UC SANTA BARBARA

THE Current

July 18, 2018

Sonia Fernandez

# Small Scale, Huge Impact

The solutions to some of our most pressing clean energy needs may lie not only in large-scale projects such as wind farms or hydroelectrics, but also in the realm of the smallest objects — think microscopic particles and quasiparticles.

Understanding and improving how some of the newer clean energy technologies work could lead to more efficient materials and devices that can enable people to reduce their reliance on greenhouse-gas producing fossil fuels or outdated energy infrastructure.

UC Santa Barbara mechanical engineering assistant professor Bolin Liao is at the forefront of this endeavor to illuminate the behaviors and interactions of the most fundamental energy carriers in materials. Now, with an early career research award from the U.S. Department of Energy (DOE), he is closer than ever to advancing understanding of the deep workings of devices such as thermoelectric modules and photovoltaic cells.

Liao joins 83 other early career scientists from DOE labs and U.S. universities who also have received significant funding from the DOE Office of Science's Early Career Research Program. He will receive $150,000 per year for five years for his research.

"The College of Engineering continues to attract outstanding junior faculty, like Professor Bolin Liao," said Rod Alferness, dean of the College of Engineering. "I am pleased to see him receive an early-career research award and am grateful to the Department of Energy for providing critical funding for his exciting and innovative

research into energy at the quantum-particle level, which is highly relevant to meeting the world's rapidly expanding need for clean, renewable energy."

"I'm thankful for this award," said Liao, who leads the Transport for Energy Applications Laboratory (TEALab) at UCSB. As an early career researcher, he noted, the funding allows him to get ahead on his work, which investigates the phase coherence of tiny energy carriers such as electrons, phonons and photons, as well as their collective excitations.

"In (quantum) physics, a particle is also a wave," Liao said, explaining that if the waveforms of two (or more) particles are coherent, they bear a fixed or constant phase relationship to one another. And that, he added, could lead to higher energy conversion efficiency. Collective coherent motions of these particles in condensed matter (such as a solid) could also produce non-equilibrium states with tunable energy transport properties.

However, advanced instrumentation is needed to observe the energy carriers and their collective excitations — which have very short coherence times and lengths. For this reason, a newly developed, scanning ultrafast electron microscope (SUEM) will be used to visualize and analyze coherent couplings, decoherence processes and other interactions, which will contribute to basic understanding of the behaviors of these fundamental units of energy transport and provide foundation for future technology development.

"Supporting talented researchers early in their career is key to building and maintaining a skilled and effective scientific workforce for the nation. By investing in the next generation of scientific researchers, we are supporting lifelong discovery science to fuel the nation's innovation system," said Secretary of Energy Rick Perry. "We are proud of the accomplishments these young scientists have already made, and look forward to following their achievements in years to come."

Now in its ninth year, the DOE Office of Science's Early Career Research program is designed to bolster the nation's scientific workforce by providing support to exceptional researchers during the crucial early career years, when many scientists do their most formative work. Awardees were selected from a large pool of university- and national laboratory-based applicants, and selection was based on peer review by outside scientific experts.

## 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.