Comet Investigative Observing Campaign (CIOC)

C/Siding Spring Update for SBAG 11, 29 July 2014

**CIOC Team** established Jan 2013 at SBAG-8. Team has a mix of experiences, skillsets, and research specialties. Abundant contributions from early- and mid-SBAG scientists. Reported monthly to Lindley Johnson, Kelly Fast, & Jim Green.

**Members chosen from SBAG, MEPAG***: Lisse, Battams, DiSanti, Farnham, Fernandez, Kelley, Knight, Lemmon, Li, Seelos, Vervack, Warner, Yanamandra-Fisher.

**Mantra**: Facilitate, facilitate, facilitate. 2014 Bottom line is to maximize the science returned from Comet Siding Spring by involving every telescope available (mainly Southern on Earth, high sensitivity remote, + Mars Fleet) for observations.

**CIOC Contact Info**:  [http://www.cometcampaign.org](http://www.cometcampaign.org)
Comet C/2013 A1 (Siding Spring)

- Discovered on 3 January 2013 by Robert H. McNaught (also discoverer of >10 other comets) at V ~ 19.
- Used the 0.5-meter Uppsala Southern Schmidt Telescope at Siding Spring Observatory, Australia
- Orbit determined within a few days, first solutions implied a potential Mars collision. Refinements showed a very near-miss on Oct 19, 2014 5 days before perihelion. Comet will be coming “up” from the South, and will be passing “almost horizontally” between the Sun and Mars.
- Comet Siding Spring has grown and brightened considerably since its discovery. (COBS @ Crni Vrnh reports V~10.8 on 7/28/2014, 2.5’ width, $r_h=1.9$ AU)
Comet Siding Spring (C/2013 A1) is racing toward Mars for a close encounter in October 2014.

Closest approach to Mars: ~86,000 miles (138,000 km)

Best Earth Observing Time in mid-September; Mars C.A. ~ 138,000 km, @ 16:38 UT, 56 km/sec relative (but max danger maybe 100 min later when Mars + s/c cross comet’s orbit)
How Close is 138,000 Km?

• 1/3 the average Earth-Moon distance.
• 1/16 the distance of the closest comet to flyby Earth in the last 500 years.
• The C.A. distance of a very good NEA apparition.
• 15x the mean distance of $R = 11$ km Phobos from Mars.
• 6x the mean distance of 6 km Deimos from Mars (note that at $R_{CSS,\text{nuc}} = 0.3 \text{ – } 5$ km, CSS is smaller than the moons by 1.2x to 35x).
• $R_{\text{Hill Sphere, Mars}} \sim 577,000$ km
• In the outer coma ($10^5 \text{ – } 10^6$ km) of an active comet.
Good news!

Comet Siding Spring is running 0.5 – 0.75 mags brighter than the JPL Horizons Predictions.

Still TBD:

How easily a 10th magnitude object will be detectable near 0th mag Mars.
Onset of Activity

- Secular lightcurve data constrains brightness
- PanSTARRS data from 20 Nov and 2 Dec 2011 (~10 AU)
  - No detections to mag 23
- Suggests activity started ramping up between 10.5 and 8 AU
Scientific Importance of Comet C/2013 A1 (Siding Spring):

- **Dynamically New** - First passage through inner system since formation & ejection
  - Icy planetesimal older than Earth likely containing leftover primordial SS material
  - Detailed orbital knowledge for Oort comet perturbed Mya to into inner system
- **On a Mars-grazing Orbit**, with > 1 yr lead time since discovery
  - Peri-Mars on Oct 19, 2014 at $r_{C.A.} = 132,000$ km, 1/3 Earth-Moon distance and 16 closer than the closest comet has come to Earth in the last 500 yrs.
- Unlike ISON in 2013, this is the only very close planetary encounter for CSS.
- CSS is coming so close to Mars that MRO should be able to resolve the nucleus, and Mars and the orbiters will be in the outer coma of the comet. => A free s/c flyby of the comet starring the Mars fleet of orbiters + rovers.
C/Siding Spring has likely spent the 4.5 Gyr since its formation far from the Sun and the planets in the deep freeze of the Oort Cloud. For C/SS to come from the depths of the Cloud, with more than a year’s notice, at \( \sim 129^\circ \) inclination to the ecliptic and have an extremely close encounter with Mars at/near perihelion is very rare.
CIOC Campaign

• A Campaign Focused on Oct 18 – 20, 2014

• Observing Opportunities from Ground Limited: Southern Twilight Comet, Brightest from Earth in mid- to late-September => Good Opportunities to characterize the comet pre-Mars, pre-perihelion.

• No NASA IRTF, KECK Public Calls

• Mars Fleet: MRO, Mars Odyssey, MEX, MSL, Opportunity, MOM, MAVEN. Practice for Comet C/2013 A1 (Siding Spring)’s VERY close Mars approach on 10/19/14

• Helio Fleet: SOHO, STEREO

• Astrophysics Spacecraft: SWIFT, WISE, HST, Spitzer, Chandra

• CIOC Website (FAQS, news, lightcurves, schedules/logs, no archiving)  http://www.cometcampaign.org

• PRO-AM COLLABORATIONS: Facebook, Twitter, and Pinterest groups; COBSA & other “professional amateurs”; Jet Morphology campaign; Ion tail campaign

• NASA HQ EPO: Ask an Astronomer; FAQs; Media Point of Contact – PBS, NHK, Discovery, BBC, NYT, etc.

• Siding Spring WORKSHOPS: 2014 Aug 11 (Observer’s Planning) & 2014 Sept 19 (Mars Hazard Tag-Up) at APL/JPL. Free, Livestreamed. SBAG invited to attend – send email to carey.lisse@jhuapl.edu for WebEx, meeting site details.
New CIOC Website Established:  
http://www.cometcampaign.org  
(site name purchased from GoDaddy)

- Latest news/updates about the comet
- Updated MPC lightcurve
- Workshop information
- Resources for amateur/pro-amateur/professional astronomers
- Blog posts from CIOC Team members
- Observer on-line schedule
- Observing logs
- List of papers/CBETS published
- Feedback form
- Associated: email exploder.

- > 1,500,000 pageviews since launch -
Aug 11th
Observer’s Workshop
Speakers:
Representing Multiple S/c + Ground Based Observing Platforms

- **HQ Introduction (Green/Johnson/Fast)** 8:30 – 8:45
- **Comet Siding Spring Overview** 8:45 – 9:30
  - CSS in context; the campaign; focus on C.A. day; issues with detecting 10th mag
  - CSS at 0th mag Mars (Lisse)
  - Hazard modeling results & what we can expect from the encounter (Farnham)
- **Spacecraft Based Observations** 9:45 – 12:30
  - **HST** (J-Y Li/Lisse/Clarke) (30min+5min)
  - **SWIFT** (Bodewits) (15min+5min)
  - **Spitzer** (Kelley) (5min+5min)
  - **WISE** (Bauer) (15min+5min)
  - **STEREO/Hi2, SOHO/SWAN** (Battams 10min + 5min)
  - **Chandra** (Lisse) (10min+5min)
  - **Herschel** (T. Mueller) (15min+5min)
  - **BOPPS** (Cheng/Hibbitts) (10min + 5min)
- **Earth Based Observations of a Southern, twilight/daytime object** 13:30-15:00
  - **TRAPPIST** (Jehin/Opitom) (15min + 5min)
  - **Crni Vrnh/C OBS** (Jure Zakrajšek/CIOC) (15min? + 5min)
  - **NASA/IRTF** (Villanueva for Kelley/Lisse) (15min+5min)
  - **VLT** (Kelley) (10min+5min)
  - **Subaru** (Padma/Ootsubo); SOFIA (Wooden) (15min+5min)
  - Radio – **ALMA, APEX, Arecibo** (Cordiner/Millam) (15min+5min)
  - Pro-AM Summary of Observations to Date + Future Plans (Padma) (15min+5min)
- **Mars Based Observations** 15:15 – 18:00
  - **MRO** (Tammppari/Delamere/Humm/Kass) (30min+5min)
  - **MAVEN** (Yelle/Crismani) (20min+5min)
  - **Mars Odyssey** (Christensen/Malin/McSween/Bell) (15min+5min)
  - **MSL/Oppportunity** (Bell/Lemmon/Lasue) (20min+5min)
  - **MEX** (Bertaix/Bibring?) (15min+5min)
  - **MOM** (Bhardwaj?) (10min +5min)
Example of Cross-Disciplinary Reuse of Assets: 10 of the 15 reported s/c detections of Comet ISON [Out of 20 attempted; other detections include FORTIS, Herschel, ISS, VEX, SOFIA]
ISON MRO/HiRISE Observations

- Used Red CCDs 4, 5 and 6 centered on CCD 5 and Blue-Green CCDs 12 & 13
- Observation frame 6000 columns by 4000 lines (6 x 4 milliradian, 1240 x 825 arc-second)
- Six observations per orbit
  - 5 ISON images (2 - 2.5sec, 2 - 1sec and 1 - 0.2sec)
  - 1 star cal at 0.12s to verify telescope PSF
- ISON detected in all five orbits Sept 29th –Oct 2nd

Delamere et al. 2014
A model size of the nucleus depends on the nucleus albedo, phase function, and how much of the signal comes from the nucleus rather than the coma.

This gives a family of reasonable solutions ranging from ~100 to 1000 m diameter.
Simulation using Halley image
16 by 16 pixel box

Delamere et al. 2014

PSF not applied to simulated images
Upcoming Venues Where Comet C/2013 A1 (Siding Spring) Will be Discussed

- Observer’s Workshop, (11 Aug 2014) APL/WebEx
- Mars Fleet Tag-Up Workshop, (19 Sept 2014) APL/WebEx
- Winter 2014 AGU (14-19 Dec), San Francisco USA
- LPSC 2015 (15-20 Mar), Houston, TX USA
- AAS/DPS 09-14 Nov 2015, Washington, DC USA
- Special issue of Icarus for the Comet Siding Spring observing results? (Current volunteers for special editors: P. Yamaranda-Fisher, ground based observations; R Vervack., s/c observations; C. Lisse, big picture context papers.) Submission deadline Winter 2015, publication in late 2016 to mid 2017.
Comet Siding Spring at Mars Observer’s Workshop
August 11, 2014  APL/JPL/WebEx
Some Siding Spring Science Questions to Answer

- How big is this DN Oort Cloud Comet? Is it sub-km like ISON?
- Is Comet Siding Spring like ISON and also a C/Kohoutek 1973 analogue?
- Did we detect Siding Spring early out past the orbit of Saturn because it was unusually volatile rich or DN? Or because it was surrounded by a cloud of active near-nucleus icy grains? Or was it in outburst from 10 – 5 AU?
- Why did CSS have evidence for jets far from the Sun, pre-perihelion, and ISON didn’t until 0.3 – 0.4 AU?