UC SANTA BARBARA

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Scholars of Outstanding Promise

Every so often the work of an early career researcher becomes so important, it captures the attention of their professional peers. Recognizing these young "scholars of outstanding promise," the Alfred P. Sloan Foundation awards Sloan Research Fellowships to support their future breakthroughs and careers as leaders in their fields.

This year, three of those 128 early-career innovators come from UC Santa Barbara.

"I congratulate Sung Soo Kim, Fedor Manin and Timothy Brandt on this exceptional honor," said Pierre Wiltzius, dean of mathematical, physical and life sciences. "With these fellowships, they join a rarefied group of 125 other extraordinarily talented young scholars whose research shows great promise. I look forward to learning about the valuable discoveries these awards will support."

"A Sloan Research Fellow is a rising star, plain and simple," said Adam F. Falk, president of the Alfred P. Sloan Foundation. "To receive a fellowship is to be told by the scientific community that your achievements as a young scholar are already driving the research frontier."

Neural Navigator

What allows us to navigate unfamiliar territory? How do we choose the landmarks by which we construct mental maps of the world around us? These calculations — essential to our survival as a species — are so deeply ingrained that we don't notice

them, even as we find our way through dark rooms or drive ourselves home on autopilot. And in the human brain the network of neurons is so complex and distributed that it’s not possible to pinpoint where and how these processes occur to translate perception into behavior.

But neuroscientist Sung Soo Kim, an assistant professor in UC Santa Barbara’s Department of Molecular, Cellular and Developmental Biology, has a plan.

“The human brain is composed of billions of neurons and trillions of connections,” he said. “But the fruit fly has only about 150,000 neurons,” and a rich repertoire of behaviors. Not only are the neurons responsible for navigation — called “compass neurons” — conveniently arranged in a donut-shaped structure in the insects’ heads, the connections between neurons in the entire fly brain can now be fully reconstructed from electron microscopy. This allows Kim to tease apart all the components underlying the fly’s navigation system.

“Further, because we have a very strong set of genetic tools, we can target individual neurons in the fly brain to figure out how the interactions between neurons — called ‘circuit dynamics' — would affect behaviors,” he said.

“That’s the ultimate goal,” Kim added. “I’m honored to receive the Sloan Research Fellowship, a prestigious award in neuroscience. It will not only support my lab but also help me to preform research that I hope will eventually reveal how interaction between neurons influence animal behavior.”

Topology Trailblazer

Numbers are the language of the universe, and Fedor Manin is here to listen. An assistant professor in the Department of Mathematics, he works to take topology — the study of properties of geometric objects that are invariant under transformation — and connect them with concepts of probability and computation.

“People often explain that ‘a topologist can’t tell a doughnut from a coffee cup,’” he said in an oft-quoted description of this mathematical field. Indeed, after a certain amount of stretching and twisting, a coffee cup could rearrange itself around the hole in its handle to become a doughnut without interrupting its surface, rendering the two objects indistinct.

But when might a coffee cup not be equivalent to a doughnut?

“Say we have a 6-dimensional coffee cup,” Manin said, “and we know we can stretch it into a doughnut, but if you’re only allowed to stretch at a constant rate, how long does that take? Can we get a computer to decide whether you can do it?” In some cases it’s guaranteed that two topologically equivalent objects will easily transform into one another, he said, but in others it’s not possible for even computers to tell whether two are topologically the same. His work examines the transformation in terms of both the geometric complexity (the deformation) and the algorithmic complexity (the computer’s ability to discern equality or — lack thereof). Insights could propel knowledge forward in a variety of investigations, from protein folding to programming robots.

“I’m hugely honored to receive the Sloan Fellowship,” Manin said. “It’s a recognition that what I do is valued by the community, which is very gratifying.”

Celestial Spotter

Astrophysicist Timothy Brandt loves puzzles, and so he set his sights upon one of the grandest ones of them all: finding distant planets that are virtually invisible.

“I have spent years trying to discover and image faint planets around bright stars,” said Brandt, an assistant professor in the Department of Physics. “Images have a unique emotional impact, and by collecting light emitted by these planets, we can learn about their atmospheres.”

Unfortunately, he continued, this method is difficult and requires a lot of luck. “Most stars do not have giant planets around them that are bright enough to see with our current telescopes,” he said. “Given the huge amounts of telescope time required, we can’t just look at every bright star in the sky and hope to get lucky.”

However, thanks to the award, the solution to this puzzle is within reach.

“A Sloan Fellowship will allow me to find and weigh planets around nearby stars,” Brandt said. “I hope to combine new data from a European satellite called Gaia with the exceptional telescope facilities supported by the University of California to image giant planets and to measure their masses and orbits.”

To do this, Brandt will use ultra-precise measurements of the positions of stars to measure the gravitational pull exerted by their nearby, unseen companions. “This is similar to the approach that was used to discover Neptune: Precise measurements of

Uranus suggested that the planet was being tugged by another, previously unknown planet," he said.

In the case of unseen planets in a faraway solar system, it's their star he will be scrutinizing for tiny shifts that could indicate the presence of a nearby planet. From there, he can aim large telescopes to directly image these planets, calculate their masses and understand their atmospheres.

"In the future," he said, "similar methods could discover Earth-like planets and probe their atmospheres for signs of life."

A Sloan Research Fellowship is one of the most prestigious awards available to young researchers, in part because so many past fellows have become towering figures in the history of science. Sloan research fellows have gone on to greater accomplishments and received further accolades, including the Nobel Prize, the Fields Medal, the National Medal of Science and the John Bates Clark Medal.

"It is great to see the different kinds of colleges and universities that now have Sloan Research Fellows on their faculty," said Daniel L. Goroff, director of the Sloan Research Fellowship program. "What those institutions clearly have in common is that they are successfully attracting remarkable researchers who then thrive on their campuses."

About UC Santa Barbara

The University of California, Santa Barbara is a leading research institution that also provides a comprehensive liberal arts learning experience. Our academic community of faculty, students, and staff is characterized by a culture of interdisciplinary collaboration that is responsive to the needs of our multicultural and global society. All of this takes place within a living and learning environment like no other, as we draw inspiration from the beauty and resources of our extraordinary location at the edge of the Pacific Ocean.