‘It’s your future’: High schoolers and teachers learn quantum at UT Arlington camp

Students and teachers perform levitation experiments and learn about how particles work at a UT Arlington-sponsored summer camp.

Student George Rosales watches as magnets are used to pick up a superconductor cooled by liquid nitrogen during a quantum physics summer camp at Martin High School in Arlington on Monday, June 26, 2023. The camp was sponsored by UT Arlington and organized by Quantum for All, an organization aiming to spread quantum education to high schools across the U.S. (Juan Figueroa / Staff Photographer)

By Lila Levinson
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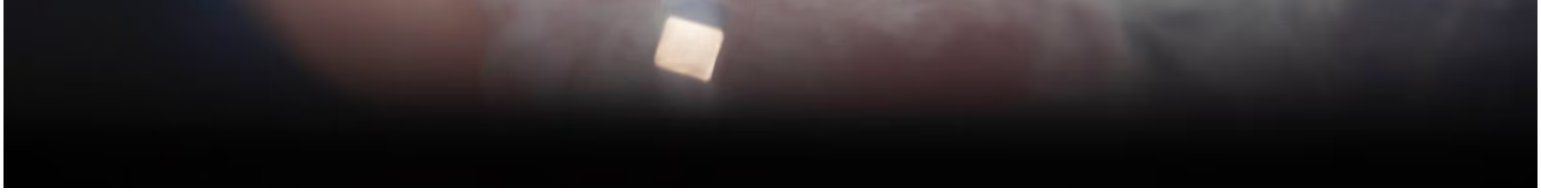
Levitation isn't on the list of activities for most summer camps, but recently at Martin High School in Arlington, it was the focus.

Outfitted with rubber aprons and safety goggles, high school students held magnets above disks that looked steaming hot. They were actually extremely cold. When the magnets were aligned correctly, they hovered above the disks, rotating eerily.

This floating trick wasn't magic — it was based on quantum physics.



High school student Gavin Gilbreath Mann watches a magnet levitate over a superconductor cooled by liquid nitrogen. The superconductor's special properties lock the magnet into place, where it hovers. (Juan Figueroa / Staff Photographer)

Interacting with the world makes us all experts in physics. We know that a ball thrown in the air will come back down and a playground swing will stay still without a push.

The same general rules apply to pretty much everything we can see. But when you get down to the level of the particles that form atoms, the rules change. Those rules are described by quantum physics.

And the rules go way beyond just physics. Fields from chemistry to computing — and technology from cellphones to humble fluorescent bulbs — use these same principles. Innovations in this area could help us improve cybersecurity and build safer trains.

These applications of quantum physics and many others are encompassed by the field of quantum information science, or "quantum" for short.

"It's your future," said Karen Jo Matsler, a master teacher at the University of Texas at Arlington's STEM teacher training program. She leads Quantum for All, the organization that runs the camp. The group received nearly $1 million from the National Science Foundation in 2021 to spread quantum education by making the concepts more approachable.

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Most students in the U.S. don't learn about quantum in school. Matsler, who taught high school and university physics for over 30 years, thinks this is a mistake.

Karen Jo Matsler, a master teacher in UT Arlington's STEM teacher training program, is the founder and leader of Quantum for All. (Courtesy of University of Texas)

Diana Franklin, a computer science professor at the University of Chicago, and Chandralekha Singh, a physics professor at the University of Pittsburgh, agree.

Franklin and Singh help lead the National Q-12 Education Partnership, a group that works with academic and industry leaders to support quantum education in U.S. science classes. Quantum for All is one of the Q-12 Partnership's many affiliates, which include other quantum education organizations and tech companies like Google and IBM.

Franklin and Singh say that, in order for quantum technologies to continue revolutionizing the world, quantum really does need to be for all.

“We … have missed out on the lens of women and racial/ethnic minority students,” said Singh, referring to the quantum revolution.

Franklin added: “Everyone needs to be at the design table so that the products can be designed in a way that's beneficial to everyone.”

Approachable and fun

Both Q-12 and Quantum for All focus on breaking down quantum to be approachable and fun for teachers and students, rather than mysterious and scary. “When you start early, things are not spooky,” said Singh, who also serves on the advisory board of Quantum for All.

Christina Tran, a rising junior at Martin High School, definitely isn't spooked. She attended Quantum for All's camp last summer, too. "They break it down so well that … it doesn't discourage you from learning," she said.

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In addition to learning, Tran and the other campers had fun with hands-on experiments at the Arlington summer camp in June.

Earlier in the day, students built model trains that levitated using magnets. While the trains moved quickly because they didn't have contact with the ground to slow them down, they were wobbly and some flipped over.

(From left) Students Cate Nguyen, Emily Hoang, Davy Huynh and Jennifer Udoh clap after their model train, which is magnetically levitating, makes it down the track. (Juan Figueroa / Staff Photographer)

So the students tried out a different solution — quantum levitation.

Quantum levitation has two components — a strong magnet and a superconductor, which is a material that has special quantum properties when it is extremely cold.

When the magnet is moved on top of the cold superconductor, these special properties make the superconductor act as a second magnet.

The magnet-like superconductor repels the original magnet up and away from it. But gravity still pulls the magnet down. Trapped between two opposing forces, the magnet levitates above the superconductor.

Watch: High schoolers and teachers learn quantum at UT Arlington camp

Students and teachers perform levitation experiments and learn about how particles work at a UT Arlington-sponsored summer camp. (Liesbeth Powers)

After this happens, the magnet and the superconductor are invisibly locked together as if they're connected by invisible strings. If either piece is moved carefully, so as not to break the lock, the other will move with it.

At one table, a teacher demonstrated this by dunking a superconductor in liquid nitrogen and moving it toward a large magnet, creating the quantum lock. Then, the teacher turned the magnet upside down and showed that the disk stayed attached, hovering just below.

Elsewhere, students gently tossed small magnets at a superconductor and watched them bounce away, repelled.

Tran said she loved getting “to pick up the [superconductor] and work with the nitrogen.” She added that while liquid nitrogen is “amazing,” she’s “over” liquid nitrogen ice cream.

After the experiments, the students agreed that quantum levitation was more stable than magnetic levitation. They thought that applying this technique to trains might provide a lot of the same pros as a magnetic levitation without some of the downsides.

Preparing students and teachers

Due in part to Matsler’s efforts, Texas now requires quantum education as part of the core curriculum. Organizations like Quantum for All and the Q-12 Partnership are connecting teachers to emerging quantum resources that they can incorporate into physics, chemistry, computer science and math classes.

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To help make teachers feel more confident teaching quantum concepts, Quantum for All combines teacher training with practical experience. This year, teachers came to Arlington from all over the country for a week of training, then immediately turned around and taught what they had learned to high school students at the camp.

This type of practice makes Ashley Fiamengo, a chemistry teacher in the Irving Independent School District, feel more comfortable bringing the concepts back to the classroom. "[You're] a little more confident because you've done it again," she said.

Pierce Nguyen tries to levitate a magnet. (Juan Figueroa / Staff Photographer)

Fiamengo has been attending Quantum for All teacher trainings since the organization started offering them in 2020. She said, “It is the best form of professional development I’ve ever had.”

Fiamengo and the other teachers who attended the camp will continue to tweak the camp’s curriculum based on their experiences with campers and their own students.

Quantum for All will then collate this feedback to strengthen the curriculum before making it publicly available. Matsler hopes that starting next spring, teachers everywhere will be able to access these resources.

For young people who are excited about quantum science but missed Quantum for All’s camp, there are lots of opportunities to learn more. [The Q-12 Partnership has a number of interactive, free games on their website that help teach quantum concepts] (and they come with teacher guides that don’t require any background knowledge to teach).

[A new video series] from the Chicago Quantum Exchange, a quantum research and outreach program, uses fun animations to break down complicated quantum ideas.

Lila Levinson reports on science for The Dallas Morning News as part of a fellowship with the American Association for the Advancement of Science.

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