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UCSB Physicist Receives Prestigious Packard Fellowship Award

Without a laboratory –– using only a blackboard, computer, and his powerful intellect –– a young theoretical physicist at UC Santa Barbara is quickly racking up national and international awards honoring his research in quantum physics. Although Cenke Xu works in an abstract realm, his research may have far-reaching practical applications.

An assistant professor in the Department of Physics, Xu has emerged on the national and international stage with his pursuit of new states of matter. This month, he was awarded the coveted Packard Fellowship –– as one of only 16 scientific researchers from across the country to receive this distinction. He will receive an unrestricted research grant of $875,000 over five years.

"I am delighted to congratulate Professor Cenke Xu on being awarded a prestigious Packard Fellowship," said Chancellor Henry T. Yang. "Professor Xu's exciting research on quantum states with nontrivial topological structures is garnering widespread attention; he was recently recognized with a National Science Foundation CAREER award, a Sloan Research Fellowship, and named Outstanding Young Researcher by the Overseas Chinese Physics Association. UC Santa Barbara is grateful to the David and Lucile Packard Foundation for their partnership in advancing scientific research on our campus for over three decades."

As a theoretical physicist, Xu is a trailblazer, exploring new worlds in science. "Everyone is familiar with the states of matter in the classical world: solid, liquid, and gas. The goal of my research is to look for and understand new states of matter in the quantum world," Xu said.

"Since the discovery of quantum mechanics about 100 years ago, many new states of matter have been understood, including the underlying physics or ‘mechanism' for metals, insulators, and semiconductors. These make up the foundation of the entire modern electronic industry," he continued.

Approximately 30 years ago, condensed matter physicists reached a consensus that the interplay between the strong interaction and quantum fluctuation can lead to much more exotic and richer states of matter, said Xu. The mechanism for metals, insulators, and semiconductors can be understood in terms of completely free, or non-interacting, quantum electrons. However, many other phenomena can only be understood after taking into account both quantum mechanics and the strong interaction, since single electrons become almost invisible in these systems. These states are usually called "unconventional" or "exotic" states of matter.

"One particular type of such an unconventional state is the ‘fractional quantum Hall state,' " said Xu. This is the state where quantum mechanics and the strong interaction make the electrons move hand-in-hand so that single electrons are no longer a good description of the system. Eventually the "particle" of this system carries a fraction of the electron charge. Physicists have been surprised by this phenomenon, and have found it can only occur in strongly interacting, quantum, many-body systems –– systems with large numbers of constituents. Fractionalization of physical quantities is the most striking –– but also universal –– phenomenon of these unconventional states.

"The goal of my research is to understand and classify unconventional states like the fractional quantum Hall state, and also the transition between these states," said Xu. "Besides classification, I am also trying to propose experimental methods to detect and probe these unconventional states in laboratories."

Omer Blaes, chair of the Department of Physics, said: "Cenke Xu is an extraordinarily bright and creative theoretical physicist working on understanding strongly quantum phenomena in solid state matter, a field that is rich with potential practical applications. The Packard Fellowship will provide him with considerable freedom to

pursue one of his primary interests: the study of quantum phases of matter, particularly topological phases and quantum critical points or phase transitions around topological phases. These may provide an important key to understanding and classifying the rich diversity of behavior in numerous classes of materials."

Xu thanked both the Department of Physics and UCSB for nominating him for the fellowship. "I want to thank my colleagues in my department for their support in my research and teaching, and also the Office of Research for their help during my preparation for the application," he said.

Xu received his Ph.D. just five years ago from UC Berkeley. Then, following his postdoctoral research as a Junior Fellow with the Society of Fellows at Harvard University, he joined the faculty at UCSB in 2010.

Over the past 25 years, the Packard Fellowships program has awarded $316 million to support 489 faculty members from 52 top national universities. It is among the nation's largest nongovernmental fellowships, designed with minimal constraints on how the funding is used –– to give the Fellows freedom to look at complex issues with a fresh perspective. Packard Fellows have gone on to receive additional awards and honors, including the Nobel Prize in Physics; the Fields Medal; the MacArthur Fellowships; and elections to the National Academy of Sciences and the National Academy of Engineering.

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