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Search for Dust Around Ceres

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1. Introduction

Since the first but ambiguous evidence of water sublimation activity on Ceres was reported more than two decades ago [1] and the negative results in a number of follow up observations [2], water vapor has recently been unambiguously detected by the Herschel Space Observatory observations [3]. The mechanism of water sublimation on Ceres is still unclear, but the most probable mechanisms include cometary-like sublimation and cryovolcanism. Such sublimation activity could entrain dust grains in the outgassing, resulting in either a dust envelope or dust plumes above the surface of Ceres. Given the much higher escape velocity of ~0.5 km/s on the surface of Ceres compared to those on comets (a few m/s), any dust around Ceres might be short-lived, and/or close to the surface of Ceres. The implications of possible dust around Ceres motivated NASA's Dawn mission to perform a high-sensitivity, high-resolution search for dust around Ceres. The Dawn spacecraft, during its first science orbit around Ceres, will have an excellent opportunity to search for dust at a pixel scale of 1.4 km/pixel from the night-side of Ceres looking close to the direction of the Sun. This observing geometry is the most favorable to search for dust around Ceres due to the significant increase of dust brightness and decrease in the surface brightness of Ceres towards high solar phase angle. Here we report the results of this search for dust around Ceres with Dawn's Framing Camera (FC) [4].

2. Observations

Dawn's first science orbit around Ceres, the Rotational Characterization 3 (RC3) orbit, includes night-side observations of Ceres that are specifically designed to carry out a dust search. The altitude of 13,500 km of the RC3 orbit allows the whole disk of Ceres to fit within the field-of-view of the FC. The night-side observations start as the spacecraft crosses the terminator over the south pole of Ceres in a polar orbit that is within 5º of the Ceres-Sun vector, continuing until the Sun is about 25º from the camera's boresight. The observations reach a phase angle of about 155º. After the night-side equator crossing to the northern hemisphere, the observations resume from about 155º phase angle, lasting until the terminator crossing over the north pole towards the day-side of Ceres. The whole night-side observations cover 7 rotations of Ceres on each side of the equator, and the two Ceres rotations at the highest phase angles between 145º and 155º will be our primary dataset to search for dust and is the most favorable geometry for detection. Based on the characteristics and the performance of FC during the Vesta phase, we estimate the sensitivity of 10^6 particles/m^2 for a 5-σ detection of dust with 1 μm grains, an albedo of 0.1, and a phase function of typical cometary dust [5].

3. Preliminary Results

The data from the first half of the night-side observations from the south of Ceres' equator have been collected. No dust plumes or envelopes have been identified. The second half of the observations will be performed after the close of the abstract submission for this EPSC 2015 conference. The existence or otherwise lack of dust associated with the sublimation activity of water on Ceres will help put constraints on the nature and characteristics of outgassing on Ceres.

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