

Expanding Science and Innovation with CubeSat Instruments. J. D. Baker, NASA Jet Propulsion Laboratory, 4800 Oak Grove Drive, MS 321-625, Pasadena, California 91109, John.D.Baker@jpl.nasa.gov

Abstract: Imagine flying through the vapor plumes above Europa and being able to identify the composition of the ejecta without risking your primary spacecraft. While outer planet CubeSats are still a dream, today the first low cost deep space CubeSats for the INSPIRE (Interplanetary NanoSpacecraft Pathfinder In a Relevant Environment) mission have been developed and more are on the way.

Deep space and planetary spacecraft started small. The Explorer, Ranger and Pioneer spacecraft series back in the 1950's and 60's taught us about what it meant to fly in space. Recent advances in microelectronics, manufacturing and sensor technology make it possible to fly very capable small spacecraft to make focused science measurements at low cost.

The NASA Science Mission Directorate funded and Jet Propulsion Laboratory developed INSPIRE mission, will test new compact low cost solutions with two spacecraft (Figure 1) for Deep Space Network X-band communication, proximity communications, dopler navigation and propulsion using 3D printed components. The innovations extend beyond the engineering subsystems to include a new science grade vector helium magnetometer and on-board science data processing.

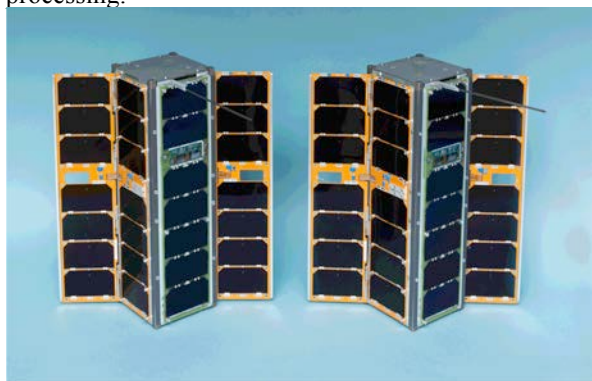


Figure 1 - INSPIRE Flight Spacecraft

Two other mission concepts are building on these developments; selected for further refinement by NASA's Human Exploration and Operations Mission Directorate (HEOMD) Advanced Exploration Systems (AES) Division as potential secondaries on the Space Launch System (SLS) EM-1 flight, the Lunar Flashlight mission (Figure 2) will detect surface ice deposits in the lunar permanently shadowed craters and the NEA Scout mission (Figure 3) will characterize a near-Earth asteroid (NEA). The JPL-MSFC Lunar Flashlight mission concept will fly a new four channel

filtered spectrometer and the MSFC-JPL NEA Scout will fly a high resolution camera with four spectral bands for measuring the asteroid physical characteristics and mineralogy.

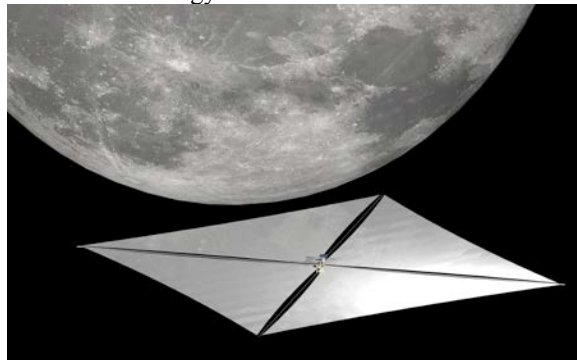


Figure 2 - Lunar Flashlight Mission Concept

Both mission concepts use solar sails for propulsion. Lunar Flashlight will also use its solar sail to reflect sunlight into the permanently shadowed craters of the Moon.

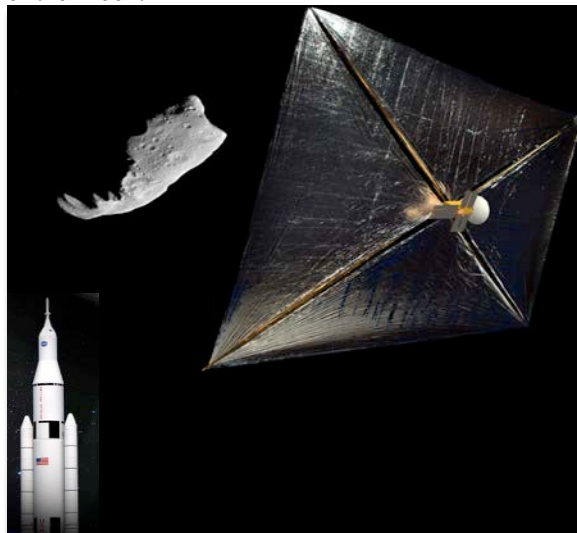


Figure 3 - NEA Scout Mission Concept

CubeSats can be used to make focused science measurements, distributed field or atmospheric measurements or to extend the reach of the primary spacecraft into high risk or harsh environments. Presently, there are a limited number of science instruments available today that fit into CubeSat volumes. With more science instrumentation, the potential applications of CubeSats will grow dramatically and can provide a key role in Planetary science while broadening our engagement with Universities and the public.