

**Statement of
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before the

**Committee on Science, Space and Technology
U.S. House of Representatives**

Chairman Smith and Members of the Committee, thank you for the opportunity to appear today to discuss NASA's Planetary Science program. In my opening statement, I would like to explain how the Mars 2020 and Europa Clipper mission fit into our overall planetary exploration portfolio.

NASA is at the leading edge of a journey of scientific discovery that promises to reveal new knowledge of our solar system's content, origin, evolution and the potential for life elsewhere. NASA Planetary Science is engaged in one of the oldest of scientific pursuits: the observation and discovery of our solar system's planetary objects. NASA advances the scientific understanding of the solar system in extraordinary ways, while pushing the limits of spacecraft and robotic engineering design and operations.

In the past couple of years, with the flyby of the New Horizons spacecraft through the Pluto system, humankind had completed its initial survey of our Solar System neighborhood. The United States remains the first and only nation to reach every major body from Mercury to Pluto with a space probe. Solar System exploration has always been and continues to be a grand human enterprise that seeks to discover the nature and origin of the celestial bodies among which we live and to explore whether life exists beyond Earth.

Today, NASA has numerous missions exploring and operating throughout the solar system. After the spectacular flyby of Pluto and its moons, New Horizons will encounter a small Kuiper Belt object (KBO), a building block of Pluto-sized KBOs on January 1, 2019. Missions such as the Lunar Reconnaissance Orbiter brought us back to the Moon and enabled new discoveries that are rewriting textbooks.

The indomitable Curiosity and Opportunity rovers supported by the Odyssey, Mars Reconnaissance Orbiter, and MAVEN (Mars Atmosphere and Volatile EvolutionN) orbiters at Mars are informing us about one of our closest neighbors. For example, this past March, results from NASA's MAVEN mission revealed that the solar wind is responsible, over billions of years, for stripping away most of the Martian atmosphere, transforming Mars from a planet that could have supported life in its distant past into the frigid, desert world that we see today. This discovery is a significant step towards unraveling the mystery of Mars' past environments and, in a broader context, informs us about the processes that can change a planet's habitability over time.

Adding to our missions at Mars, the InSight (Interior Exploration using Seismic Investigations, Geodesy and Heat Transport) lander will be launched in May 2018 and land on the surface in November. InSight is designed as a seismic and heat flow subsurface probe that will study the interior structure of Mars along with understanding its present-day level of global activity. And just two years later, the Mars 2020 rover will launch, carrying seven instruments to conduct geological assessments on the Martian surface, determine the potential habitability of the environment, directly search for signs of ancient Martian life, and for the first time, collect high-grade rock core samples for potential future return to Earth. I look forward to Dr. Farley's testimony which will provide additional details about the Mars 2020 mission.

Between Mars and Jupiter is the main asteroid belt; where NASA's Dawn mission is currently studying the dwarf planet, Ceres – the largest object in the main asteroid belt. A few short months ago, scientists using Dawn's instruments found evidence of organic materials in and around Ceres' northern hemisphere crater called Ernutet. This discovery is the first clear detection of such molecules from orbit on a main belt body and interesting to scientists because organic molecules are necessary, though not sufficient, components of life on Earth.

However, Ceres is not the only small body NASA is investigating. This past January, NASA selected two new Discovery missions, called Lucy and Psyche, which will visit asteroids we have never seen up close before to enable groundbreaking science. Lucy will visit six of Jupiter's mysterious Trojan asteroids, while Psyche will study a unique, metal asteroid (16 Psyche) thought to be an exposed planetary iron-nickel core.

Moreover, NASA's current robotic asteroid rendezvous and sample return mission, dubbed OSIRIS-REx (for Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer) recently conducted a search of elusive objects known as Earth-Trojan asteroids during its current journey to the asteroid Bennu. Although no Earth-Trojans were discovered, the spacecraft's camera operated flawlessly and demonstrated that it could image objects significantly dimmer than originally expected. In September, OSIRIS-REx will flyby the Earth, getting the gravity assist it needs to arrive at its destination in August 2018. The first U.S. mission of its kind, OSIRIS-REx will approach the near-Earth Asteroid Bennu, map the asteroid, and collect a sample of as much as 1 kilogram for return to Earth in 2023. Bennu is believed to contain water and organic compounds such as amino acids. Examination of objects like Bennu will allow scientists to investigate how planets formed and how materials, like water, could have been brought to early Earth from later impacts.

NASA's Planetary Defense Coordination Office (PDCO) ensures the early detection of potentially hazardous objects and leads the research into impact mitigation and deflection strategies. PDCO's Near-Earth Object (NEO) Observations Program supports surveys that contribute to a sustained and productive campaign to find and track NEOs, collecting data of sufficient precision to allow accurate predictions of the future trajectories of discovered objects. To date, NASA-funded survey projects have catalogued more than 16,000 objects, at a current rate of about 1,500 per year – none of which pose a significant risk of impact with Earth over the next 100 years.

In our outer solar system, NASA's Juno spacecraft achieved a first-ever polar orbit at Jupiter last July and has shown us Jupiter in exquisite detail never seen before. Indeed, Juno has uncovered that Jupiter's magnetic fields are more complicated than originally thought. Juno has revealed that the belts and zones that give the planet's cloud tops their distinctive look extend deep into its interior, that the core of the planet is larger than expected, and that both northern and southern polar regions maintain numerous Earth-sized cyclones.

After 13 years orbiting Saturn, our Cassini spacecraft has completed 13 of a series of 22 daring dives through the 1,500-mile-wide gap between the planet and its rings as part of the mission's Grand Finale. Between April and September of this year, the mission team hopes to gain powerful insights into the planet's internal structure and the origins of the rings, obtain the first-ever sampling of Saturn's atmosphere and particles coming from the main rings, and capture the closest-ever views of Saturn's clouds and inner rings. When Cassini makes its final plunge into Saturn's atmosphere on September 15th, it will send data from several instruments - most notably, data on the atmosphere's composition - until its signal is lost.

And while Cassini may be ending this year, another outer planet mission is just getting started. NASA is working on a mission called Europa Clipper that will send a highly capable, radiation-tolerant spacecraft into a long, looping orbit around Jupiter to perform repeated close flybys of Europa, one of the most fascinating of Jupiter's moons. Europa is believed to harbor a salty ocean underneath a thick crust of ice. The goal of this mission is to conduct a detailed reconnaissance of Europa and to answer the big question, "Is Europa habitable?" Testimony from Dr. Pappalardo, of NASA's Jet Propulsion Laboratory, will provide exciting details about this future mission.

With such a vast array of ground-breaking missions, it is no surprise that NASA has always strived to develop creative and innovative ways to explore our solar system. Moving forward with that same perspective, NASA's Science Mission Directorate is incorporating a new initiative this year to use small, less expensive satellites (CubeSats or SmallSats) to advance selected high-priority science objectives in a cost-effective manner. This initiative will implement recommendations from the National Academy of Sciences, which concluded that, due to recent technological progress, these small satellites are suitable to address such science goals. The initiative will also provide partnership opportunities for commercial partners and our international counterparts to further leverage and align with investments made within NASA.

NASA's Planetary Science Division, in particular, has selected nineteen mission concept studies to define planetary science investigations that can be accomplished using small secondary payloads. The science targets under study span the solar system, including Mars, the outer planets, Venus, small bodies, and the Moon. The types of science proposed using CubeSats include determining the processes that control the climate on Mars, characterizing the composition of Venus' atmosphere, and exploring the interior structure of near-Earth asteroids. Other concepts include landers on the Moon to determine the age and structure of irregular surface features, and small spacecraft to characterize the solar wind upstream of Jupiter.

Finally, NASA recognizes there is still much to learn. On a grand scale, the solar system is a natural laboratory, within which we seek to unravel the mysteries of the universe and our place

within it. With your support, we will continue to tackle solar system exploration goals identified as top priorities by the planetary science community and advance along the path of discovery and innovation for future generations to come.

Again, thank you for the opportunity to testify today and I look forward to responding to any questions you may have.