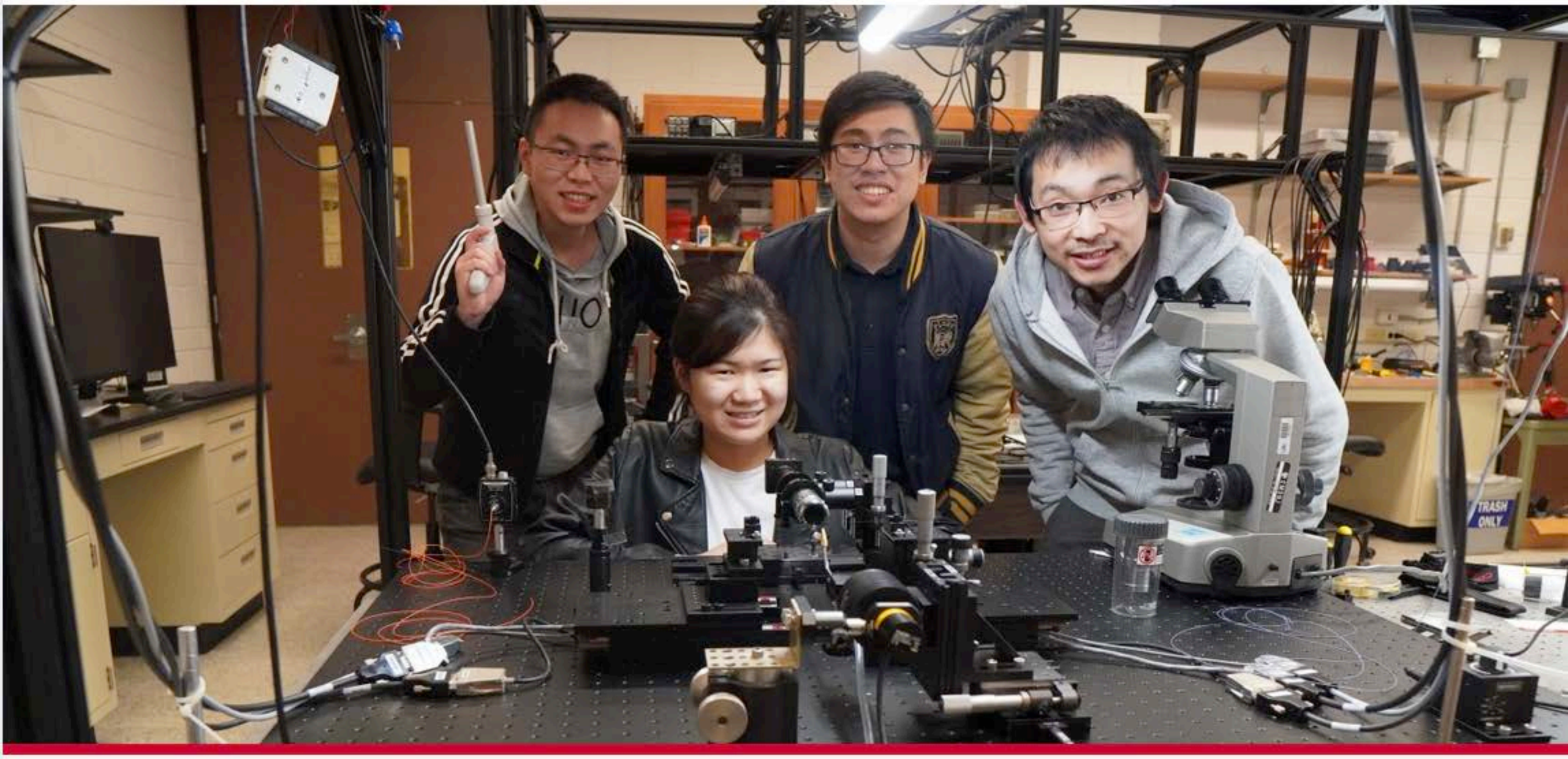

Xuejian Wu Awarded Two NSF Grants to Develop Next Generation of Quantum Sensors

By Lawrence Lerner
Aug 30, 2023

Assistant Professor Xuejian Wu, of Rutgers University–Newark's Department of Physics, has won two National Science Foundation grants to help expand quantum information science research and education.

The first grant, funded over two years at $250,000, will support Wu in continuing to develop the next generation of quantum (atomic) sensors for inertial navigation, a type of navigation that is important for aircraft, spacecraft, satellites, submarines and ships when Global Positioning Satellite (GPS) signals are inaccessible. This new grant follows on the heels of a Rutgers Global International Collaborative Research grant that Wu won in December 2021 to support this research, which expired this summer.

The second grant, at $800,000 over three years, will enable Wu and his co-PI, Professor Holger Muller at the University of California, Berkeley, to continue developing new quantum gravimeters for

precisely surveying gravity and estimating the density of underground rocks out in the field. This project will advance work that Wu did as a post-doctoral researcher at UC Berkeley before arriving at RU-N in January 2021.

"I am very excited by these two NSF awards, which are my first external grants," said Wu. "As a new research group, they will support us in building our projects and funding my undergraduate and graduate students."

Sensors have long been used by scientists, engineers and geologists to measure gravitational fields in and around objects. In geophysics, researchers use these precise instruments to measure gravity data and test for the presence of underground water or study underground lava activity near a volcano before an eruption, for instance. Physicists and engineers also use them underwater and in space.

Scientists primarily have used what are called classical sensors for these jobs, where a spring pulls on an object when gravitational or rotational force is applied, and the spring is measured before and after to assess the amount of the force. These instruments are compact and easy to use, but they're sensitive to temperature and humidity, not accurate, and need to be callibrated before and after each usage, according to Wu.

About two decades ago, scientists started developing sensors using atoms and lasers, with the atoms as objects and lasers in place of springs. They're more complicated to build, requiring laser and electronic control systems, but they're very precise without the other drawbacks of classical sensors, and researchers have been working to make them more compact, robust and mobile so they can perform well out in the field and on drones, submarines and other objects underwater and in space.

> "Students from minority groups will benefit from participating in cutting-edge research, making them more competitive for graduate schools, postdocs or research positions in the academy, government and industry."

Wu has been working with various researchers for years, at both UC Berkeley and in France, to push quantum sensing to new heights, equipping these important instruments with unprecedented sensitivity, miniaturized size, turn-key operation and versatile functions.

With these new NSF grants, Wu will not only push the boundaries on quantum information science research but will also expand education and outreach efforts by working with the Garden State Louis Stokes Alliance for Minority Participation (LSAMP) program—also funded by NSF and Directed by RU-N Distinguished Service Professor Alec Gates—to recruit undergraduates and graduate students from minority groups to join his projects. He'll also create summer research opportunities for high school students from Science Park High School in Newark and Union County Magnet High School in Scotch Plains, NJ.

In addition, the grant collaboration with Professor Mueller, of UC Berkeley, will support exchanges for RU-N students to do short-term research out in California with Mueller's lab group, and Wu will work with Mueller and a local optics company, Thorlabs, Inc. in Newton, NJ, to develop a new certificate program in Optical Engineering at RU-N to promote students' career development in the optics and photonics industry.

The grants, which are part of the NSF's efforts to expand its support for quantum information science and engineering (QISE), are two of the 22 awards that NSF handed out this cycle, totaling $38 million and spanning a variety of subjects including physics, computer sciences, materials research, engineering and chemistry.

NSF's QISE initiative began after Congress' passage of the National Quantum Initiative Act in 2018, tailored to meet the needs of the emerging field and ensure the U.S. continues serving as a global leader in science and engineering. As part of this nationwide effort, NSF developed the Expanding Capacity in Quantum Information Science and Engineering (ExpandQISE) program to lower barriers to access and broaden the diversity of participating institutions.

Among the 22 awardee institutions this cycle are six historically Black colleges and universities and three Hispanic-serving institutions, of which RU-N is one.

"Supporting research and expanding participation at minority-serving institutions is extremely important, and NSF has recently offered several new funding opportunities for scientists and educators at these sites," said Wu. "Students from minority groups will benefit from participating in cutting-edge research, making them more competitive for graduate schools, postdocs or research positions in the academy, government and industry."

Wu is grateful for the chance to work on cutting-edge research with the support of both Rutgers and the NSF, while opening up doors of opportunity for and impacting the lives of students.

"These grants are stepping-stones that will allow progress in my research and produce results and publications," said Wu. "And I'm excited to develop new courses and laboratory experiments, based on my research, that will train students for the ongoing second quantum revolution, creating new talent in the emerging field of quantum sensing, computing, communication and materials."

ABOVE PHOTO: From Left to Right: Guanghui Su (graduate student), Nami Uchida (undergraduate), Timothy Nguyen (graduate), and Professor Xuejian Wu (PI)

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