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### 209.19 – Study of the Comet C/2013 A1 (Siding Spring)

The comet called C/2013 A1 (SIDING SPRING) was discovered on January 3, 2013 in Australia. In January 28/2014, NASA announced that is preparing for the close encounter that will happen between the comet C/2013 A1 and Mars on October 19-2014. The Mission called "MAVEN" will insert in Mars orbit on september 21—2014. The comet will pass just 138,000 kilometers far from the surface of Mars. The probability that the comet collides with Mars is small but the dust particles emitted by the comet can cause damage to spacecrafts and probes that are in orbit around that planet. NASA is making preparations to take all precautions. If the comet is quite active, there will be almost no time to take security measures with Mars orbiters. For that reason NASA is already ahead of the facts. According to scientists of the "JET PROPULSION LABORATORY-JPL", dust particles spewing from the comet may be traveling at 56 km / sec in relation to the orbiters, fifty times faster than the speed of a bullet. From our Observatory, located in Pasto-Colombia, we captured several pictures, videos and astrometry data during several days. The pictures of the asteroid were captured with the following equipment: CGE PRO 1400 CELESTRON (f/11 Schmidt-Cassegrain Telescope) and STL-1001 SBIG camera. Astrometry was carried out, and we calculated the orbital elements.

Summary And Conclusions: We obtained the following orbital parameters: eccentricity = 1.0003983, orbital inclination = 129.03078 deg, longitude of the ascending node = 300.99538 deg, argument of perihelion = 2.42310 deg, perihelion distance = 1.40023196 A.U. The parameters were calculated based on 20 observations (Jan 21 to April 02) with mean residual = 0.334 arcseconds.

We also obtained the light curve of the body with our data (January to November/2014)

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### 209.20 – Coma Morphology of Recent Comets: C/ISON (2012 S1), C/Pan-STARRS (2012 K1), C/Jacques (2014 E2), and C/Siding Spring (2013 A1)

We will present preliminary results from recent and upcoming imaging campaigns of four comets using Lowell Observatory's 4.3-m Discovery Channel Telescope, 42-in Hall Telescope, and/or 31-in telescope:

1. Observations of C/ISON (2012 S1) were carried out from January through November 2013. A small, sunward fan was detected in dust images acquired in March, April, May, and September. Two faint CN features approximately orthogonal to the tail appeared on November 1 and were visible until our final night of data on November 12. This significantly predates their first reported appearance in broadband images on November 14 (Boehnhard et al., CBET 3715; Ye et al., CBET 3718) and suggests that the features were not caused by a catastrophic disruption of the nucleus at that time.
2. We observed C/Pan-STARRS (2012 K1) regularly from October 2013 through June 2014 when it entered solar conjunction. Enhanced CN images in May and June 2014 exhibited a side-on pinwheel morphology that varied from night to night; similar morphology was not seen in concurrent dust images. Analysis of the rotation period is underway.
3. C/Jacques (2014 E2) was observed in April, May, and August 2014, and additional observations are scheduled through September 2014. After enhancement of the August images, Jacques exhibited two side-on CN corkscrews roughly orthogonal to the tail. The CN morphology was different from night to night but did not vary noticeably during ~1 hr of observations on a given night. Jacques also exhibited a smaller sunward dust feature in August that did not appear to vary during the observations. We will combine these data with our scheduled observations to investigate periodicity and compare the spatial distribution of multiple gas species.
4. Observations of C/Siding Spring (2013 A1) are scheduled around its close approach to Mars on October 19, 2014. This work is supported by NASA's Planetary Astronomy Program grants NNX09AB51G and NNX11AD95G.

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### 209.21 – The TRAPPIST comet survey in 2014

TRAPPIST (TRAnsiting Planets and Planetesimals Small Telescope) is a 60-cm robotic telescope that has been installed in June 2010 at the ESO La Silla Observatory [1]. Operated from Liège (Belgium) it is devoted to the detection and characterisation of exoplanets and to the study of comets and other small bodies in the Solar System.

A set of narrowband cometary filters designed by the NASA for the Hale-Bopp Observing Campaign [2] is permanently mounted on the telescope along with classic Johnson-Cousins filters. We describe here the hardware and the goals of the project. For relatively bright comets ( $V < 12$ ) we measure several times a week the gaseous production rates (using a

Haser model) and the spatial distribution of several species among which OH, NH, CN, C2 and C3 as well as ions like CO<sup>+</sup>. The dust production rates (Afrho) and color of the dust are determined through four dust continuum bands from the UV to the red (UC, BC, GC, RC filters). We will present the dust and gas production rates of the brightest comets observed in 2014: C/2012 K1 (PANSTARRS), C/2014 E2 (Jacques), C/2013 A1 (Siding Springs) and C/2013 V5 (Oukaimeden). Each of these comets have been observed at least once a week for several weeks to several months. Light curves with respect to the heliocentric distance will be presented and discussed.

[1] Jehin et al., *The Messenger*, 145, 2-6, 2011.

[2] Farnham et al., *Icarus*, 147, 180-204, 2000.

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### **209.22 – Impact-Induced Shock-Stress Effects in Cometary Analogue Olivine, Pyroxene, Carbonate and Serpentine Minerals**

The primary goal of the Stardust mission was to collect dust particles as the spacecraft flew past Comet 81P/Wild 2. The morphologies of several returned grains of forsterite and enstatite suggest that they have experienced shock effects due to collisions (Jacobs et al. *MAPS* 44, 2009; Keller et al., *GCA* 72, 2008; Tomeoka et al, *MAPS* 43, 2008). Because the particles were collected at an encounter speed of ~6 km/s, it was natural to question whether the collection process itself generated those microstructural shock features or if they were sustained prior to their capture in the aerogel. Analyses of the grains suggest the latter, namely, that the particles had undergone high-velocity impacts sometime before their capture.

With this in mind, unshocked minerals were impacted with the vertical gun in the NASA Johnson Space Center Experimental Impact Laboratory at 2.0 – 2.8 km/s, speeds that a typical comet might experience during its tenure in the Kuiper Belt (Stern 2002). Targets included minerals found in cometary dust and asteroids, including magnesium-rich pyroxenes (enstatite and diopside), magnesium-rich olivine (forsterite), carbonates (magnesite and siderite), and serpentine. Projectiles were Al<sub>2</sub>O<sub>3</sub> spheres. Transmission electron microscope (TEM) imaging of experimentally shocked forsterite and enstatite samples reveal morphologies and densities of planar dislocations similar to those of the Stardust samples. Comparisons between TEM images of the Stardust grains and those of the experimentally shocked minerals will be presented.

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### **209.23 – Visible and Infrared Study of Comet 2P/Encke's Nucleus During Its 2013 Apparition**

The 2013 apparition of comet 2P/Encke provided an opportunity to study the comet while it was relatively close to Earth (0.48 AU on October 17, the closest pass until 2030). We initiated a multiwavelength observing campaign for September and October with the goal of further characterizing the physical, thermal, and rotational properties of 2P's nucleus. Spectral observations were timed to coincide with an equator-on view of the nucleus, a rarely-seen vantage point compared to previous data (e.g. [1,2,3,4]). The spectra span both Wien-side thermal emission and reflected sunlight, covering 0.7 to 2.5  $\mu$ m, and sample all of the nucleus's rotational longitudes. They were obtained using the SpeX instrument at the NASA Infrared Telescope Facility (IRTF). We will present results on thermal inertia and albedo from a preliminary analysis of these data. Visible observations over the past 13 years have shown that the rotation period of 2P's nucleus increases by ~4 minutes per orbit [5,6], and that the light curve has a two-humped shape but that the humps have quite different amplitudes (e.g. [7]). Thus the equator-on view gave us the chance to further investigate 2P's rotation state and shape. We used the CSUSB Murillo Family Observatory 0.5-meter telescope [8], the NOAO Kitt Peak 2.1-meter telescope, and the MORIS instrument at NASA/IRTF to obtain R-band, time-series photometry of the nucleus. We will present new, preliminary constraints on the secular changes in the nucleus's spin state and on the nucleus's shape based on these new data. We thank the allocation committees of the IRTF and NOAO telescopes for granting the time used for this project. References: [1] Y. R. Fernandez et al. 2000, *Icarus* 147, 145. [2] M. S. Kelley et al. 2006, *ApJ* 651, 1256. [3] Y. R. Fernandez et al. 2008, 40th Meeting of the DPS, #16.24. [4] P. Abell et al. 2009, 41st Meeting of the DPS, #20.02. [5] B. E. A. Mueller et al. 2008, 40th Meeting of the DPS, #16.25. [6] N. H. Samarasinha and B. E. A. Mueller 2013, *ApJ* 775, L10. [7] Y. R. Fernandez et al. 2005, *Icarus* 175, 194. [8] L. M. Woodney et al. 2013, 45th Meeting of the DPS, #413.25.