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IAF SPACE EXPLORATION SYMPOSIUM (A3)
Solar System Exploration including Ocean Worlds (5)

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FOSSIL - FINDING OUR COSMIC ROOTS

Abstract

FOSSIL (Fragments from the Origins of the Solar System and our Interstellar Locale) is a concept to explore the largest solar system object visible to the unaided eye - the zodiacal cloud. The cloud's many dust particles are each a tiny time capsule from a comet or asteroid, a primitive building block of the planets. The FOSSIL concept is for the in situ compositional analysis of interplanetary dust particles, and also of the particles passing through the solar system from interstellar space. By measuring the zodiacal and interstellar particles' velocity vectors and compositions, the approach resolves fundamental questions about the solar system's origins. The FOSSIL concept is to: (1) Discover whether today's local interstellar dust matches the composition of the feedstock from which the solar system formed; (2) Determine whether comets' fine-grained component preserves unprocessed pre-solar dust or shows signs of processing in the early solar system, and (3) Learn whether comets' and asteroids' organic material share a common source or formed from distinct reservoirs. The FOSSIL concept is based on the use of a Dust Telescope (DT) with the capability to measure the composition and the velocity vector of dust particles to unambiguously separate interstellar from zodiacal particles, and identify a subset of zodiacal particles that are exclusively cometary. In the DT, particles pass through the trajectory sensor unharmed and impact a target plate, where they are vaporized and partially ionized. The ions are electrostatically focused onto a detector where the time-of-flight mass spectrum is recorded, enabling measurement of the composition of the interstellar solids, detection of cometary minerals altered by high temperatures or exposure to liquid water in the early solar system, and characterization of the organic materials from the comets and asteroids that are still being delivered to the Earth today. FOSSIL's objectives crosscut several disciplines with planetary science. Astrophysics interests lie in understanding interstellar solar matter and the only debris disk accessible in situ. Heliophysics interest is in the verification of large-scale heliospheric magnetic field models by the measured effect on the motion of electrically charged interstellar dust. Reporting the makeup of interplanetary dust that ablates in our atmosphere is valuable to Earth sciences. FOSSIL's DT is scalable and can be accommodated to a variety of mission opportunities, without restriction on launch dates, and for a large number of possible orbits.