National Aeronautics and
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**Committee on Science, Space,
and Technology**

United States House of Representatives

Statement by:

Dr. Mark Clampin, Deputy Associate Administrator, Science Mission Directorate
National Aeronautics and Space Administration

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Statement of
Dr. Mark Clampin
Deputy Associate Administrator
Science Mission Directorate
National Aeronautics and Space Administration
before the
Committee on Science, Space, and Technology
United States House of Representatives
Regarding
Assessing U.S. Leadership in Quantum Science and Technology

Good morning. I am Dr. Mark Clampin, Deputy Associate Administrator for NASA's Science Mission Directorate (SMD).

On behalf of NASA, I want to express our gratitude to the Committee and Congress for your attention to opportunities emerging in quantum science and the new possibilities it opens for space science and the space economy. Like many of our Federal colleagues, we are excited by the advances that can be made through quantum research and development.

You may recall that at a hearing of this Committee on quantum research and development in 2023, Dr. Eleanor Rieffel of NASA's Ames Research Center in Silicon Valley discussed NASA's efforts and her leadership of the Quantum Artificial Intelligence Laboratory (QuAIL) at Ames. QuAIL is the agency's hub for assessing and advancing the potential of quantum computers to impact the agency's most complex challenges.

NASA is at the forefront of putting quantum science into action in both quantum computing and quantum sensing. QuAIL is just one of the many ways the United States is leading the world toward a future powered by quantum technologies. NASA leverages the unique environment of space to drive quantum science breakthroughs that advance technological innovations, navigation, computing, communication, scientific discovery and much more that we cannot yet fathom.

NASA partners with industry, other government agencies, and universities to develop and advance quantum technologies, pioneering their uses and minimizing risks so the United States private sector can adopt and scale them - ultimately benefitting everyday consumers. By developing these technologies to solve exquisitely difficult problems, NASA ensures that there is a sustained pipeline of innovation for new space-based missions and industry that will enable us to uncover the secrets of the universe, protect life in space and on Earth, and understand if we are alone in the universe.

As the Committee seeks to reauthorize the National Quantum Initiative Act and direct American breakthroughs in quantum science, I want to highlight several areas where NASA sees exciting prospects for disruptive advances as we prepare to send humanity on its epic journey to the Moon, and onward to Mars and beyond for the first time in our history. Quantum will play a major role in ensuring that both astronauts and spacecraft are protected and thriving on the journey to these extreme environments.

Quantum sensing is not new to NASA. In 1964, NASA's Mariner IV was the first U.S. mission to fly a quantum sensor via an optically pumped vector magnetometer. Mariner IV was the first spacecraft to explore Mars and gave humanity its first close-up glimpse of another planet, setting a standard for US leadership in this scientific area.

In 2018, NASA's Cold Atom Laboratory launched to the International Space Station. The Cold Atom Laboratory is the world's premier space-based science lab and the coldest known spot in the universe. It allows scientists, working with astronauts, to examine Bose-Einstein Condensates, a unique state of matter even colder than frozen material, where atoms move in lockstep together without the pull of gravity. Bose-Einstein Condensates test fundamental ideas in quantum mechanics, statistical mechanics, and strongly-correlated many-body physics in condensed matter that can only be done in this environment. Studying cold atom physics is a key building block in developing next-generation quantum sensors and simulators.

Today, NASA is building on the knowledge we learned from the Cold Atom Lab to study gravity gradients on Earth in a Quantum Gravity Gradiometer using the technique of atom interferometry. Ultra-precise measurement of the Earth's gravitational changes will allow NASA to better support drought monitoring, water management, and determination of flood potential. Atom interferometry further offers a new, disruptive approach to deep space navigation, geological mapping of the planets, and the study of gravitational waves as a probe of cosmic inflation.

In astrophysics, NASA seeks to achieve the near impossible in its study of black holes, dark matter, and in expanding astronomers' reach. Right now, the Japan Aerospace Exploration Agency (JAXA)'s X-Ray Imaging and Spectroscopy Mission (XRISM) studies the hot universe using X-ray spectrometers based on quantum micro-calorimeters developed by NASA. These detectors provide images with spectroscopic maps that have allowed scientists to understand the nature of material flowing into black holes. The XRISM quantum imager is an excellent example of how NASA scientific ideas break new ground in advancing space science technologies that could be commercialized space applications. NASA's next challenge is to advance this imaging capability to a broader range of wavelengths, such as for the potential future Habitable Worlds Observatory.

Finally, quantum science supports exploration of our own solar system, from the Moon to Mars and beyond. NASA funded quantum detectors that have now been used in ground receivers for deep space optical communications, or DSOC. The DSOC technology demonstration aboard our Psyche mission used these sensors to show data rates over 8 megabits per second from just beyond Mars – a tremendous improvement over our current capabilities. The DSOC project has exceeded all technical goals after two years and establishes a strong framework for future high-speed communications for crewed missions to Mars. This research has now been commercialized and is integrated into a technology demonstration to support Artemis II, where a commercial quantum sensor will be used in an optical communications system to transmit high-resolution video and images of the lunar surface down to Earth.

The application of quantum concepts for space exploration requires specialized approaches driven by the extreme environment in space. NASA is developing concepts for an atomic lunar seismometer and accelerometer, magnetometers based on quantum color-center devices that can help NASA explore the water-heavy moons around Jupiter and Saturn, and a portable optical frequency comb for spectrometry that could help us characterize resources on the Moon for human exploration. There remain many new areas of quantum science that have potential space applications, including super-resolution, interferometry, and magnetometers. These advancements support both the US space economy and NASA as we travel deeper and deeper into our solar system and farther from the reach of Earth's ground navigation systems.

These are just a few of the many investments and exciting prospects NASA is supporting in quantum science. The agency's work in analyzing quantum computing architectures and algorithms is important not only for our future missions but for advancing efforts across the federal government, especially alongside the Department of War and the Department of Energy. NASA is at the tip of the arrow for America's advanced technology strategy, especially for space applications. It's our job to go first and confront the hardest technical problems and we are looking forward to partnering with industry to take US quantum technology even further.

I would like to include with my testimony an article published last year in EPJ Quantum Technology that covers these and several other concepts NASA is pursuing. I appreciate the number of opportunities the Committee has provided to engage on the reauthorization of the National Quantum Initiative Act.

Thank you for this opportunity to testify, and I welcome your questions.