards include the Gold Medal of the Royal Astronomical Society, the Balzan International Prize, the Bruce Medal of the Astronomical Society of the Pacific, the Heineman Prize for Astrophysics, the Bower Award for Science of the Franklin Institute, the Cosmology Prize of the Peter Gruber Foundation, the Einstein Award of the World Cultural Council, and the Crafoord Prize (Royal Swedish Academy). He is currently on the Board of Trustees of the National Museum of Science and Industry, the Institute for Public Policy Research, and the Princeton Institute for Advanced

CHRISTIAN D'SOUZA

External Professor Raissa D'Souza, a new Science Steering Committee member, works as a professor of engineering at U.C. Davis, where she is helping launch their Complex Systems Center. An avid rock climber, she hopes one day to scale El Capitan in Yosemite National Park.

Study, and has served on many bodies connected with education, space research, arms control, and international collaboration in science. In 2005 he was appointed to the House of Lords and elected president of the Royal Society.

He has authored or co-authored more than 500 research papers, mainly on astrophysics and cosmology, as well as seven books (five for general readership), and numerous magazine and newspaper articles on scientific and general subjects.

Distinguished Professor **Donald Saari** directs the Institute for Mathematical Behavioral Science at the University of California, Irvine. While he was still a physical scientist deeply interested in the evolution of the universe via the Newtonian N-body problem, Saari became irresistibly drawn to the challenges of the social sciences thanks to his many conversations with students and faculty from these areas. His main research now focuses on modifying dynamical concepts to create new ways to address social and behavioral concerns.

Saari is the past chief editor of the *Bulletin of the American Mathematical Society* and serves on the editorial boards of several journals on analysis, dynamics, economics, and decision analysis. He is particularly proud of receiving over 10 awards for teaching, being honored twice during his time at Northwestern University with a "Most Influential Professor" award, and, for over 20 years, serving as Santa Claus for departmental Christmas parties.

Phil Anderson, Marcus Feldman, Murray Gell-Mann, John Holland, David Lane, Alan Perelson, and **Dan Stein** have been reappointed to the Science Board from hiatus.

SCIENCE STEERING COMMITTEE
This group meets bi-monthly to advise the SFI administration on science issues. SFI welcomes these new members:

Trained as a statistical physicist, applied mathematician, and theoretical computer scientist, **Raissa D'Souza** currently works as a professor of engineering at U.C. Davis, where she is helping launch their Complex Systems Center. Her research focuses on building mathematical models of feedback and interaction in layered networked systems.

D'Souza has visited SFI regularly since 1996, when she attended the Complex Systems Summer School as a Ph.D. student studying cellular automata. She returned to the Complex Systems Summer School as a lecturer in 2006 and 2007, and helped organize the SFI-sponsored residency month at the Institute for Complex Systems in Valparaiso, Chile. She is now a member of the SFI External Faculty.

An avid rock climber and aspiring blue water sailor, D'Souza intends someday to count scaling El Cap and sailing to French Polynesia among her accomplishments.

A member of the resident faculty, **J. Doyne Farmer** is one of the preeminent scientists in the SFI community. He has broad interests in complex systems, and has researched dynamical

systems theory, time series analysis, and theoretical biology. At present his main interest is developing quantitative theories for financial markets and the evolution of technologies.

Farmer began his career as part of the "chaos cabal" at U.C. Santa Cruz, a group of physics graduate students who did early research in what came to be known as chaos theory. He went on to apply the laws of physics to beat the game of roulette, then worked for Los Alamos National Laboratory's theoretical division, and launched a quantitative stock trading firm called "Prediction Company."

In addition to his current work for the Institute, Farmer serves on the editorial boards of the journals *Quantitative Finance* and *Artificial Life.* He sits on the steering committee of a public policy institute in Santa Fe and served 10 years as a board member of a non-profit dedicated to preserving wildlands in the Southwest.

Charles Stevens, an SFI external professor, heads the Molecular Neurobiology Laboratory at the Salk Institute. He researches mechanisms responsible for synaptic transmission, and ultimately aims to discover the mathematical architecture of neural circuits. In his lab, Stevens studies brain slices and cell cultures gathered from fish using a combination of molecular biological, electrophysiological, anatomical, and theoretical methods. When neural design principles are identified, the lab then checks to verify whether the same principles hold in mammals.

Stevens holds both an M.D. and a Ph.D. in biophysics, with undergraduate training in psychology.

EXTERNAL PROFESSORS
The driving force of SFI's scientific life is its network of external researchers, affiliated with universities and research institutions throughout the world. Here are the most recent additions:

Morten Christiansen co-directs the Cognitive Science Program at Cornell University, where he is an associate professor of psychology. His research focuses on the interaction of biological and environmental constraints in the processing, acquisition, and evolution of language, which he approaches using a variety of methodologies, including computational modeling, corpus analyses, psycholinguistic experimentation, neurophysiological recordings, and molecular genetics. Christiansen has authored more than 90 scientific papers and has edited volumes on connectionist psycholinguistics, language evolution, and, most recently, language universals.

Outside of work, he likes to run, ski, and hike with his family.

Vincent Danos teaches at the University of Edinburgh, UK. He is also Directeur de Recherches CNRS with the Équipe Preuves, Programmes, Systèmes. Danos's expertise in computer science and interest in biology have led him to accomplish path-breaking work towards new forms of modeling biological networks.

Danos serves on the editorial boards of the journals *Transactions on Computational Systems Biology, Logical Methods in Computer Science,* and the *International Journal of Software and Informatics.* He spent 2006 and 2007 as a visiting professor at

Harvard Systems Biology, while also working for the Plectix company in Boston.

In his free time, Danos writes non-narrative novels considered by specialists as generally unsuitable for publication.

A professor of ecology and evolutionary biology at Princeton University, **Andrew Dobson** studies the ecology of infectious diseases. His research focuses on the community ecology of infectious diseases in a variety of endangered and fragile ecosystems: the Serengeti in East Africa, the coastal salt marshes and grasslands of California, and the forest fragments of Malaysia and Bangladesh. He also tracks the emergence of conjunctivitis in New England house finches, and investigates the interaction between climate variability and the transmission of malaria and cholera in India and Bangladesh.

Dobson has received the Wildlife Trust Conservation Award, the "Deutsche Umweltstiftung" prize for environmental reading, and serves on the editorial boards of *Trends in Ecology and Evolution,* the *Journal of Helminthology, Frontiers in Ecology, PLOS-Biology,* and *EcoHealth.*

Santiago Elena's scientific interests relate to the evolutionary biology of microbes. A research professor at the Spanish National Research Council's Instituto de Biología Molecular y Celular de Plantas, he focuses on studying the mechanisms that generate and maintain the genetic variability of RNA viruses in crops. He has also been exploring the endless potential of digital organisms as model systems for evolutionary studies, and is developing in

Pablo Marquet, a new external professor, teaches and researches ecology at the Catholic University of Chile and at the Center for Advanced Studies in Ecology and Biodiversity, also in Santiago, Chile. He has investigated a broad range of ecological and evolutionary phenomena, including this curious volcano door.

silico and mathematical hierarchical models of the entire viral infectious cycle.

Elena serves on the editorial boards of *The American Naturalist,* the *International Journal of Evolutionary Biology, The Open Genomics Journal, The Open Virology Journal, BMC Evolutionary Biology,* and *Infection, Genetics and Evolution.*

Elena says his only aspiration in life outside of science is to bring happiness to his wife and three kids.

Jessica Green applies theoretical, computational, and empirical approaches to study biodiversity and biogeography across life's domains. She is particularly interested in the causes and consequences of microbial diversity, and exploring patterns and principles that may be common to microbes, plants, and animals. Her lab uses interdisciplinary approaches at the interface of environmental genomics, ecology, phylogenetics, mathematics, and informatics.

Green is a professor at the University of Oregon's Center for Ecology and Evolutionary Biology. She has recently received a grant from the Moore Foundation to develop new approaches for analyzing vast quantities of metagenomic data, and a grant from

New External Professor John Rundle directs the California Institute for Hazard Research at U.C. Davis, where he explores the dynamics of earthquakes. Though he generally works with computer models, his animal friend Konrad, at the Lone Pine Koala Sanctuary in Brisbane, Australia, may prove helpful.

the hierarchical structure of the universe, predicted the disintegration of the proton, and explained the fractal distribution of galaxies. Mercader currently directs the Center for Astrobiology in Spain, which was launched by the NASA Astrobiology Institute.

Mercader has received honors and awards from numerous institutions, including the Gravity Research Foundation of Massachusetts, NASA, the Association of Spanish Scientists, the Spanish Armed Forces, and the community of Andalusia.

An ornithologist by hobby and lover of popular science, Mercader spent eight years in Spanish National Radio (Radio 1) contributing to two weekly programs devoted to science.

the Sloan Foundation to study the impact of sustainable design on the indoor air environment.

Outside of science, Green spends time with her two young boys, Max and Mauro, and her roller derby team, the Flat Track Furies.

Pablo Marquet teaches and researches ecology at the Catholic University of Chile and at the Center for Advanced Studies in Ecology and Biodiversity, also in Chile. His research program focuses on the search for the general principles that underlie the seemingly endless diversity and variability of ecological systems. Marquet has investigated a broad range of ecological phenomena and evolutionary phenomena, from the implications of the body size of organisms in marine and terrestrial communities to metapopulation dynamics, scaling, food webs, and climate change. He continually tries to apply research results from his laboratory to problems related to the conservation of biological diversity, such as the optimal design of networks of protected areas in the dynamic context imposed by changing land-use patterns and climate change.

Marquet has received many professional and academic honors, including a Guggenheim Fellowship. He is currently a member of the editorial board of the journals *Theoretical Ecology* and *Conservation Letters*.

Juan Perez Mercader's fundamental interest lies in using theoretical physics to gain knowledge of the universe and life. In 1998 he co-discovered Gravito-magnetism, a property of space-time predicted by Einstein and others in 1918, which Mercader detected and measured. He also explained from first principles

A specialist in complex economics, **Kazuo Nishimura** directs the Institute for Economic Research at Kyoto University. He contributes prolifically to the field of economic theory, and also works to improve mathematical education in Japan and abroad. He is currently the president of the International Society for Education and the managing editor of the *International Journal of Economic Theory.*

Nishimura is widely known as a gadfly to Japan's public education system, as he periodically surveys university students' math skills to test the quality of their primary-school instruction. To address the problem of declining math skills among many Japanese students, he co-authored a series of self-learning textbooks for elementary school students, which resulted in dramatically improved test scores in schools that adopted the texts.

He has received publication prizes from the Japan Mathematical Society, the Mathematical Society of Japan, and the University of Rochester, from which he also received an award for excellent scholarship. He was awarded an honorary doctorate from the University of Aix-Marseilles III, and has held visiting appointments at universities in Austria, France, and the United States.

John Rundle directs the California Institute for Hazard Research at U.C. Davis. His research focuses on understanding the dynamics of earthquakes through numerical simulations, pattern analysis of complex systems, dynamics of driven nonlinear Earth systems, and adaptation in general complex systems. More

simply, he makes computer models of earthquake faults so he can learn to predict seismic events. He hopes to be able to make earthquake forecasts a year or two in advance for geographical locations in California.

Rundle serves on the editorial boards of the *Earth and Planetary Science Journal,* the *ARI, Bulletin of Istanbul Technical University,* and *Computing in Science and Engineering.* He has received awards and recognition from the American Physical Society, the American Geophysical Union, the Southern California Earthquake Center, the Geosciences Research Program (U.S. Department of Energy), NASA and the Jet Propulsion Laboratory, the International Association of Seismology and Physics of the Earth's Interior, and Sandia National Laboratories.

Rajiv Sethi teaches economics at Barnard College and is a faculty fellow at Columbia University's Institute for Social and Economic Research and Policy. His recent research deals with segregation in neighborhoods and social networks, stereotyping in economic interactions, disparities across groups in crime victimization and incarceration, and the transmission across generations of group inequality. He has also worked on the evolution of social norms and interdependent preferences, decision-making under bounded rationality, and the dynamics of asset prices in financial markets.

Sethi is currently on leave at the Institute for Advanced Study, where he is conducting collaborative research with Muhamet Yildiz on communication, beliefs, and public disagreement. He holds editorial positions with the *Journal of Economic Behavior and Organization* and the *Journal of Public Economic Theory.*

In his free time he likes to visit wildlife sanctuaries and blog about music.

Erica Jen and **Stuart Kauffman** have returned to their external professorships after taking hiatus.

OMIDYAR POSTDOCTORAL FELLOWS

Three young researchers have been accepted as SFI's first incoming Omidyar Fellows. The Omidyar Fellows Program was established at SFI in late 2008 with a gift from eBay Founder Pierre Omidyar, an SFI Trustee. The program aims to attract scholars from the social, physical, and natural sciences to spend two to three years as postdoctoral fellows at SFI delving into the major questions facing science and society. The addition of the 2009 cohort brings the total number of SFI Omidyar Fellows to 13; ten current postdoctoral fellows were renamed as Omidyar Fellows this year. The three new 2009 Omidyar Fellows are:

Simon DeDeo's education includes postdoctoral fellowships at the Institute for the Physics and Mathematics of the Universe, University of Tokyo; and the Kavli Institute for Cosmological Physics, University of Chicago. He holds a Ph.D. in astrophysical sciences from Harvard University, a masters in applied mathematics and theoretical physics from Cambridge University, and an A.B. in astrophysics from Harvard University. He is a past short-term visitor to SFI.

DeDeo's research examines ways to use astrophysical and cosmological phenomena to test novel ideas in fundamental physics. At Princeton, he demonstrated ways to use neutron stars to test the nature of gravity and new tools for extracting information on how the universe condensed from a primordial state into the galaxies and larger structures we see today. At the universities of Chicago and Tokyo, he extended this work to show how more radical theories of space-time structure could be tested with the universe as laboratory, while collaborating with experimenters to develop new techniques optimized for such tests.

His work at SFI extends the "historical reasoning" of cosmology to the biological sciences, where he will bring the philosophies and methods developed for studies of unrepeatable cosmological phenomena to biological systems governed by the unrepeatable accidents of development and evolution.

In his non-scientific work, DeDeo writes and reviews poetry.

Laura Fortunato holds a Ph.D. in anthropology from University College London (including one year of cross-disciplinary training in biology), a masters (MRes) in anthropology from University College London, and a dottore in biological sciences from the University of Padova. She is a past participant in SFI's Complex Systems Summer School in Beijing.

Fortunato's research examines the evolution of human social organization, focusing on the social norms regulating kinship and marriage, including the differing norms among societies (monogamy vs. polygyny, for example) and how these variations arose. She combines theoretical and statistical methods used in the study of nonhuman social systems with theory and data from the historical and social sciences, including anthropology, linguistics, and archaeology.

Her future research will investigate how societies' organizations of relatedness and reproduction explain the evolution of unique features of our species' social behavior, such as our predisposition to cooperate in large groups of unrelated individuals. In her free time, Fortunato applies insights from her research to investigate the social dynamics of characters in Italian opera.

Jeremy Van Cleve's education includes a Ph.D. in biology from Stanford University and a B.A. in mathematics and biology from Oberlin College. He participated in SFI's 2001 Research Experiences for Undergraduates summer program and, as a high school student, received a 1999 SFI prize for scientific excellence.

He is broadly interested in applying analytical and simulation methods to problems in evolutionary and ecological theory. As part of his dissertation research, he has studied the evolution of genomic imprinting, exploring interactions of genetic dynamics with population structure and, through models, the evolution of behaviors that increase the payoff of a social partner.

Van Cleve's SFI research will extend his thesis work through exploration of epigenetic phenomena and their role in adaptation and developing theory that builds on the recent explosion in empirical data from epigenetics.

More information about the **Omidyar Fellows Program** can be found at www.santafe.edu/education/fellowships-postdoctoral.php. ◀