A new analysis of archival images of comet 29P/Schwassmann-Wachmann 1 to constrain the rotation state of and active regions on its nucleus

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Introduction: 29P/Schwassmann-Wachmann 1 (SW1) is a unique comet (and Centaur) with an almost circular orbit just outside the orbit of Jupiter. This orbit results in SW1 receiving a nearly constant insolation, thus giving a simpler environment in which to study thermal properties and behaviors of this comet's nucleus. Such knowledge is crucial for improving our understanding of coma morphology, nuclear thermal evolution, and nuclear structure. To this end, our overarching goal is to develop a thermophysical model of SW1's nucleus that makes use of realistic physical and structural properties as inputs. This model will help to explain the highly variable gas- and dust-production rates of this comet; SW1 is well known for its frequent but stochastic outbursts of mass loss [1,2,3]. Here we will report new constraints on the effective radius, beaming parameter, spin state, and location of active regions on the nucleus of SW1.

Results: The analysis completed so far consists of a re-analysis of Spitzer Space Telescope thermal-IR images of SW1 from UT 2003 November 21 and 24, when SW1 was observed outside of outburst. The images are from Spitzer's IRAC 5.8-μm and 8.0-μm bands and MIPS 24.0-μm and 70-μm bands. This analysis is similar to that of Stansberry et al. [4, 5], but with data products generated from the latest Spitzer pipeline. Also, analysis of the 5.8-μm image had not been reported before. Coma removal techniques (e.g., Fernández et al. [6]) were applied to each image letting us measure the nuclear point-source contribution to each image. The measured flux densities for each band were fit with a Near Earth Asteroid Thermal Model (NEATM, [7]) and resulted in values for the effective radius of SW1's nucleus, constraints on the thermal inertia, and an IR beaming-parameter value.

Current efforts have shifted to constraining the spin properties of SW1's nucleus and surface areas of activity through use of an existing Monte Carlo model [8, 9] to reproduce existing images (in our possession) of SW1's dust coma while in and out of outburst. The images analyzed so far consist of R-band (CCD) images of SW1 taken with the Kitt Peak National Observatory 2.1-m telescope on Sept. 25.5, 26.5, 27.5, 28.5, and 29.5 UT in 2008 [10]. SW1 was undergoing an outburst during this time and showed three continuous radial jets of material as well as at least one and possibly two expanding shells, all of which may let us constrain the active areas and the spin properties of the nucleus. By using the nucleus's spin state, location and extent of active areas, and dust-grain velocities as inputs to the model, we will mimic the observed coma morphology. Using this technique, we will present constraints to the nuclear properties of SW1. It is expected that due to the large size of SW1's nucleus measured earlier, any rotational excitation of the nucleus would/should have damped to a principal-axis spin state, simplifying our modeling efforts. The coma modeling will also enable us to examine this assumption.

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