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Mechanical engineer Bolin Liao to develop platform for imaging and controlling quantum interactions with 2D materials

Among the central goals in experimental quantum and materials sciences is to witness, study and eventually control interactions between atomic and subatomic particles. Though rapid and fleeting, these behaviors at such tiny scales underlie some of our most cutting-edge technology in various fields, including semiconductor research and quantum computing.

UC Santa Barbara mechanical engineering professor Bolin Liao has been working to capture these behaviors in quantum materials, directly observing what in some cases had only been understood by theory and calculation. It's a gargantuan task to image such tiny phenomena. But by combining the nanoscale spatial resolution of a scanning electron microscope and the picosecond-scale time resolution of an ultrafast laser, Liao and his team were able to develop one of the nation's few scanning ultrafast electron microscopes (SUEM). Their SUEM is able to take "movies" of light-stimulated energy transport in semiconductor materials.

Now, Liao is ready to take the technology to the next level. Chosen as one of the Gordon and Betty Moore Foundation's 2026 Experimental Physics Investigators, Liao will receive critical support in his endeavor to take scanning ultrafast electron

microscopy from imaging technique to experimental platform.

“This is a great opportunity from the Moore Foundation,” said Liao, adding that he was “very excited” for the support for one of the projects he is most proud of. Liao joins 20 other investigators who will receive $1.35 million over five years to accelerate their research breakthroughs.

“With nearly 100 investigators now at work, we are seeing the range of bold, original science we hoped this initiative would make possible,” said Theodore Holdapp, program director for the Experimental Physics Investigators Initiative. “From the start, our aim has been to accelerate progress at the frontier of experimental physics by giving brilliant, mid-career scientists the kind of flexible, sustained support that federal grants rarely can. That freedom lets them take on risky, high-reward experiments and follow ideas when research results lead them down new pathways.”

For Liao’s project, the focus will be on polaritons, which are light-induced excitations that form when photons (light) interact with matter. The matter in this case comes in the form of atomically-thin material whose electrons are free to interact.

“We’re going to look at how electrons talk to photons in a vacuum,” Liao said. Generally, they don’t interact in a vacuum, despite being the most common particles we encounter, he explained.But through the strategic introduction of quantum materials as an intermediate, it’s possible to break that barrier.

“If we design the material properly, we can actually induce various kinds of interactions between them,” Liao said. “I think it’s going to be a very exciting and interesting project.”

The research, according to the Moore Foundation, “has the potential to study moiré systems” — a configuration of two-dimensional layers of material that can generate new and promising electronic properties — “and other nonequilibrium phenomena, while laying a foundation for advances in nanoscale electron optics, quantum coherent measurement and electron beam control.”

Tags
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