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Gordon and Betty Moore Foundation Experimental Physics Investigators awards to UCSB experimentalists opens the door to new insights and innovations

UC Santa Barbara physicists Sebastian Streichan, David Patterson and Andrea Young are among the 22 mid-career researchers to be named Gordon and Betty Moore Foundation Experimental Physics Investigators this year. They join 19 other physicists from around the country who will receive $1.3 million in support over five years for their innovative work to advance the frontier of fundamental research in experimental physics.

“We once again received proposals from amazing mid-career investigators who are taking their research to new levels,” said Theodore Happ, program director for the foundation’s Experimental Physics Investigators Initiative. “We are excited to see them join our existing cohorts of experimental physicists who are pushing the boundaries of our understanding of the universe.”

“I am thrilled to congratulate Andrea Young, David Patterson and Sebastian Streichan on being selected for the Gordon and Betty Moore Foundation’s Experimental Physics Investigators Initiative,” said Shelly Gable, dean of mathematical, life and physical sciences at UCSB. “For three of our faculty to receive this honor in a single cohort is a powerful affirmation of the world-class caliber of our Physics Department. The Moore Foundation invests in the person, not just the project, and by selecting professors Young, Patterson and Streichan, they are betting on three incredibly creative minds to push the boundaries of science. We are exceptionally proud of this achievement and can’t wait to see what they uncover.”

The physics of tissue morphogenesis

How do living systems structure themselves? From undifferentiated masses of cells to fully developed organisms, living cells orchestrate themselves into myriad arrangements as embryonic cells divide, building a variety of structures.

“This happens not just at the level of the body plan, but deep within tissues,” said Streichan, who studies the physics of soft and living matter. “What makes this remarkable is that such order typically arises in cold, equilibrium systems — yet embryos are warm, dynamic and far from equilibrium.”

To investigate further, supported by the Experimental Physics Initiative, Streichan and collaborators aim to observe how cells generate organization through physical feedback mechanisms. This, he said, will involve reconstituting tissue-level order in vitro and investigating the underlying principles that drive it, a line of study that will offer insights into the fundamental physics of life. These insights could in turn unlock the ability to program living materials — designing soft, adaptive systems with applications in tissue engineering, synthetic biology and materials science.

The mysteries of chiral molecules

Look at your hands. You can clap your palms together and find that they match up, digit for digit, but if you superimpose one on the other, both palms down or palms up, they won’t match. The same is true for many molecules in the world around us, a phenomenon known as chirality.

“Many molecules, including those in our own bodies, come in left-handed and right-handed versions,” said Patterson, who specializes in atomic, molecular and optical physics. “At first glance, these versions look like mirror images, but scientists believe they’re not *exactly* the same.” The difference, he said, is unimaginably small

— about one part in a million billion — and it has never been directly observed.

But with support from the Moore Foundation, Patterson and team will be able to observe these infinitesimal differences for the first time, by shining extremely precise lasers on single trapped molecules and measuring the faint vibrations inside them. If successful, this work could lead to new insight into chirality, which is central to many processes in biology — for instance, an overwhelming number of the biomolecules that constitute our bodies are left-handed, though it is still unclear why. As an added benefit, Patterson said, the tools developed for these studies will allow scientists across many disciplines to analyze substances that were previously too small to detect — even substances as small as a single molecule.

The potential of quantum materials

The search for novel quantum materials is on. These materials, which host powerful quantum behaviors, are highly sought after for their potential to revolutionize technology.

In his lab, condensed matter physicist Andrea Young has been investigating the properties of electronic states in low-dimension quantum material. These states, such as magnetism and superconductivity, emerge on the surface and at the edges of atomically thin material at atomic and subatomic scales, requiring extremely sensitive technology to observe and measure them.

With the help of the Experimental Physics Initiative, Young and his team can take a big step toward not just probing the emergent properties that arise from low-dimension atomic material — in this case rhombohedral multilayer graphene — but also leveraging these properties, through the development of novel electronic and magnetic devices. According to the Moore Foundation, “by developing both the fundamental and physical understanding of mechanisms in these systems as well as advancing their materials engineering, Young’s work opens new pathways toward novel analog quantum technologies and future quantum information systems.”

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