OU takes a Quantum Leap

With the well-appointed Lin Hall now home to the Center for Quantum Research and Technology, the university enters the international race to apply the science in commercial endeavors.

By Chip Minty

From the outside, the newly completed Lin Hall blends with many of the other buildings across campus, with its red brick, white stone and Cherokee Gothic style that distinguishes architecture at the University of Oklahoma.

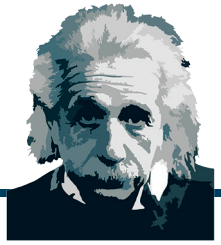
But on the inside, Lin Hall is like an Italian sports car revving its engine on the south oval. The hall is home to OU's Center for Quantum Research and Technology, which is the kind of facility research universities across the country dream of having.

Hugh Scott

Lin Hall, part of OU's Homer Dodge Physics Complex, houses more than 18,000 square feet of research laboratory space, as well as office space for faculty and graduate students. The new academic center is one of only a few buildings in the world to meet the NIST-A requirements on vibrations, temperature and humidity, as well as electromagnetic interference.

To the nation's most elite scientists and engineers, Lin Hall is even better than a loaded Lamborghini. When they look under the hood of this beauty, they see what they need to complete the quantum journey Albert Einstein began in 1905.

The term "quantum" is well known by most, but the actual science is well understood by few. But, judging from the worldwide funding and attention it is receiving, quantum theory is more important today than the first moon shot was 50 years ago. *continued*



Travis Caperton

Tomás Díaz de la Rubia, the university's vice president for research and partnerships, says OU is on the verge of a quantum technology transformation that could have great economic impact in the near future.

Einstein helped get the ball rolling when he suggested that German physicist Max Planck's revolutionary quantum hypothesis would eventually require the laws of physics to be rewritten. Einstein continued his work in quantum physics and ultimately won a Nobel Prize for it in 1921.

Scientists have been on the quantum trail ever since, and they are now closing in on a revolution that may soon carry quantum mechanics from the laboratory to the marketplace. Massive change is on the horizon, and OU will have a front-row seat, says Tomás Díaz de la Rubia, the university's vice president for research and partnerships.

"We're on the edge right now of a tremendous technology transition, globally, in which quantum technologies are emerging. Over the next five to 10 years, they are going to emerge very strongly as the new transformational technology in society.

"That's why I say we're on the verge of a very significant transformation that is going to have massive global impact from an economic perspective, but also from a defense and national security perspective.

"If we're able to harness the power of quantum physics, we'll be able to develop computers that have the capacity to do the type of mathematical calculations that we've never imagined before. That may lead to discovering new materials, chemicals and processes with implications and applications in all kinds of fields of life.

"At the same time, we'll be able to create quantum sensors with sensitivity of a higher magnitude than anything we have today. Those quantum sensors could have applications in all kinds of fields, ranging from defense and national security to oil and gas exploration to medical diagnostics to autonomous vehicle transportation. You name it.

"These are the early days of this technology, but if it is truly realized, it has the potential to be transformative. That's why the Center for Quantum Research and Technology is so important and so timely," he concludes.

Díaz de la Rubia assumed his role at OU late last year after spending four years at Purdue University, serving as the chief scientific officer and senior vice president for strategic initiatives. Prior to that, he served 24 years at the Lawrence Livermore National Laboratory, where he was deputy director of science and technology as well as chief research officer. Díaz de la Rubia has spent an additional three years in the private sector.

"We're on the edge right now of a tremendous technology transition, globally, in which quantum technologies are emerging."

He says the Center for Quantum Research and Technology was one reason he left his post at Purdue. Lin Hall and the center will be in the thick of the quantum transformation as OU physicists, chemists, computer scientists and engineers work together in some of the most pristine, multidisciplinary and technologically advanced laboratory environments.

Named in honor of former OU physicist Chun Lin, the 18,000-square-foot Lin Hall includes several labs as well as office space for faculty and an astronomy observatory on the roof. But the laboratories are what sets the building apart.

Travis Caperton

Former OU physics professor Chun Lin accepts his Seed Sower award from OU at the dedication of his namesake, Lin Hall, which houses the Center for Quantum Technology and Research.

There are only a few buildings in the world that can meet the National Institute of Standards and Technology's highest specifications for vibration, temperature, humidity and electromagnetic interference. OU's Lin Hall is one of them.

All labs have advanced heating and cooling systems that guard against temperature swings. The building is also designed to dampen the faintest of vibrations, and shield against electromagnetic radiation.

In other words, research and discovery in the field of quantum mechanics has become so advanced and sensitive that a freight train passing a half mile away or a student talking on his or her iPhone could cause a setback, and this building ensures that will not happen.

In this race to unlock the deepest secrets of quantum, buildings like the $37 million Lin Hall are essential, says David Wrobel, dean of OU's College of Arts and Sciences.

"Standard facilities cannot accommodate quantum research anymore," he says. "The technical requirements are too advanced."

Great research institutions such as Harvard, the Massachusetts Institute of Technology, Purdue University and the University of Colorado are competing for the best scientists, who can attract millions of dollars in government research grants, and Lin Hall has put OU on the map.

"If you don't have the facilities, the best researchers will not come," Wrobel says. "We are attracting those people because we can guarantee they'll be in adequate facilities."

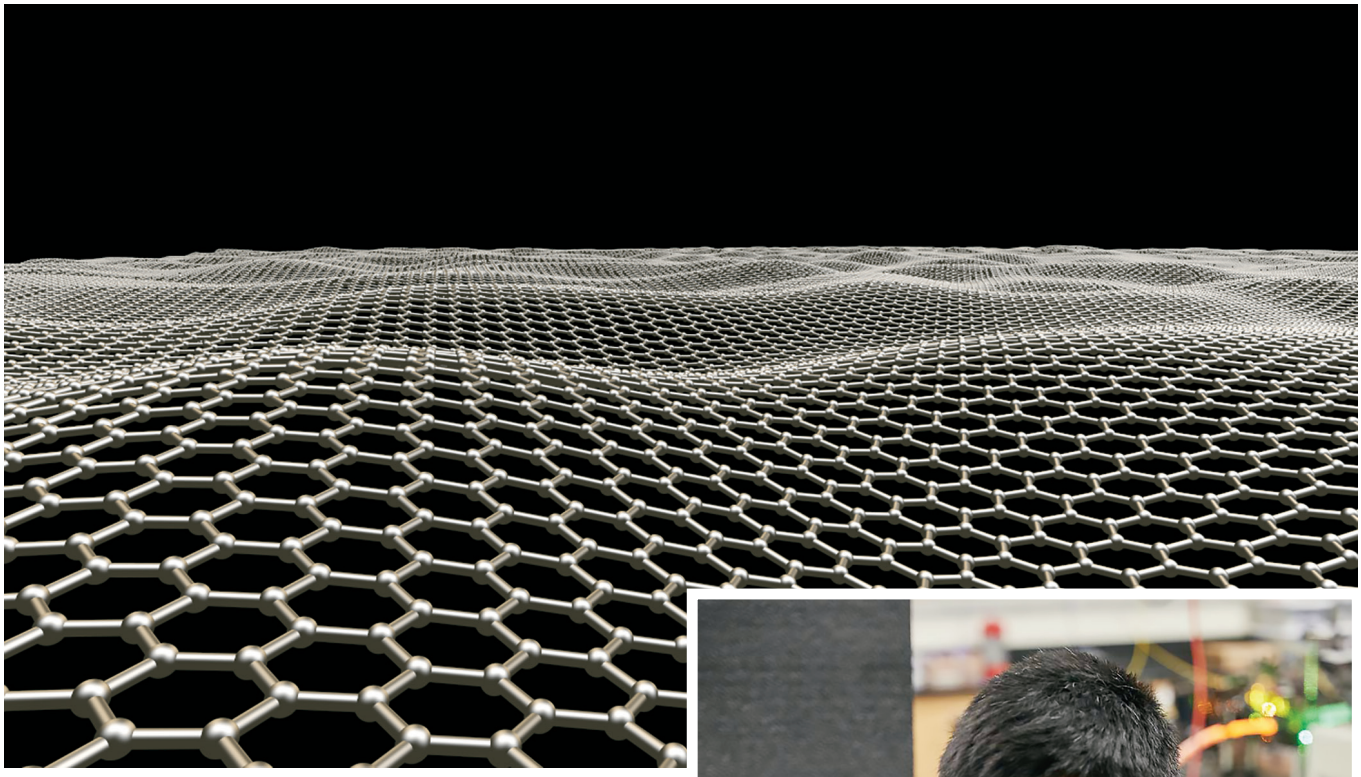
The dean says significant donations from the Avenir Foundation and former OU physics professor Lin helped fund construction as well as endowments for additional faculty researchers and graduate students.

Soon, five new researchers will be added to the faculty, says OU physics professor Alberto Marino, who is serving as the center's interim director. He says competition for the best people always has been stiff; because of Lin Hall and the center's advanced laboratory space, OU can now attract top-notch talent in the quantum field.

After spending the early part of his career at the National Institute of Standards and Technology, Marino moved to OU seven years ago and set up a lab to study the generation and control of quantum states through the interaction of light and atoms.

He and colleagues consider themselves fundamental researchers, but now, Marino says they are looking for opportunities to apply their discoveries. For example, Marino's work on the use of light for quantum-enhanced sensing could eventually contribute to revolutionary advances in sensing technology.

"There is a huge push to move the field forward, and there

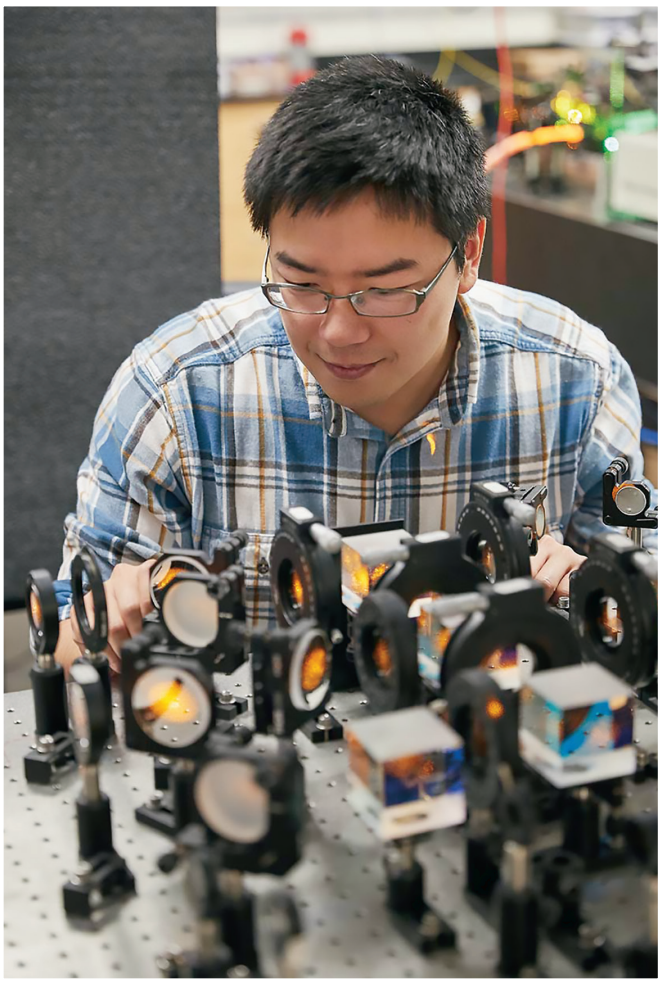


An artist's representation of a graphene system, a super-thin material that is remarkably strong and holds great potential for applicable quantum technology.

are more and more people coming into the field, making it more interdisciplinary," he says. "Over the next few years, we will expand into engineering and chemistry. Other departments will be involved in the center, which will allow us to do more than we can do by ourselves."

OU Vice President Díaz de la Rubia uses the term "co-creation" to describe the new approach to discovery in quantum physics.

"Once you understand the fundamentals of how quantum works, you've got to build a device. You've got to build a computer, you've got to build a sensor, you've got to build a communications network, for example. But it's not just a sensor,



Hugh Scott

Shan Zhong, a graduate student for OU physicist Arne Schwettmann, adjusts laser optics in a lab. A new breed of atomic sensors is capable of measuring faint microwave and gravitational fields, with applications in everything from defense to oil production.

Hugh Scott

Alberto Marino, OU physics professor and interim director for the Center for Quantum Technology and Research, is investigating the use of light for quantum-enhanced sensing that could contribute to revolutionary advances in that technology.

it's a system," he says. "The sensor has to have a system around it for computing and data processing, and it has to live in an environment in the field. That requires engineering and computer scientists and so on.

"It takes a village," he says. "It takes the convergence of all of these different academic enterprises and disciplines to come together to actually do something that translates into an application for society."

At stake are hundreds of millions of dollars in government research grants, not to mention the economic benefit of new, high-paying jobs and new start-up companies that could bloom from technology developed by OU.

In December of 2018, Congress passed the National Quantum Initiative Act, authorizing more than $1 billion to be spent annually for quantum research. The grants are being distributed through the National Science Foundation, the Department of Energy, and the National Institute of Science and Technology.

There is a global race to develop quantum technology, Díaz de la Rubia says, and the government recognizes there is a potential for the U.S. to be left behind.

"There is now a strategic plan in the country, driven by the administration and Congress to really make sure we are competitive and ahead of the competition, ahead of China, ahead of Russia and other countries. The Europeans are investing enormous amounts of money in this area as well," Díaz de la Rubia says. "The research has very important practical consequences."

Amid these revolutionary times in quantum mechanics, he says it is more important than ever to translate quantum knowledge into applications and technologies.

"Those will have, over time, big commercial implications," he says.

Traditionally, experimental physicists have done fundamental research, then they have passed their findings on for potential development by commercial entities outside OU, but that's like watching money and opportunity walk out the door, Díaz de la Rubia says.

Discoveries that are made at OU should stay at OU, and for that to happen, it will take teamwork.

"You cannot gas a nucleus and hand it off. You can do much better if you do it as a team together, where you have folks that are doing the basic research, working with the folks that are doing the applied research, and with the folks that are doing the computer science. Then, they're all working toward the same goal."

Dean Wrobel says the center is an exciting addition to OU's landscape of potential, and it brings significant opportunity to attract more federal money and future jobs.

"OU has the potential to diversify the state's economy, and we may see tangible benefits by 2025," Wrobel says.

OU is poised to take the next step with a blank page, ready to grow in new directions, Díaz de la Rubia says.

"That's exciting. To build something new, especially considering what's already here and building on that," he says.

"But, if you're going to have impact, if you're going to develop technologies that are actually going to do anything useful for anybody, including having commercial spinoffs and applications, you have to do it as a team.

"That's where I want to see this go."

Chip Minty is a Norman-based writer and the principal of Minty Communications, LLC.