Naval Aviator Turned NPS Doctoral Student Earns National Recognition for Applied Quantum Research

From fighter pilot to physicist, U.S. Navy Cmdr. Jens Berdahl's award-winning research in quantum science advances applications for national defense.

Naval Postgraduate School team developing the atomic fountain for quantum sensing research from left: Dr. Frank Narducci, doctoral student Cmdr. Jens Berdahl, machinists George Jaksha and Daniel Moreno, and visiting scientist Takaho Tsubakiyama.

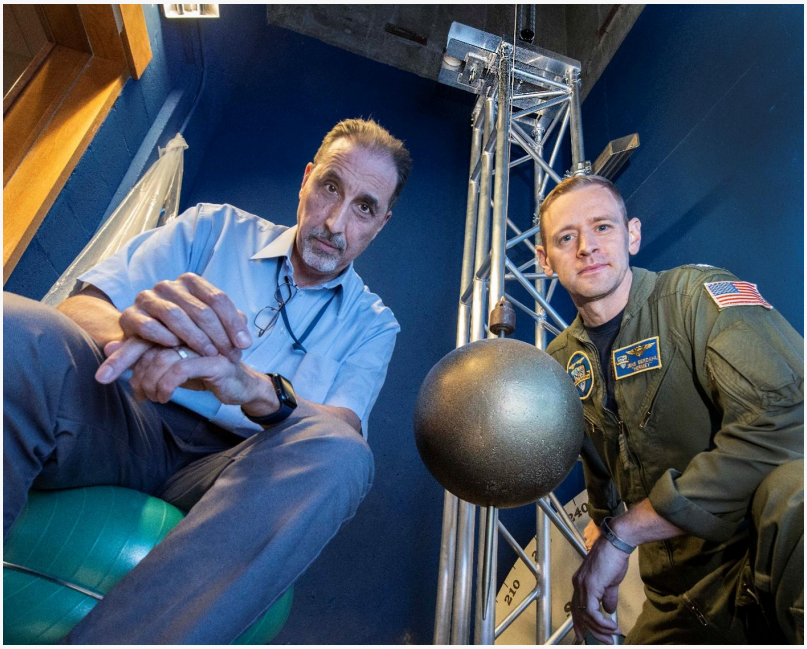
MONTEREY, CA, UNITED STATES, December 7, 2025 /EINPresswire.com/ -- A Naval Postgraduate School (NPS) physics doctoral student has just been presented with a prestigious award for his pioneering research in quantum sensing using a unique atomic fountain.

U.S. Navy Cmdr. Jens Berdahl, a former naval aviator and F/A-18 pilot currently pursuing his doctorate through the service's Permanent Military Professor (PMP) program, was recently presented with the highly competitive Margaret Burbidge Award for Best Experimental Research by a Graduate Student. Presented by the American Physical Society, Far West Section, Berdahl received the award while presenting his research on NPS's atomic fountain at the society's 2025 annual meeting, Oct. 10-12, at the University of California, Santa Cruz.

"Cmdr. Berdahl winning this award demonstrates to the world that NPS — and specifically NPS students and visiting scholars — can compete with the best that's out there!" said Dr. Frank Narducci of the NPS Department of Physics, principal investigator on the project.

"One major significance of this award is that it validates for the student that they are doing good — and in this case, great — work," he continued. "Often, as a student is beginning, the student will not have perspective on how their work compares to their peers. Here, this award says that they are doing the best work from among this subset of others working at the same level."

Winning the award was certainly a great honor, Berdahl said, but he was quick to ascribe his victory to a small team working on the Atomic Fountain. Working alongside Narducci and Mr. Takaho Tsubakiyama, a visiting researcher under the Engineer and Scientist Exchange Program (ESEP) from Japan's Ministry of Defense, Berdahl is conducting his research on quantum sensing to detect minuscule changes in mass, or the absence of mass, from afar; quite useful for varied applications, such as tracking a submarine, conducting precision navigation in a GPS-denied environment, and identifying a tunnel network being carved out of a mountain or other threats adversaries want to keep hidden.



Dr. Frank Narducci, professor of physics at Naval Postgraduate School with his doctoral student U.S. Navy Cmdr. Jens Berdahl are advancing defense applications of quantum science.

Such work in quantum science aligns directly with the six Critical Technology Areas recently announced by the Office of the Under Secretary of War for Research and Engineering (OUSWR&E) as essential to address the United States' most pressing national security challenges.

"One of the things that's unique about this project is that we are trying to make these sensitive measurements on operationally relevant time scales," Berdahl said. "With many defense applications, we may not have the luxury of loitering to collect data for very long. Instead, these sensors may be used on unmanned underwater vehicles (UUV) or unmanned aerial vehicles (UAV) with limited dwell times."

Their project consists of erecting an Atomic Fountain in an unused elevator shaft in Spanagel Hall on the NPS campus. An initial "baby tower" measures nearly 24 feet (8 meters) in height, while the final version will stand approximately 100 feet (30 meters) tall, offering greater sensitivity.

The team's objective is to measure gravity, Tsubakiyama explained.

"All of us have mass, which means all of us change gravity a little. We can't feel that difference because it's very tiny," he said. "With our quantum sensor, the sensitivity to gravity will reach nine decimal places of precision. At that level, we can measure those small gravity differences."

The NPS Atomic Fountain consists of two parts: a Magneto-Optical Trap (MOT) and an interferometer.

The MOT captures atoms in electromagnetic fields and cools them in an ultra-high vacuum, expressing the atoms' wave-like nature and allowing them to exist in superposition: where a single atom can be in multiple locations at the same time. By adjusting the frequency of the MOT lasers, the atoms are launched vertically into the interferometric section. Using new lasers, the atoms are forced into superposition and are subsequently recombined. When apart, the two states experience gravity differently due to the masses around them. Once they come back together, the measured interference provides information about masses in the local environment. The reason for building tall atomic fountains is to maximize the amount of time the atoms are in superposition. Longer times yield better sensors.

While spatially separated, each atom is acted on by a host of interfering "noises" including other gravitational effects, the Earth's magnetic field, and the Coriolis effect of the Earth's rotation.

"All these things need to be considered; that is our main challenge," Tsubakiyama said.As the atoms return to their original, singular state, the interferometer measures infinitesimal fluctuations in gravity, yielding a treasure trove of information.

"It's a wonderful project because it has some really novel quantum science, but it's also a huge engineering challenge because we're building a 30-meter tower in an elevator shaft," Berdahl said. "It's a nice blend of theoretical and experimental challenges."

Despite the varied challenges that this project brings, Berdahl continues to be inspired by his advisor, Dr. Frank Narducci. "I've been so thankful for his thoughtful and patient instruction through this journey. He is a well-spring of knowledge, and I look forward to working with him for years to come as a military professor here at NPS, following graduation."

Berdahl also expressed profound gratitude for the machinists Mr. Daniel Moreno and Mr. George Jaksha in Spanagel Hall.

Constructing the Atomic Fountain requires all sorts of custom materials, fasteners and brackets that have unique shapes, sizes and strengths. The project also requires extreme precision, with less than 0.001-inch tolerances on some components. Each copper coil, for example, calls for 1,214 windings to create a strong magnetic field gradient without excessive heating.

"Their skill and craftsmanship are so perfectly complemented by their imagination and innovation," Berdahl said. "This shop does it all."

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