SSSC Update

Meg Schwamb
(Queen's University Belfast)
@megschwamb

Legacy Survey of Space and Time
Solar System Science Collaboration

Image Credit: Rubin Observatory/NSF/AURA

5+ million Solar System objects, 1+ billion observations!

	Currently Known	LSST Discoveries	Typical number of observations
Near Earth Objects (NEOs)	~20,000	200,000	(D>250m) 60
Main Belt Asteroids (MBAs)	~650,000	6,000,000	(D>500m) 200
Jupiter Trojans	~7000	280,000	(D>2km) 300
TransNeptunian Objects (TNOs) + Scattered Disk Objects (SDOs)	~3000	40,000	(D>200km) 450
Comets	~3000	10,000	?
Interstellar Objects (ISOs)	2	10	?

See http://ls.st/Document-29545

Slide Credit: Mario Jurić

LSST Solar System Science Collaboration (SSSC)


Meg Schwamb & David Trilling
SSSC Co-Chairs


Darin Ragozzine & Gal Sarid
Publication Coordinators


Colin Orion Chandler & Agata Rożek
Early Career Representatives

Active objects Working Group (Lead: Mike Kelley): broadly consisting of all categories of activity in the minor planet populations: short period comets, long period comets, main belt comets, impact- or rotationally-generated active asteroids,etc

Community software/infrastructure development Working Group (Lead: Henry Hsieh): broadly consisting of people interested in helping build databases, software packages, etc to be used by the Solar System community on LSST data

Inner Solar System Working Group (Lead: Bryce Bolin): broadly consisting of the main belt, Mars/Jupiter Trojans, and Jupiter irregular satellites

NEOs (Near Earth Objects) and Interstellar Objects Working Group (Lead: Sarah Greenstreet): broadly consisting of objects on orbits inward of or diffusing inward from the main belt as well as interstellar objects temporarily residing in the Solar System

Outer Solar System Working Group (Lead: Michele Bannister): broadly consisting of KBOs, Centaurs, Oort cloud, Saturn/Neptune/Uranus Trojans, and Saturn/Neptune/Uranus irregular satellites

Working Group Elections Up-Coming

Nominations due earlier this week. Voting later in the Summer

Image credit: ratinasock (Carol Raabus) - flickr - https://www.flickr.com/photos/ratinasock/4447403222/

Responded to the Commissioning Note Call

SSSC Commissioning Notes

In this document, the Vera C. Rubin Observatory Legacy Survey of Space and Time (LSST) Solar System Science Collaboration (SSSC) has compiled a series of commissioning notes, proposing on-sky observing strategies during commissioning that would enhance opportunities for science validation and testing of the Rubin Observatory's data management pipelines. The SSSC has ranked the commissioning notes below into priorities (high, medium, and low) based on the expected contribution to verifying the scientific capability of Rubin Observatory and informing Year 1 LSST operations.

PROPOSED HIGH PRIORITY WIDE-FAST-DEEP OBSERVING COMMISSIONING TASKS

Validation of Incremental Template Generation

Proposed by: Meg Schwamb & Mario Jurić

Email Contact for Further Information: mschwamb.astro@gmail.com, mjuric@astro.washington.edu

RA(s)/Decs(s): Agnostic to the specific pointing and cadence of observations

Filter(s) Required: grizy

Brief Description of Observing strategy:

http://lsst-sssc.github.io/Files/SSSC_Commissioning_Notes.pdf

Gave feedback on the international in-kind contribution proposals as part of the Rubin Observatory in-kind Contribution Evaluation Committee (CEC)

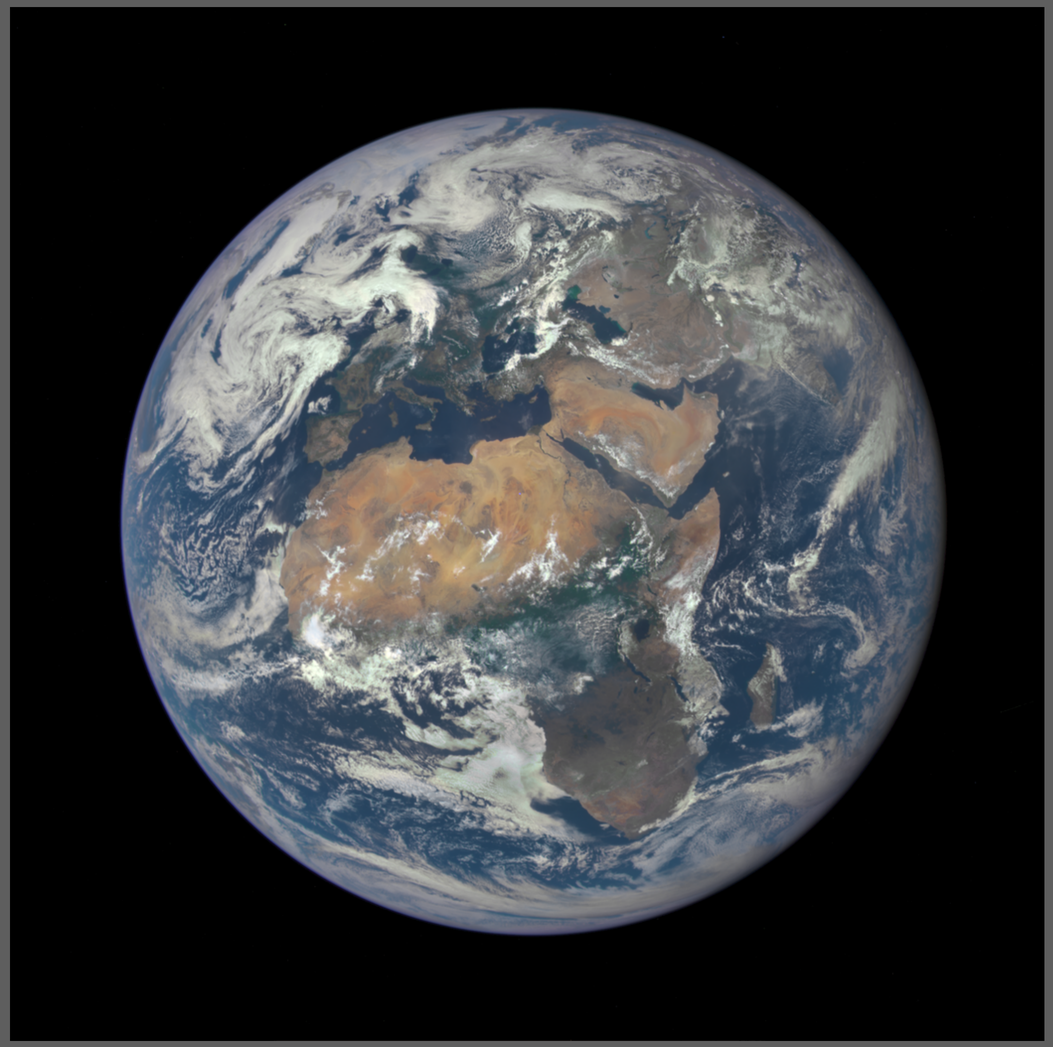


Image Credit: NASA/DISCOVR

https://project.lsst.org/groups/cec/

New CEC representatives
Primary: Henry Hsieh
Alternate: Michele Bannister

RNAAS RESEARCH NOTES OF THE AAS

OPEN ACCESS

Year 1 of the Legacy Survey of Space and Time (LSST): Recommendations for Template Production to Enable Solar System Small Body Transient and Time Domain Science

Megan E. Schwamb[1], Mario Jurić[2], Bryce T. Bolin[3,4], Luke Dones[5], Sarah Greenstreet[2,6], Henry H. Hsieh[7,8], Laura Inno[9], R. Lynne Jones[10,11], Michael S. P. Kelley[12], Matthew M. Knight[13,14] + Show full author list

Published June 2021 • © 2021. The Author(s). Published by the American Astronomical Society.

Research Notes of the AAS, Volume 5, Number 6

Citation Megan E. Schwamb *et al* 2021 *Res. Notes AAS* **5** 143

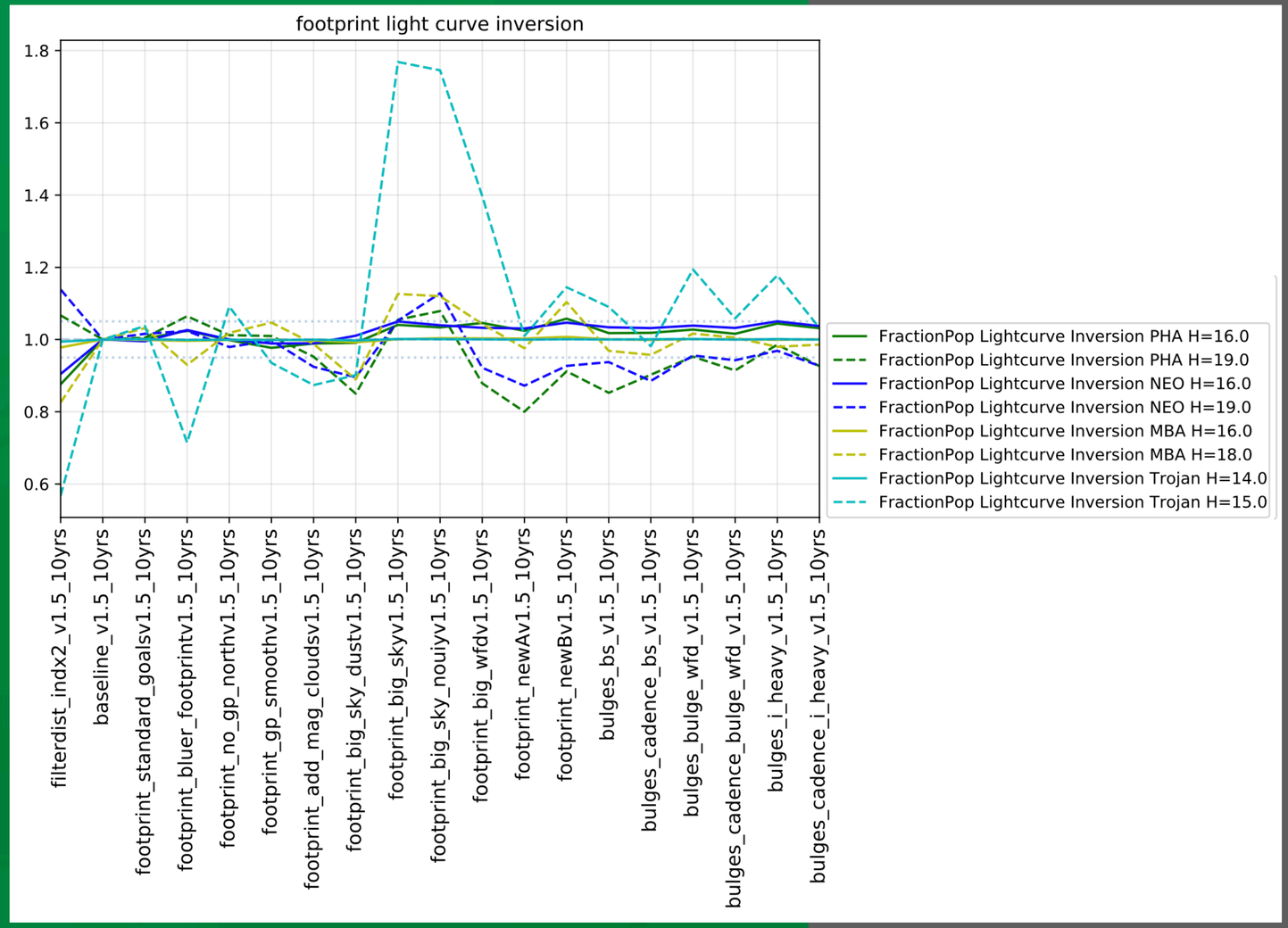
References

+ Article information

Abstract

The Vera C. Rubin Observatory Legacy Survey of Space and Time (LSST) will discover ~6 million solar system planetesimals, providing in total over a billion photometric and astrometric

2020-2021 Action- Giving Input on LSST Cadence Decision



SSSC Cadence Note:
http://lsst-sssc.github.io/Files/SSSC_cadence_note.pdf

Image Credit: Lynne Jones; Video Credit: Last Week Tonight with John Oliver

Responded to the Cadence Note Call

Vera C. Rubin Observatory Legacy Survey of Space and Time (LSST) Solar System Science Collaboration (SSSC) Cadence Note

Meg Schwamb[1], Michele Bannister, Bryce T. Bolin, Rosemary Dorsey, Henry Hsieh, Lynne Jones, Laura Inno, Tim Lister, Colin Snodgrass, Sarah Greenstreet, Cyrielle Opitom, Kat Volk, Siegfried Eggl, Michael S. P. Kelley, Steve Chesley, Wes Fraser, Alan Fitzsimmons, Mario Jurić, William J. Oldroyd, Robert Seaman, and Michael Solontoi

For the LSST SSSC

http://lsst-sssc.github.io/Files/SSSC_cadence_note.pdf

What is the SSSC doing for early career researchers and supporting a diverse research community?

EDI Brainstorming Session

3) **Individually watch video to prime the topic (4 minutes):**
https://www.youtube.com/watch?v=lLYf28E1Bfs&feature=youtu.be

4) **Discussion Topic:** Increase networking opportunities for minorities,other marginalized students, and early career professionals.

5) Come up with 1-2 actions the SSSC can take to increase networking opportunities for minorities,other marginalized students, and early career professionals.

   1) Lightning talks - collaboration exchange at a SSSC meeting or sent around every 6 months - collaboration opportunities (including bias discussion before lightning road/slides posted ?

   2) Summer internship program with URSI (LSSTC discussion, Google summer of code?)

What is the SSSC doing for early career researchers and supporting a diverse research community?

In the future more virtual events + the yearly in-person readiness sprint

	# of Attendees	# of women and gender minorities	# of ethnic / race minorities	# of early career
2018 Sprint (Seattle) LSSTC funding	25	5	3	9
2019 Sprint (Chicago)	14	2	1	3
2020 Sprint (Virtual)	53	14	6	20

Active Objects Working Group

Team AOWG

Several AOWG-focused cases proposed to the Project in our SSSC Commissioning Notes document: Bright Comet Stress Test, Comet Mix, Characterizing Activity... Across the FoV, Low Elongation Stress Test, Jovian Trojan Rotation and Activity.

Also, there was great AOWG participation in the SSSC Cadence Optimization Note 👏🎉🪘

WG Lead

Pitched ideal broker requirements and a wish list from an AO perspective at the LSSTC Enabling Science 2020 Broker Workshop (see the agenda for slides).

Assisted Software/Infrastructure Working Group with the evaluation of international in-kind software contributions.

Mike Kelley, UMD
msk@astro.umd.edu

Community Software/Infrastructure Development Working Group

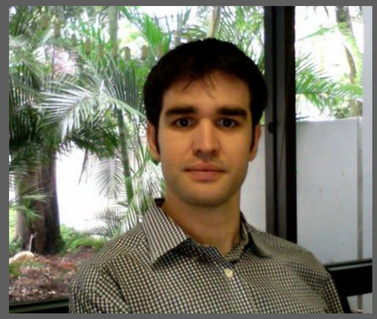
- In-kind software contribution discussion on 2021 April 13
  - Some international partners will provide “directable” software development effort to science collaborations in return for data access; will be up to SCs to plan how to use this effort
  - Amount of directable effort currently unknown, so plans need to be flexible
  - SSSC software needs have already been worked out and prioritized (Schwamb et al., 2019, RNAAS, 3, 51; Hsieh et al., 2019, arXiv:1906.11346)
  - Priorities for directable in-kind contributions will likely be based on these documents (where task sizes can be chosen to match amount of available directable effort)
- Planetary decadal survey white paper: Kelley et al., 2020, “Community Challenges in the Era of Petabyte-Scale Sky Surveys”, arXiv:2011.03584
  - Discusses computational tools and infrastructure needs for large surveys like LSST
- Active object test data set for algorithm testing/development
  - Rubin DR0 test data set will not include comets, so SSSC effort underway to create test data set from archival data (e.g., DECam); contact Colin Chandler and H. Hsieh for more details, to help out, or to specify needs/requirements
- Key NASA funding programs (SSO, SSW, PDART) are no-deadline this year
  - Coordination of SSSC-relevant proposals for software development in progress

Henry Hsieh, PSI
hhsieh@psi.edu

Inner Solar System Working Group

- Discussion of creating a real-time asteroid brightness catalogue
- Constraint of Asteroid taxonomy with Rubin Observatory grizy filters with current cadence
- Main Belt Asteroid (MBA) shape light curve inversion algorithms for Rubin Observatory MBA data
- Proper element catalogue of MBAs discovered by Rubin Observatory
  - Inclusion or update of follow-up observations into proper element calculation
- Search for new L5 and Hilda Trojan Lucy mission targets
  - Schwamb et al. https://arxiv.org/pdf/1808.10099.pdf
  - Local convergence of Hilda targets in Summer of 2024
  - Somewhat local sky convergence of L5 targets occurring in the fall of 2026
- Monitor MBAs and Trojans for anomalous brightening events/evidence of disruptions/activity

Bryce Bolin, Caltech/IPAC, bbolin@caltech.edu



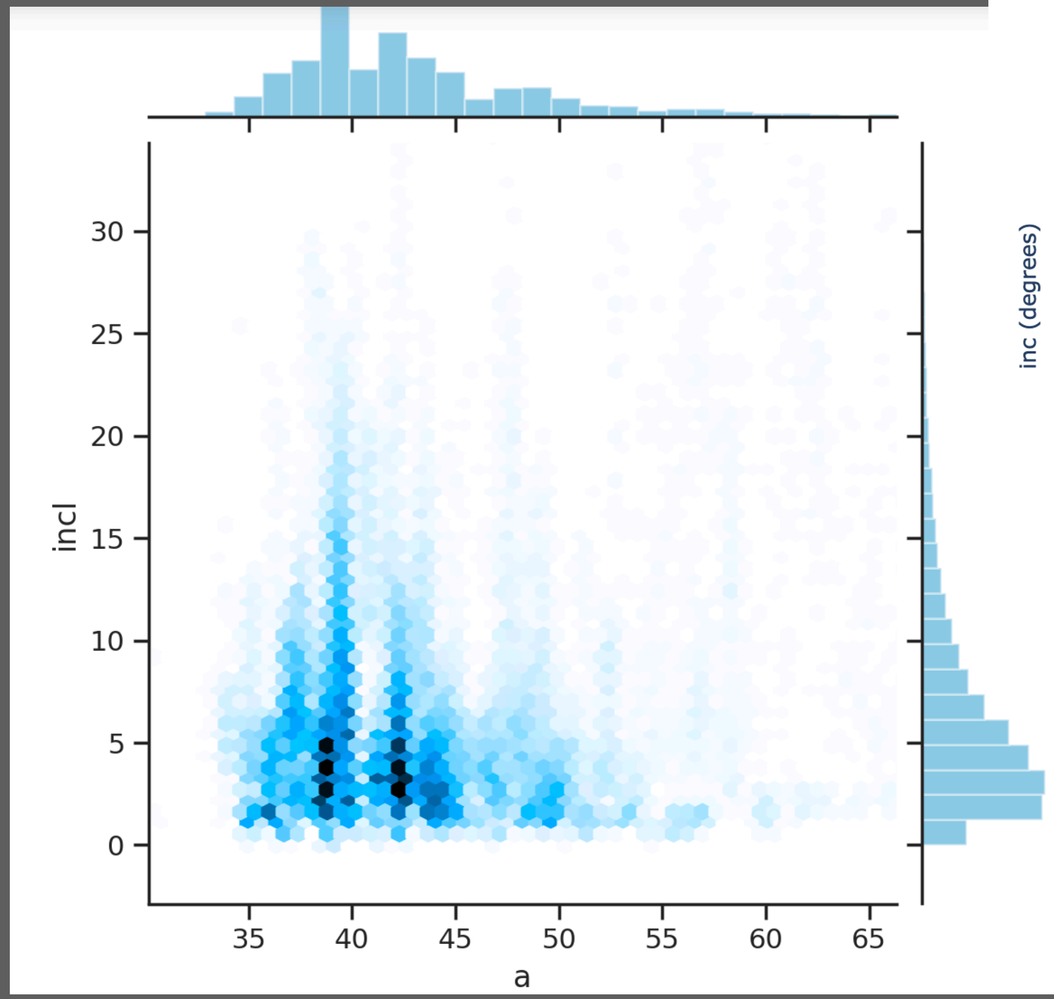
NEOs (Near Earth Objects) and Interstellar Objects Working Group

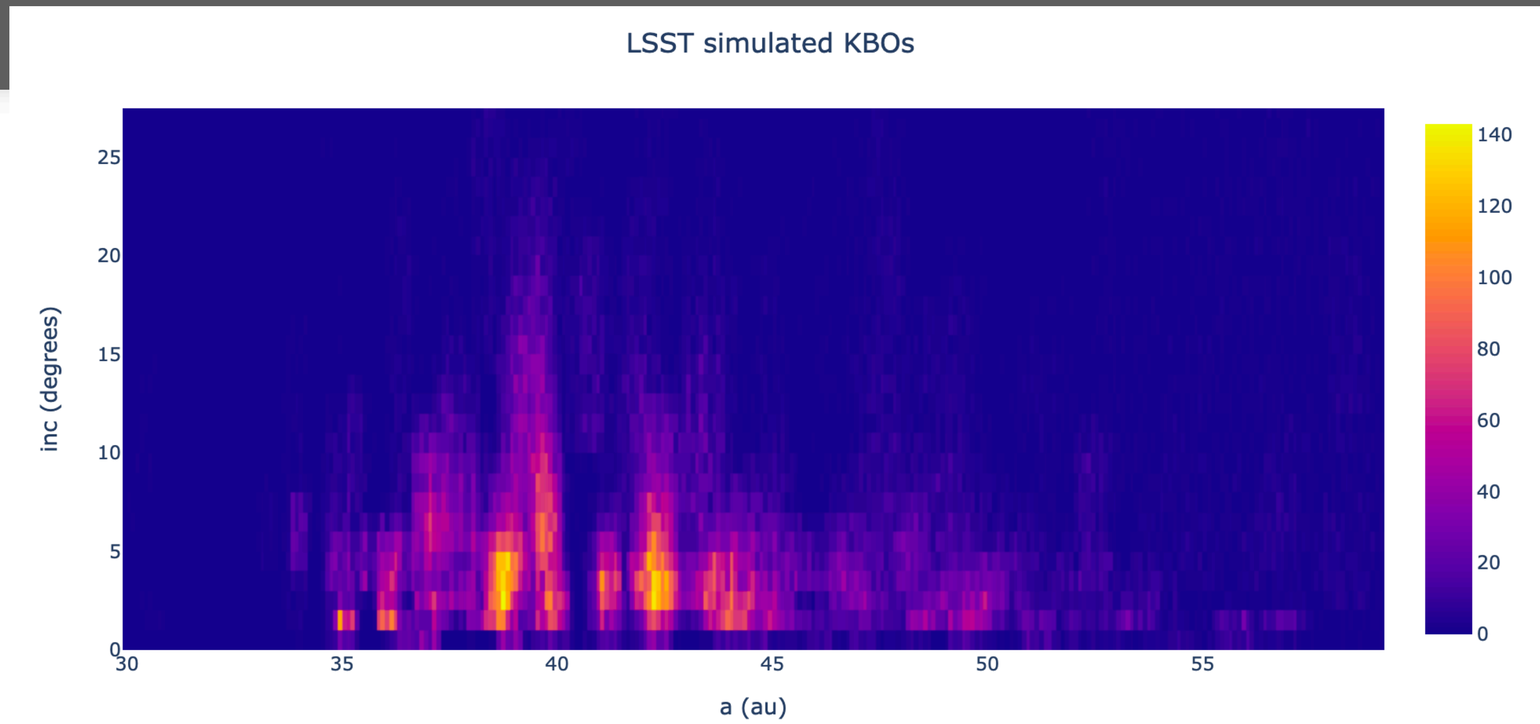
- Twilight mini-survey (TS) recommendations made in Cadence Note:
  - Several WG members discussed TS at SSSC Survey Cadence mini-workshop in Nov 2020:
    - TS in cadence simulations lacked near-Sun component as intended by original white paper (https://arxiv.org/abs/1812.00466)
    - Negatively impacted WFD observing and NEO completeness
  - WG discussion held in March 2021 to formalize recommendation:
    - Discussed modifications with Rubin Scheduling Team that achieves IEO/Earth Trojan/sun-grazing comet discovery science goals while giving back time for WFD observations
  - Recommended modifications to TS included as paragraph in Cadence Note

Thanks to all WG members that participated in the Survey Cadence mini-workshop and WG discussions and thanks to the Rubin Scheduling Team for running updated TS cadence simulations for evaluation!

Sarah Greenstreet
University of Washington/Asteroid Institute
sarah@b612foundation.org, sarahjg@uw.edu

2021 Goals - Software Development with Simulated Solar System Data Products and Precursor Datasets





(More in the next talk)

2021 Goals - (This Sprint)
Thinking about Observing Follow-up

Image Credit: Gemini Observatory/NSF/AURA/NOIRLab

- How can the SSSC be most useful?
- Helping link interested proposers together?
- How do we learn from the astrophysical transients community?
- How do we communicate within the SSSC and within then broader community about time critical observations/results?

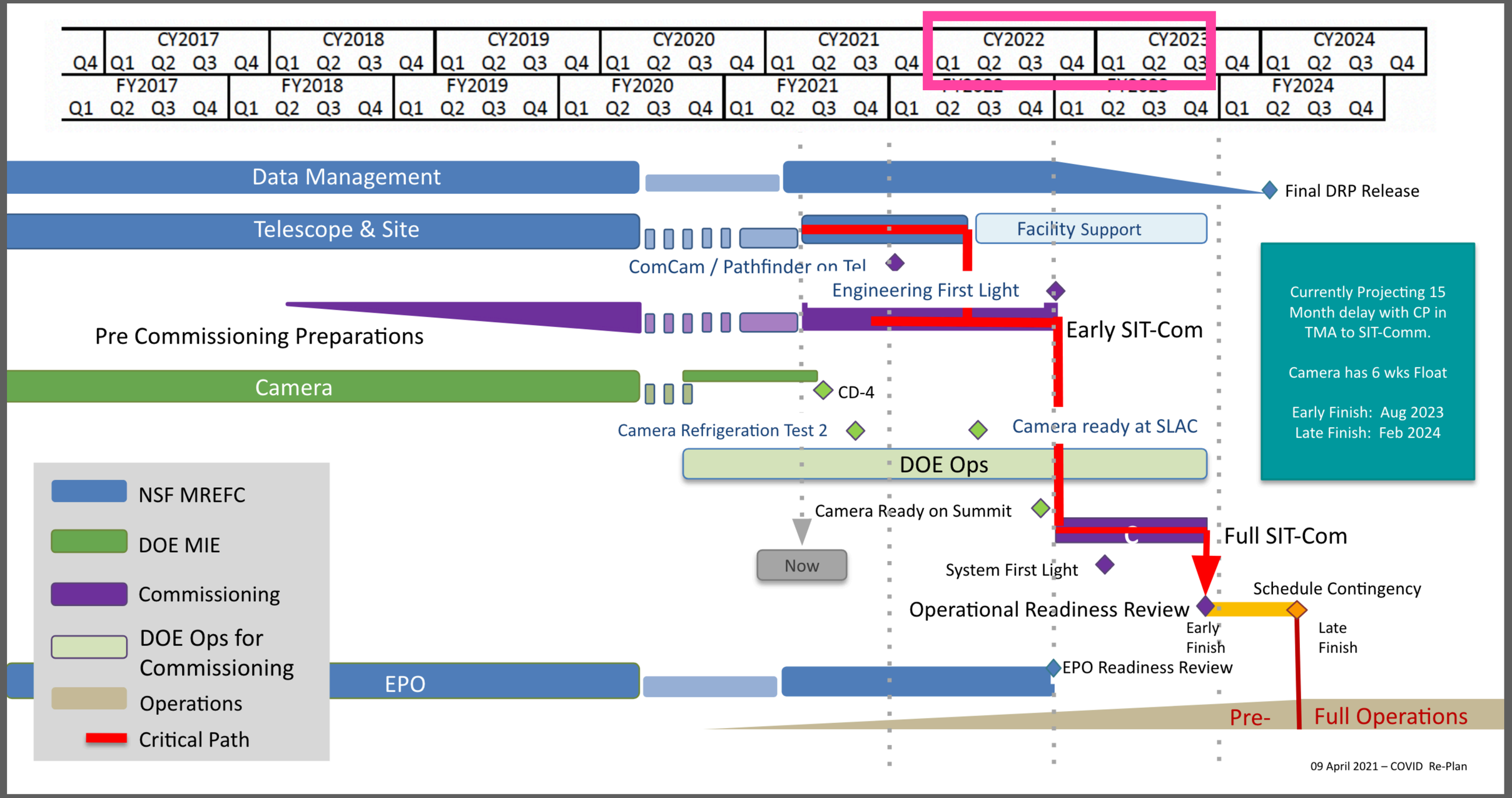


Image Credit: Rubin Observatory/NOIRLab/NSF

Alert Stream

Broker 1

SNAPS

Lasair

Secondary Broker

Planetary Astronomer / Automated Server

Image Credit: NOIR LAB/Gemini Observatory/ESO/LCO/Rubin Observatory

How can we learn from the astrophysical transients community?

Data policy

This document outlines how ePESSTO+ plans to release data products to the public.

ePESSTO+ is an ESO Large Programme. The raw data are public immediately via the ESO archive.

We will provide quicklook ("fastspec") reduced, calibrated 1D spectra of all new (i.e., previously unclassified) transients to both the ePESSTO+ collaboration and to the public within 12hrs of the end of a Chilean night and/or according to the data rights policies of our collaboration. These will be distributed via the WISeREP spectroscopic database[2]. New classifications that we make with these spectra will also be released, via the ATEL mechanism on the same time-scale, following the same policies. These spectra will be flux and wavelength calibrated using library files, and with quick extractions, and thus may not represent the best reduction possible.

http://wiki.pessto.org/

We're using different communication tools (ATels, CBETs, MPML listserv) -will these handle our needs in the next decade?

https://www.astronomerstelegram.org/?read=14251

Forecast-Mauna Kea | HORIZONS Web-Int... | Planet Four | P4: Terrains | P4: Ridges | Comet Hunters

398P/Boattini a new JFC carbon-chain poor comet

ATel #14251; *E. Jehin, Y. Moulane, J. Manfroid, F. Pozuelos, M. Ferrais, D. Hutsemekers (STAR Institute, University of Liege)*
on 7 Dec 2020; 23:22 UT
Credential Certification: Emmanuel Jehin (ejehin@uliege.be)

Subjects: Comet

Tweet

E. Jehin, Y. Moulane, J. Manfroid, F. Pozuelos, M. Ferrais, D. Hutsemekers (STAR Institute, University of Liege, Belgium) report that they obtained with TRAPPIST-North (code=Z53, at Oukaimeden Observatory, Morocco) 0.6-m robotic telescope, three sets of observations of the recently recovered comet 398P/Boattini (= 2009 Q4 = 2020 P2, CBET 4829) on November 10, 15 and 20 UT under photometric conditions using HB cometary narrowband filters (Farnham et al. 2000). All these observations are showing the clear detection of a diffuse CN (390nm) gaseous coma and no detection of the C2 (515nm) and C3 (450nm) gas emission, making 398P a new member of the Jupiter-family carbon-chain depleted comets as confirmed after computing the production rates. On November 20 UT, at a heliocentric and a geocentric distance of 1.40 and 0.47 au respectively, after proper flux calibration and solar dust continuum substraction, production rates (at 10.000 km and using a Haser Model (Vp=Vd=1km/s)(Haser 1957)) of (8.62+/-0.27) E23 s-1 for CN and upper limits of 1.29 E23 s-1 for C2 and 0.50 E23 s-1 for C3, were derived. This provides a maximum C2 ratio with respect to CN, Log[Q(C2)/Q(CN)] < -0.82, well below the carbon-chain depleted comets limit of -0.18 (A'Hearn et al. 1995, Moulane et al. 2020). No emission from OH (310nm) was detected and an upper limit of 2.61 E23 s-1 was derived. The production rates derived on the two other dates are in very good agreement and provide the same conclusion. A spectroscopic confirmation is welcome as the comet is approaching perihelion.
The dust production rate proxy A(0)f(rho) was estimated by profile fitting at 5.000 km (A'Hearn et al. 1984) and corrected for the phase angle (Schleicher 2007). On Nov 20 UT, values of A(0)fp(RC)=37+/-4 cm for the narrow band red solar continuum filter and A(0)fp(Rc)=38+/-5 cm for the broad band Johnson-Cousin filter are derived. The dust/gas ratio Log[A(0)fp(RC)/Q(CN)]=-22.41+/-0.20 is in agreement with the average value for depleted comets of -22.61 and larger than for typical comets (A'Hearn et al. 1995).

https://groups.io/g/mpml/messages

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mpml@groups.io / Messages

Minor Planet Bulletin 48-3 Available
This is a free PDF download (data provider connection and data fees may apply). The home page has links to download the full issue from the latest back to the f...
By Brian D. Warner · #36496 · 5:40pm

Re: 2014 UN271: A possible dwarf planet from the Oort Cloud on a tour through the Solar System
I asked around and Dr. Pedro Bernardinelli @phbernardinelli of the DES explained why this just came out now: Yes! We searched the first four years of data betw...
By Marshall Eubanks · #36495 · Jun 19
1 person liked this

Re: 2014 UN271: A possible dwarf planet from the Oort Cloud on a tour through the Solar System
Given that the data span from 2014-2018, but this is coming out now, was this object found in a re-analysis of the DES data? Maybe the software filters were tun...
By Marshall Eubanks · #36494 · Jun 19

2014 UN271: A possible dwarf planet from the Oort Cloud on a tour through the Solar System
Hi all, Some very recent exciting news from the Dark Energy Survey collaboration (https://minorplanetcenter.net/mpec/K21/K21M53.html) This new object, 2014...
By Sam Deen · #36493 · Jun 19
1 person liked this

Minor planet numbering question
Hi All -- I see quite a few new minor planet numberings have come out recently. But apparently there has been a change (or error) in assigning discovery credit. I'l...
By Rob Matson · #36492 · Jun 17

New Lightcurve Database Release
A new version of the LCDB is available at <https://minplanobs.org/mpinfo/php/lcdb.php> This supersedes the version of LCLIST_PUB_2021JUN.zip uploaded e...
By Brian D. Warner · #36491 · Jun 16

ESA S2P-NEO Coordination Centre monthly newsletter - June 2021

brief | Highlight All | Match Case | Match Diacritics | Whole Words

www.cbat.eps.harvard.edu/cbet/RecentCBETs.html

Forecast-Mauna Kea | HORIZONS Web-Int... | Planet Four | P4: Terrains | P4: Ridges | Comet Hunters | SiriusXM | Windyty, wind map ... | 1Password | Other Bookmarks

On-line CBETs
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TOCP RSS Feeds
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Comets
Edgar Wilson Award
Minor-Planet Satellites

Links
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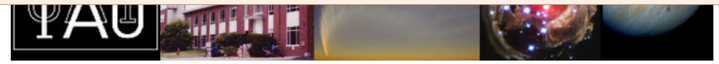
Cometary Science Center
Minor Planet Center
Origins/Harvard
EPS/Harvard

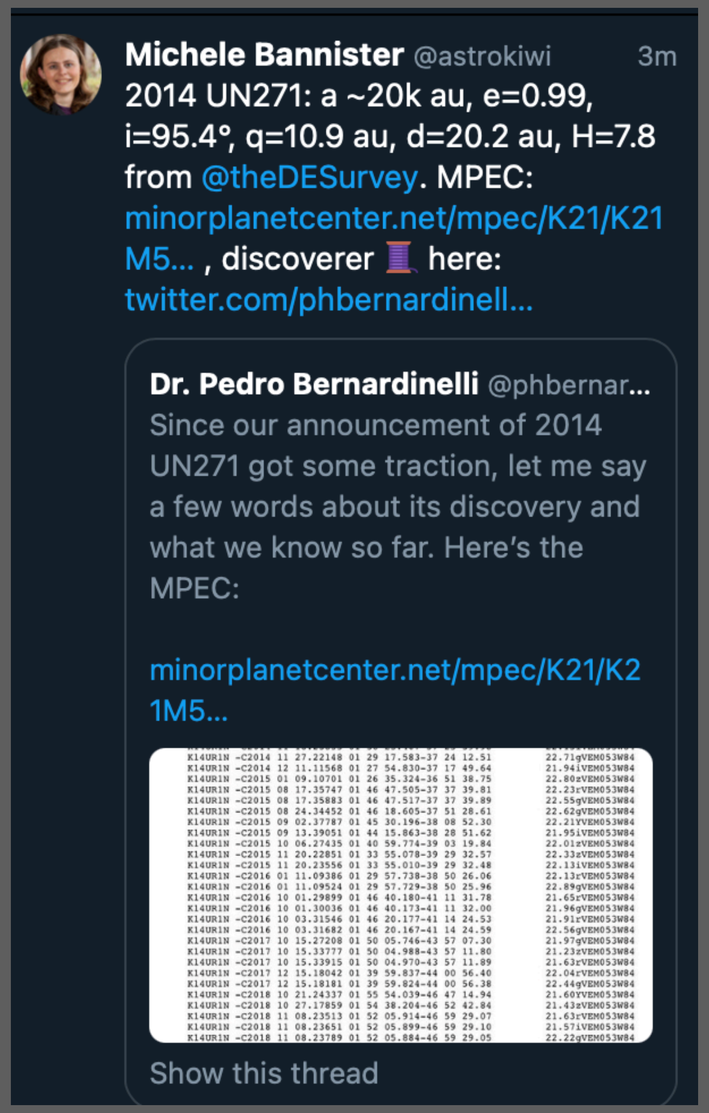


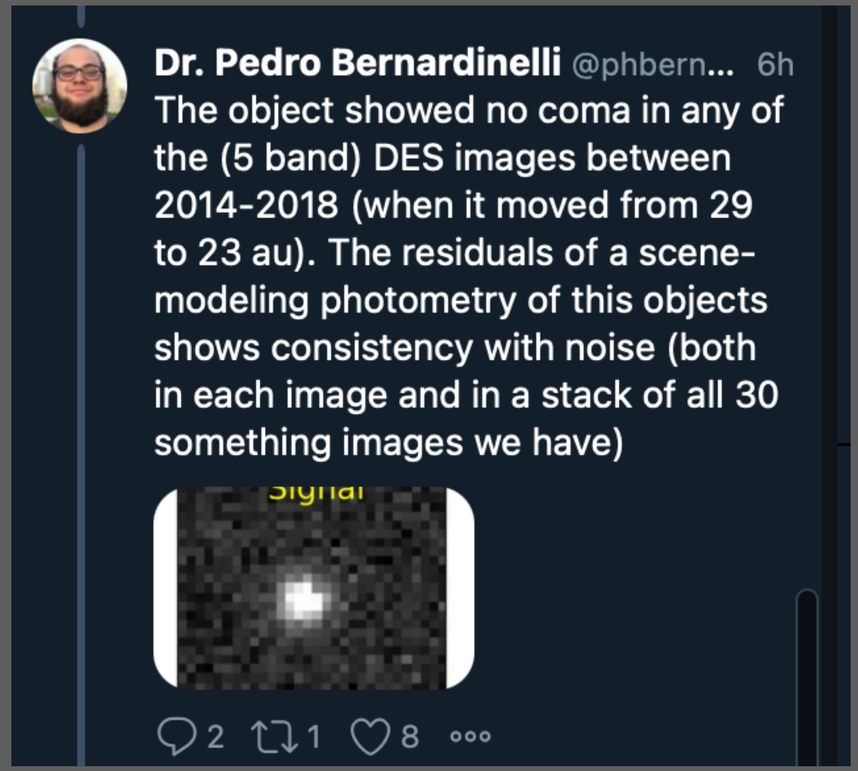
50 Most Recent CBETs

Herein are links to the text of the most recently-issued *CBETs*. The circulars are displayed in reverse chronological order, with the date of issue being shown in YYYYMMDD form after the circular number.

Display *CBET* number: Clear
Display *CBET* index page including number: Clear

- CBET 4982 : 20210620 : (7792) 1995 WZ_3
- CBET 4981 : 20210620 : (4337) ARECIBO
- CBET 4980 : 20210619 : JUNE THETA^2 SAGITTARIIDS 2021
- CBET 4979 : 20210617 : COMET P/2021 L1 = P/2006 S4 (CHRISTENSEN)
- CBET 4978 : 20210616 : (31346) 1998 PB_1
- CBET 4977 : 20210614 : V1674 HERCULIS = NOVA HERCULIS 2021 = TCP J18573095+1653396
- CBET 4976 : 20210614 : NOVA HERCULIS 2021 = TCP J18573095+1653396
- CBET 4975 : 20210609 : COMET C/2021 K2 (MASTER)
- CBET 4974 : 20210603 : COMET P/2021 J3 (ATLAS)
- CBET 4973 : 20210602 : COMET C/2021 J2 (PANSTARRS)
- CBET 4972 : 20210602 : COMET C/2021 J1 (MAURY-ATTARD)
- CBET 4971 : 20210531 : COMET P/2020 H10 = P/2009 U4 (McNAUGHT)
- CBET 4970 : 20210530 : (7307) TAKEI
- CBET 4969 : 20210529 : COMET C/2020 PV_6 (PANSTARRS)
- CBET 4968 : 20210527 : COMET C/2021 K1 (ATLAS)
- CBET 4967 : 20210527 : (3523) ARINA
- CBET 4966 : 20210512 : COMET C/2017 K2 (PANSTARRS)
- CBET 4965 : 20210511 : COMET C/2021 D1 (SWAN)
- CBET 4964 : 20210511 : COMET C/2020 R4 (ATLAS)
- CBET 4963 : 20210511 : V1405 CASSIOPEIAE
- CBET 4962 : 20210511 : V1405 CASSIOPEIAE
- CBET 4961 : 20210508 : (15107) TOEPPERWEIN
- CBET 4960 : 20210506 : COMET C/2021 E3 (ZTF)
- CBET 4959 : 20210506 : COMET C/2021 G1 (LEONARD)
- CBET 4958 : 20210429 : NEW NUMBERINGS OF SHORT-PERIOD COMETS





Twitter and Slack are great, but what when you want to find this conversation a year later?

Comet 46P/Wirtanen – Information Input

Time to Close Approach

0 Days 0 Hrs 0 Min 0 Sec

- **Campaign Home page**
- **46P/WIRTANEN HOME**
  - Current Status
  - Press Reports
  - 2018 Apparition
  - Physical Properties
  - History
  - Observations
  - Orbit
  - Observing Geometry
  - Finder Charts
  - Brightness Discussion
  - Coma Morphology
  - CN Filter Tests
  - Archived Data
  - Proposal Talking Points
  - Presentations & Telecons
  - Pronouncing "Wirtanen"
- **Other Campaign Objects**
- **RELATED LINKS**
  Hover over link for more info

Planned, Scheduled and Completed Observations

46P/Wirtanen Observing Record

This form is for adding information about your observation plans and results to the general database. Information will be displayed in the associated spreadsheets for other users to see.

The form consists of four sections, but should only take a few minutes to complete.

Next

Never submit passwords through Google Forms.

Google Forms This form was created inside of University of Maryland, College Park.

https://wirtanen.astro.umd.edu/obs_campaigns.shtml

Terms of Service

X-Ray

Far UV

Near UV

Optical

IR

Sub-millimeter / millimeter

Radar / radiowave

Unspecified or other

Striped versions are proposed or planned observations.

Comet PanSTARRS C/2016 R2 - Observations

August 2017

	30 S	31 M	01 T	02 W	03 T	04 F	05 S	06 S	07 M	08 T	09 W	10 T	11 F	12 S	13 S	14 M	15 T	16 W	17 T	18 F	19 S	20 S	21 M	22 T	23 W	24 T	25 F	26 S	27 S	28 M	29 T	30 W	31 T	01 F	02 S
Robo 31", Michael Kelley																																			
r_h	0.0 au							0.0 au							0.0 au							0.0 au							0.0 au						
Δ	0.00 au, NaN×10$^{-Infinity}$ km							0.00 au, NaN×10$^{-Infinity}$ km							0.00 au, NaN×10$^{-Infinity}$ km							0.00 au, NaN×10$^{-Infinity}$ km							0.00 au, NaN×10$^{-Infinity}$ km						
Phase	0°							0°							0°							0°							0°						
Solar elongation	0°							0°							0°							0°							0°						

September 2017

	27 S	28 M	29 T	30 W	31 T	01 F	02 S	03 S	04 M	05 T	06 W	07 T	08 F	09 S	10 S	11 M	12 T	13 W	14 T	15 F	16 S	17 S	18 M	19 T	20 W	21 T	22 F	23 S	24 S	25 M	26 T	27 W	28 T	29 F	30 S
Robo 31", Michael Kelley																																			
r_h	0.0 au							3.6 au							3.6 au							3.5 au							3.5 au						
Δ	0.00 au, NaN×10$^{-Infinity}$ km							3.60 au, 5.39×10^{8} km							3.46 au, 5.18×10^{8} km							3.32 au, 4.97×10^{8} km							3.18 au, 4.75×10^{8} km						
Phase	0°							16°							16°							16°							16°						
Solar elongation	0°							83°							89°							94°							100°						

https://wirtanen.astro.umd.edu/Obs_pages/2016R2_obs.shtml

RNAAS RESEARCH NOTES OF THE AAS

The Inbound Light Curve of 2I/Borisov

Brett Gladman[1], Aaron Boley[1], and Dave Balam[2]

Published December 2019 • © 2019. The American Astronomical Society. All rights reserved.

Research Notes of the AAS, Volume 3, Number 12

Citation Brett Gladman *et al* 2019 *Res. Notes AAS* **3** 187

Figures ▾ References ▾

+ Article information

Export citation and abstract BibTeX RIS

◂ **Previous** article in issue **Next** article in issue ▸

+ Related links

1. Introduction

The interstellar comet 2I/Borisov is entering the solar system on a strongly hyperbolic trajectory ($e = 3.4$) with perihelion on 2019 December 8.6 UT at a heliocentric distance $r = 2.0$ au. Since

AAS Research Notes

About The Journal of Brief Ideas

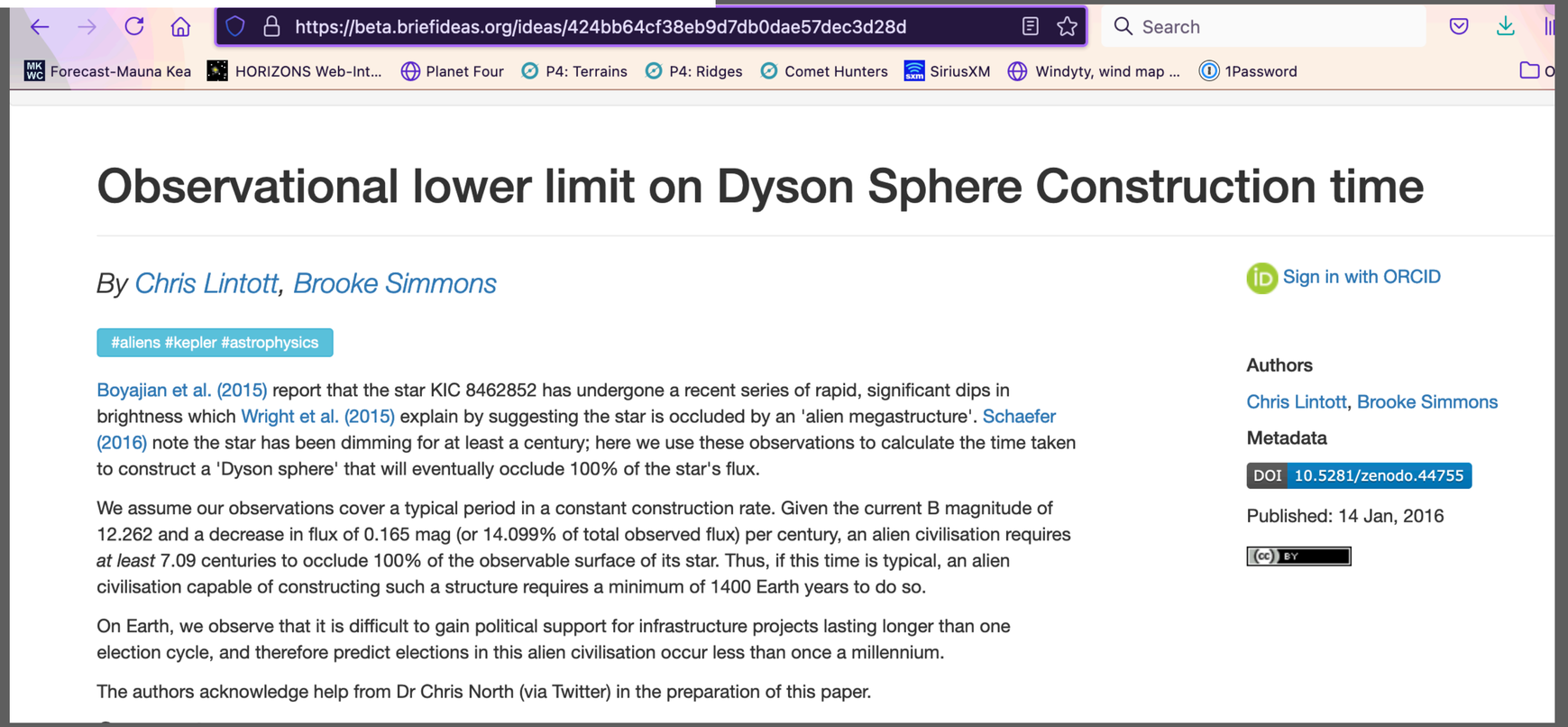
The Journal of Brief Ideas is a research journal, composed entirely of 'brief ideas'. The goal here is to provide a place for short ideas to be described - *in 200 words or less* - for these ideas to be archived (courtesy of Zenodo), searchable and citable.

Contents

Why are you doing this?

We think that that there is an inherent inefficiency in scientific publishing due to the quantum (or minimum publishable amount) of research being too large. It can takes many years to do enough research for a publication in a top-tier journal. Meanwhile, all that intellectual capital is tied up solely in the heads of the researchers rather than circulating where it could be doing some good. Also, many research ideas and results are not publishable because they are small, negative, partial, or just don't fit the criteria of other journals. But many of them can be expressed briefly and could aid other researchers.

https://beta.briefideas.org/



Observational lower limit on Dyson Sphere Construction time

By Chris Lintott, Brooke Simmons

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#aliens #kepler #astrophysics

Boyajian et al. (2015) report that the star KIC 8462852 has undergone a recent series of rapid, significant dips in brightness which Wright et al. (2015) explain by suggesting the star is occluded by an 'alien megastructure'. Schaefer (2016) note the star has been dimming for at least a century; here we use these observations to calculate the time taken to construct a 'Dyson sphere' that will eventually occlude 100% of the star's flux.

We assume our observations cover a typical period in a constant construction rate. Given the current B magnitude of 12.262 and a decrease in flux of 0.165 mag (or 14.099% of total observed flux) per century, an alien civilisation requires *at least* 7.09 centuries to occlude 100% of the observable surface of its star. Thus, if this time is typical, an alien civilisation capable of constructing such a structure requires a minimum of 1400 Earth years to do so.

On Earth, we observe that it is difficult to gain political support for infrastructure projects lasting longer than one election cycle, and therefore predict elections in this alien civilisation occur less than once a millennium.

The authors acknowledge help from Dr Chris North (via Twitter) in the preparation of this paper.

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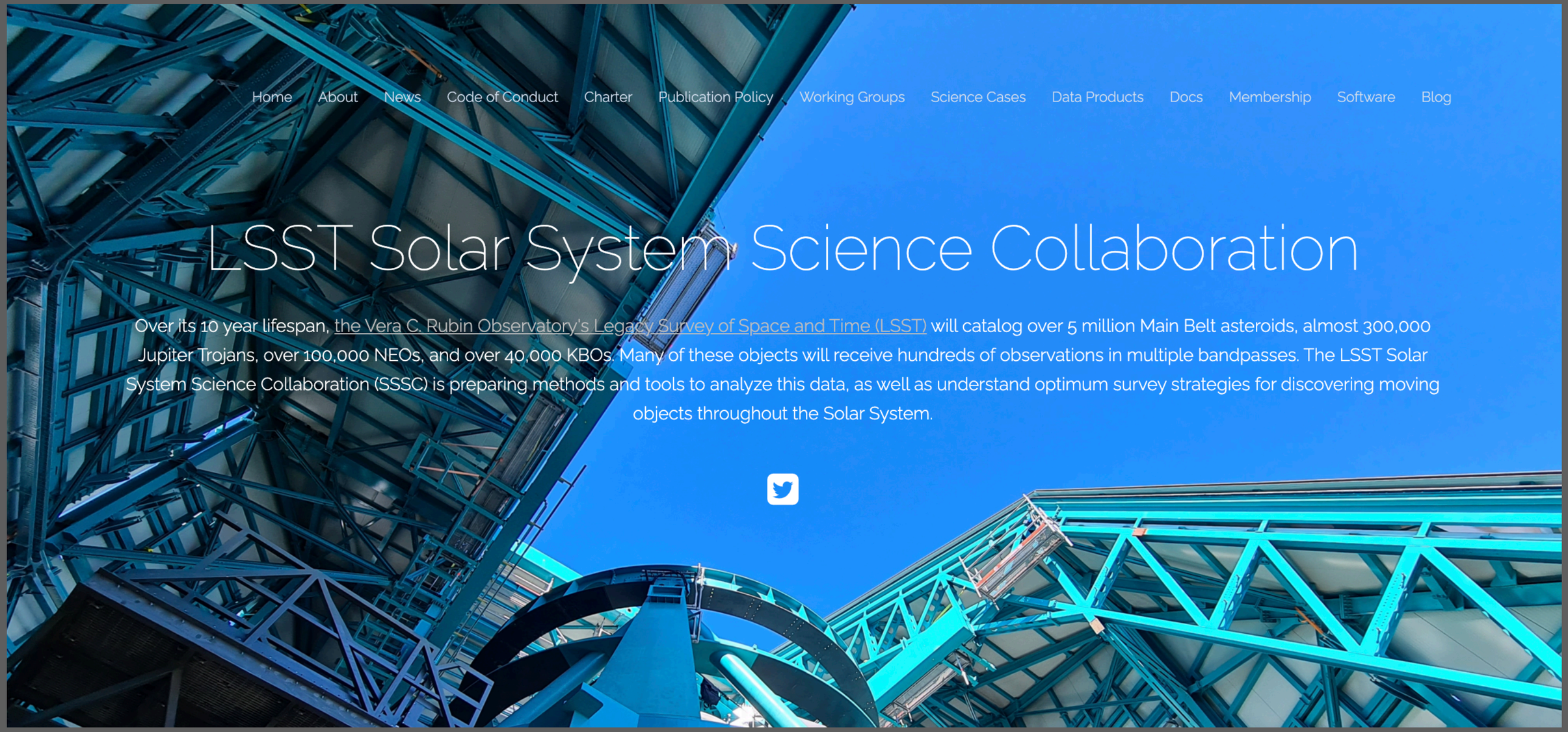
Metadata

DOI 10.5281/zenodo.44755

Published: 14 Jan, 2016

More details can be found on the SSSC's webpage



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