Statement of Objective

Characterize the integrated global properties of a primitive carbonaceous asteroid to allow for direct comparison with ground-based telescopic data of the entire asteroid population

Overview

The diversity of the asteroid population is reflected in both the large variation in their spectral properties and the large compositional range of meteorites. Although the silicate mineralogy of asteroids can be inferred by spectral matching between asteroids and meteorites [e.g., Hiroi et al., 2001], the detailed mineralogy of most asteroids is still unknown. This record is obscured by the fact that astronomy (telescopic measurements) and cosmochemistry (laboratory measurements) study inherently different samples. Telescopic reflectance spectra sample the top few μm of an object's surface while meteorites represent subsurface material. OSIRIS-REx's separate collection of bulk and surface material, combined with spectral characterization of Bennu, enables detailed understanding of the connection between the spectral properties of asteroid surfaces and the bulk composition and mineralogy of the returned samples.

The possible parent asteroid associated with a meteorite class can be constrained with reflectance spectroscopy, and is helped when a dynamical mechanism can be identified to deliver meteorite samples. Success in connecting meteorites to asteroids began with the identification of Vesta as the source of the HED meteorites [Drake 2001]. However, there are several spectral classes of asteroids whose meteorite counterparts have been difficult to locate. As a result, the compositional distribution of planetary building blocks is essentially unknown. This fact is highlighted by the recent recovery of fragments from the F-class asteroid 2008 TC3, which shocked the meteorite world by linking this class of asteroids to the ureilite meteorites [Jenniskens et al. 2009].

The spectral characteristics of the extremely dark B-type asteroids are unlike any measured meteorites, though the extremely rare and friable CM1 chondrites provide the closest spectral match [Clark et al. 2010]. Only sample return allows definitive identification of the mineralogy of such complex and important asteroids and provides the first groundtruth calibration for asteroid remote-sensing data.

The disk-integrated Asteroid Astronomy Science of Bennu will be characterized during the Approach phase. At that time, the disk of Bennu will either not be resolved or will only be poorly resolved. As a result, disk-integrated photometry will be used to obtain color indices and phase functions that are comparable with those obtained from Earth-based telescopes. The resulting color indices and phase functions will be directly compared against the Earth-based results presented in Hergenrother et al. (2012).

The 4-color photometry will enable the first low-resolution longitudinal maps of spectral variation on the surface of Bennu. The phase functions will be the first step in characterizing the light scattering properties of the surface of Bennu at visible wavelengths. These functions will directly support the production of Bi-directional Reflectance Distribution Functions (BRDF) for the 4 MapCam filters.

Level-1 Requirement

1.15 – Measure the astrometric, photometric, and spectroscopic properties of Bennu

Required Inputs

- OCAMS MapCam Images with the following corrections (Photometric, Geometric, Dark, Bias, Flat Field, Bad Pixel, Cosmic Ray)
- SPICE kernels (SPK, SP, PcK, CK, FK, IK)
- Astrometric Reference Catalogs (UCAC-4, APASS, Tycho, or similar)
- Stellar photometry reference catalogues (for verification of absolute photometric calibration) (catalogs same as above)