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The Advanced Jovian Asteroid Explorer

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The Advanced Jovian Asteroid eXplorer (AJAX) will be the first mission to characterize the geology, morphology, geophysical properties, and chemistry of a Trojan asteroid using orbital and landed elements. Trojan asteroids are at the heart of many important questions concerning the formation and early evolution of our Solar System. The exploration of these enigmatic worlds illuminates the history of planetary migration, the origin of the Late Heavy Bombardment (LHB), the sources of terrestrial planet volatiles, the history of the Jupiter system, and the evolution of trans-Neptunian bodies. Recognizing the central role of the Trojans for unlocking the mysteries of solar system formation, the 2013-2022 Planetary Science Decadal Survey (PSDS) stated that a fundamental "scientific goal for this decade (2013-2022) is to begin the scientific exploration of the Trojan asteroids". The PSDS outlined a notional New Frontiers class Trojan asteroid rendezvous mission to conduct geological, elemental composition, mineralogical, and geophysical investigations. Our innovative and exciting Discovery mission proposal, the Advanced Jupiter Asteroid eXplorer (AJAX), addresses each of the science goals of the PSDS strawman mission. AJAX accomplishes this through a focused payload and an innovative mission design. By responding to the most important questions regarding the Trojan asteroids, AJAX advances our understanding of the entire Solar System. Are these objects a remnant population of the local primordial material from which the outer planets and their satellites formed, or did they originate in the Kuiper Belt? Landed measurements of major and minor elements test hypotheses for the provenance of Trojan asteroids, revealing the dynamical history of the outer Solar System. How and when were prebiotic materials delivered to the terrestrial planets? AJAX's high-quality landed measurements include C and H concentrations, necessary to determine their inventories of volatiles and organic compounds, material that would have been delivered to the inner Solar System during the LHB. What chemical and geological processes shaped the small bodies that later merged to form the planets in our Solar System? AJAX's investigates the internal structure, geology, and regolith of a Trojan asteroid using global high-resolution stereo and multispectral imaging, measurement of the gravity field to determine density and estimate interior porosity, and landed measurement of the mechanical properties of the regolith. AJAX's year-long primary science phase begins with approach to its 30-km diameter target asteroid using imaging at a variety of phase angles to search for natural satellites and
dust lifted by possible cometary activity, and to determine shape and pole position. AJAX descends through orbits at progressively lower altitudes to complete global mapping, and conducts a low flyover for very high-resolution characterization of the surface and measurement of hydrogen abundance. Finally, it deploys a small landed package, the Planetary Object Geophysical Observer, which measures abundances of 20 elements and physical properties of the regolith. AJAX's science return facilitates improved understanding of the early stages of planetary accretion via comparison of a Trojan asteroid with near-Earth targets of OSIRIS-REx, Hayabusa 2, and NEAR, and the Kuiper Belt-derived targets of Rosetta and New Horizons.