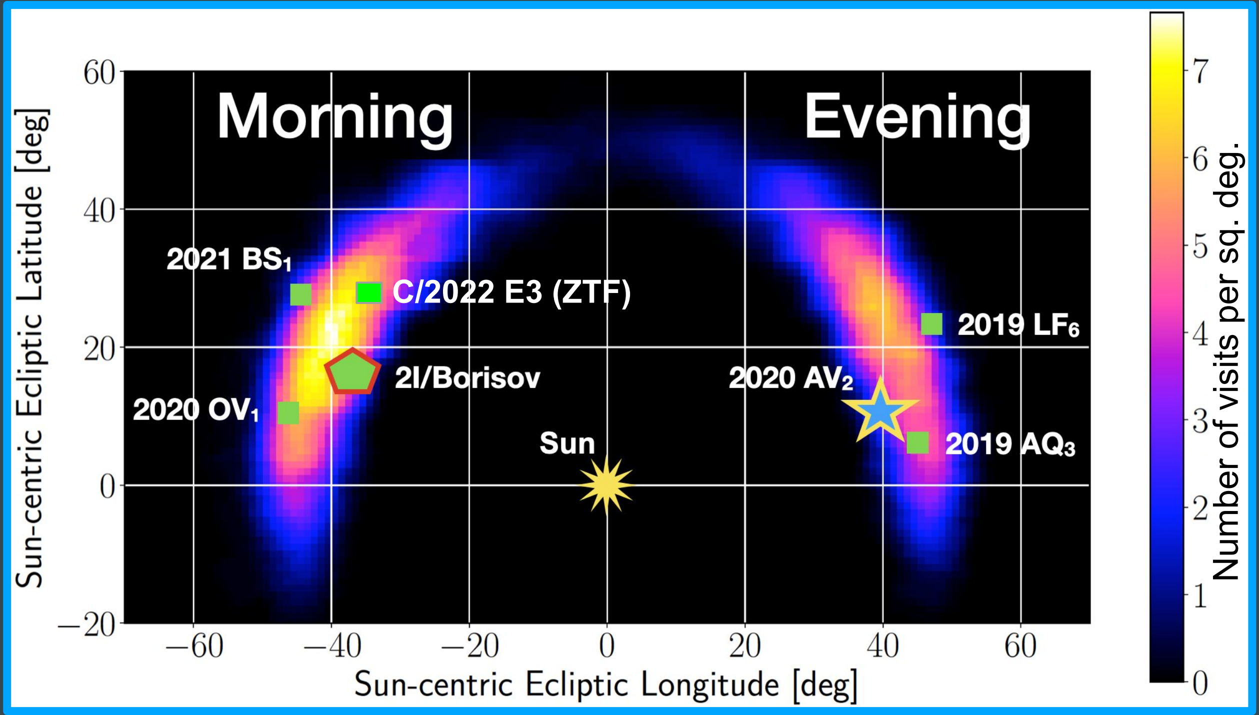
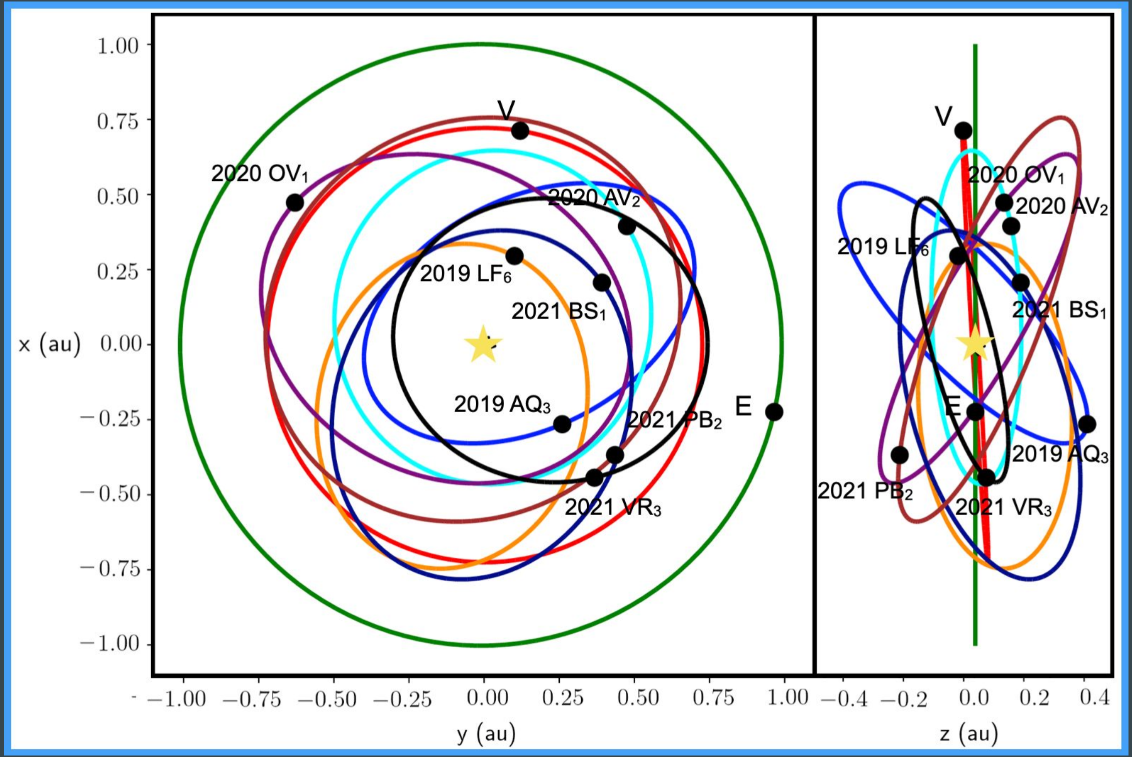
Lightning Talks

Twilight Survey for near-Sun Atira/'Ayló'chaxnim asteroids with ZTF (Bryce Bolin - Caltech/IPAC)



- Survey for inner-Earth (atiras) asteroids/inner-Venus ('Aylo'chaxnim) asteroids/near-Sun comets
- Since 2019, surveys sky within 35-55 degrees of the Sun during evening/morning twilight
- ~10% of total ZTF survey time, consists of 8-13 fields (400-600 sq. deg.) to r~20
- Each field consists of 5 x 30 s exposures in r band separated by 3-5 minutes between exposures

ZTF Atira / 'Ayló'chaxnim discoveries



6 Atiras / 1 'Aylo'chaxnim / 6 comets

6 Atiras: e.g., 2020 OV1 (Bolin et al. 2020, MPEC 2020-O66), 2021 BS1 (Bolin et al. 2021, MPEC 2021-B73),
2021 PB2 (Bolin et al. 2021, MPEC 2021-68P) and 2021 VR3 (Bolin et al. 2021, MPEC 2021-158V).

1 inner-Venus asteroid: (594913) 'Aylo'chaxnim = 2020 AV2 (Bolin et al. 2021, MPEC 2020-A99).

1 Possible naked-eye comet C/2022 E3 (ZTF), V~5 in Feb 2023, (Bolin et al. 2022, MPEC 2022-F13).

A probabilistic tail dust model (Laura Inno)

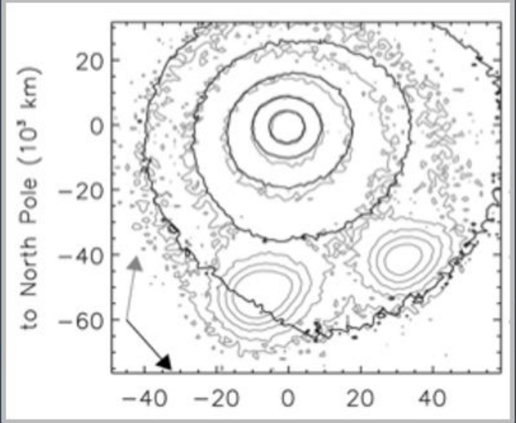
We plan to delivery

- Advanced/complementary activity detections technique
- Measurements of the lengths of comet tails or trails
- Parameters characterizing cometary activity level using a probabilistic tail dust model

Examples

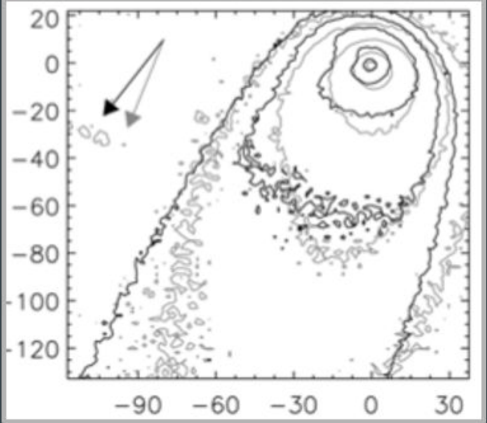
- C/2017K2: v_d=4.0 m/s, A f ρ= 53 +/- 10
- C/2019O3: v_d=0.7 m/s, A f ρ= 50 +/- 10

C/2017K2 @ rh = 6.3 au



isotropic ejection

C/2019O3 @ rh = 8.9 au

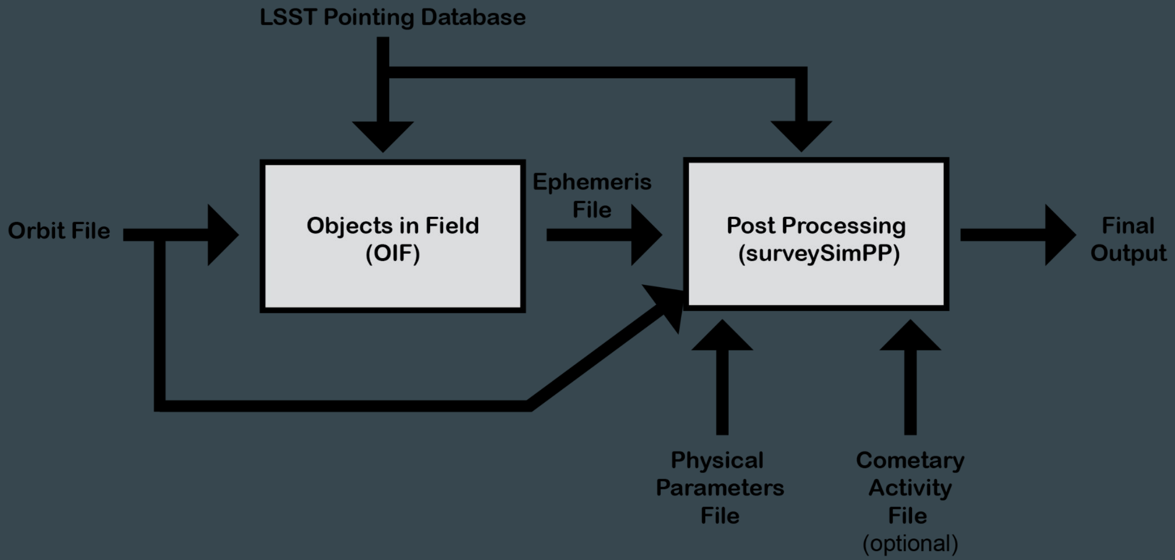


latitude > -60 deg (no obliquity)

References: **Comets beyond 4 au: How pristine are Oort nuclei? Fulle***, Lazzarin, **La Forgia***, Zakharov, **Bertini***, et al., incl. **INNO**, 2022, MNRAS, 513, 5377. doi:10.1093/mnras/stac1218 - ***SSSC members**
Based on: **CO-driven activity constrains the origin of comets Fulle**, Blum, Rotundi, A&A 2020

Also: Co-supervising A. Vanzanella project on Detecting slow-moving objects in DP0: see **T. Daylan's slide**

A Solar System Survey Simulator (Steph Merritt)



- Calculates apparent magnitude
- Trailing losses
- Uncertainties and SNR
- Vignetting
- LSST camera footprint
- Magnitude or SNR cuts
- Detection efficiency filter
- Saturation limit filter
- SSP linking filter

Contributors: Aidan Berres, Sam Cornwall, Siegfried Eggl, Grigori Fedorets, Lynne Jones, Mario Jurić, Michael S. P. Kelley, Shannon Matthews, Steph Merritt, Shantanu Naidu, Meg Schwamb, Colin Snodgrass, Dave Young, Michele Bannister, Rosemary Dorsey

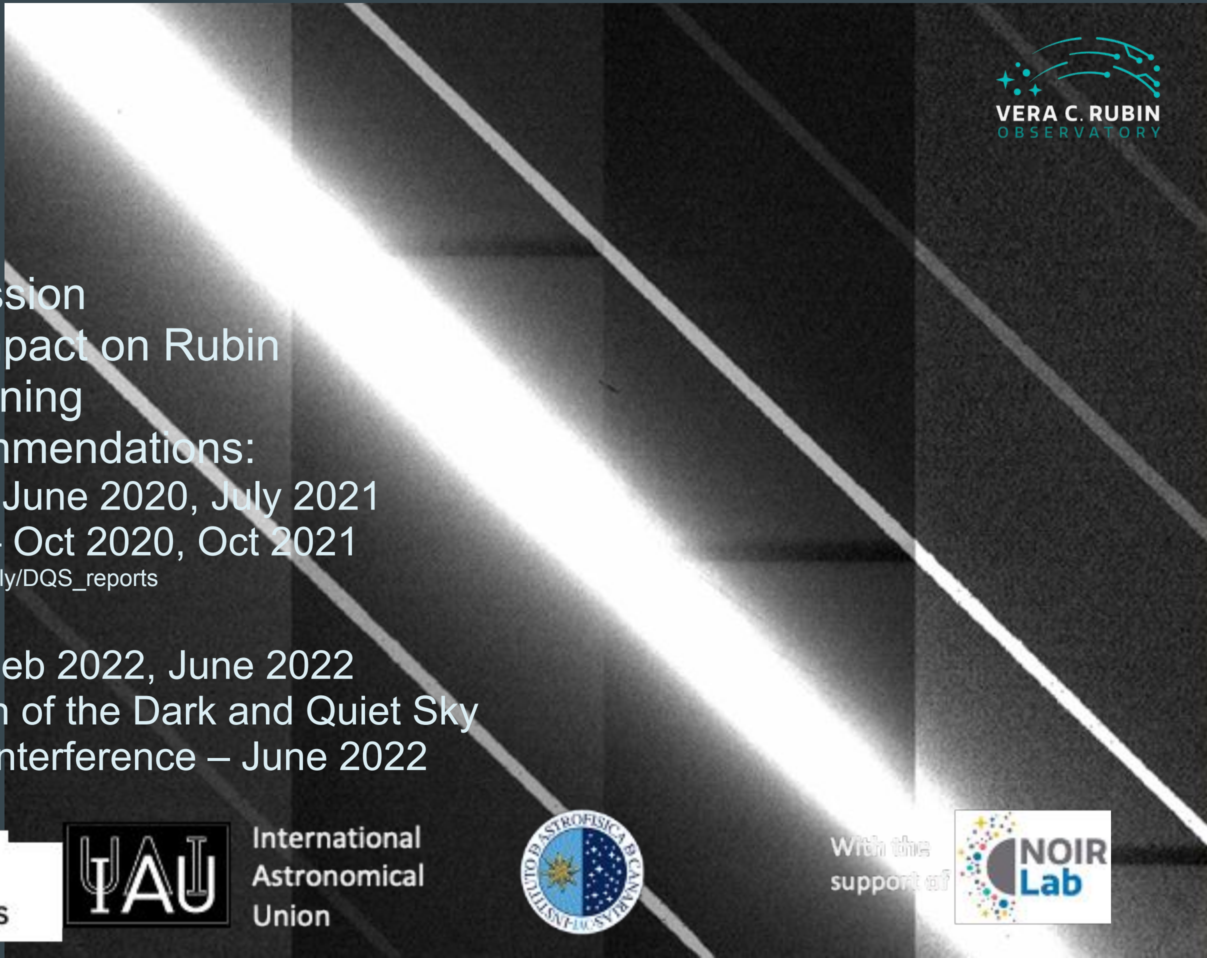
A Solar System Survey Simulator (Steph Merritt)

- Post-processing module available at:

  https://github.com/dirac-institute/survey_simulator_post_processing

- Looking for beta testers! Join the project to help out
- Submit any bugs, uncaught errors etc as GitHub issues
- Feel free to fork and submit fixes via pull requests
- Feature suggestions welcome but we are currently aiming for a finished product

Satellite Constellations: There's Plenty We Can Do! (Michele Bannister)



VERA C. RUBIN OBSERVATORY

- Identify the issues:
  - O/IR trails, radio transmission
    - Especially severe impact on Rubin
  - Diffuse global sky brightening
- Identify the pathways to recommendations:
  - SATCON1 and SATCON2 – June 2020, July 2021
  - Dark & Quiet Skies I and II – Oct 2020, Oct 2021

    4-pg summary +200 pg technical report http://bit.ly/DQS_reports
- Take the pathways:
  - UN COPUOS – Dec 2021, Feb 2022, June 2022
  - IAU Centre for the Protection of the Dark and Quiet Sky from Satellite Constellation Interference – June 2022

UNITED NATIONS Office for Outer Space Affairs

IAU International Astronomical Union

With the support of NOIRLab

IAU-CPS: status update

IAU-CPS: a multi-stakeholder, properly funded resource dedicated to the mitigation of these impacts

Announced at UN-COPUOS last week: 10 countries in support!

Fledgling website out by end of the week

AAS session on satcons: Mon 1 pm PST
“Addressing the Impact of Satellite Constellations on Astronomy: The Pathway Forward”

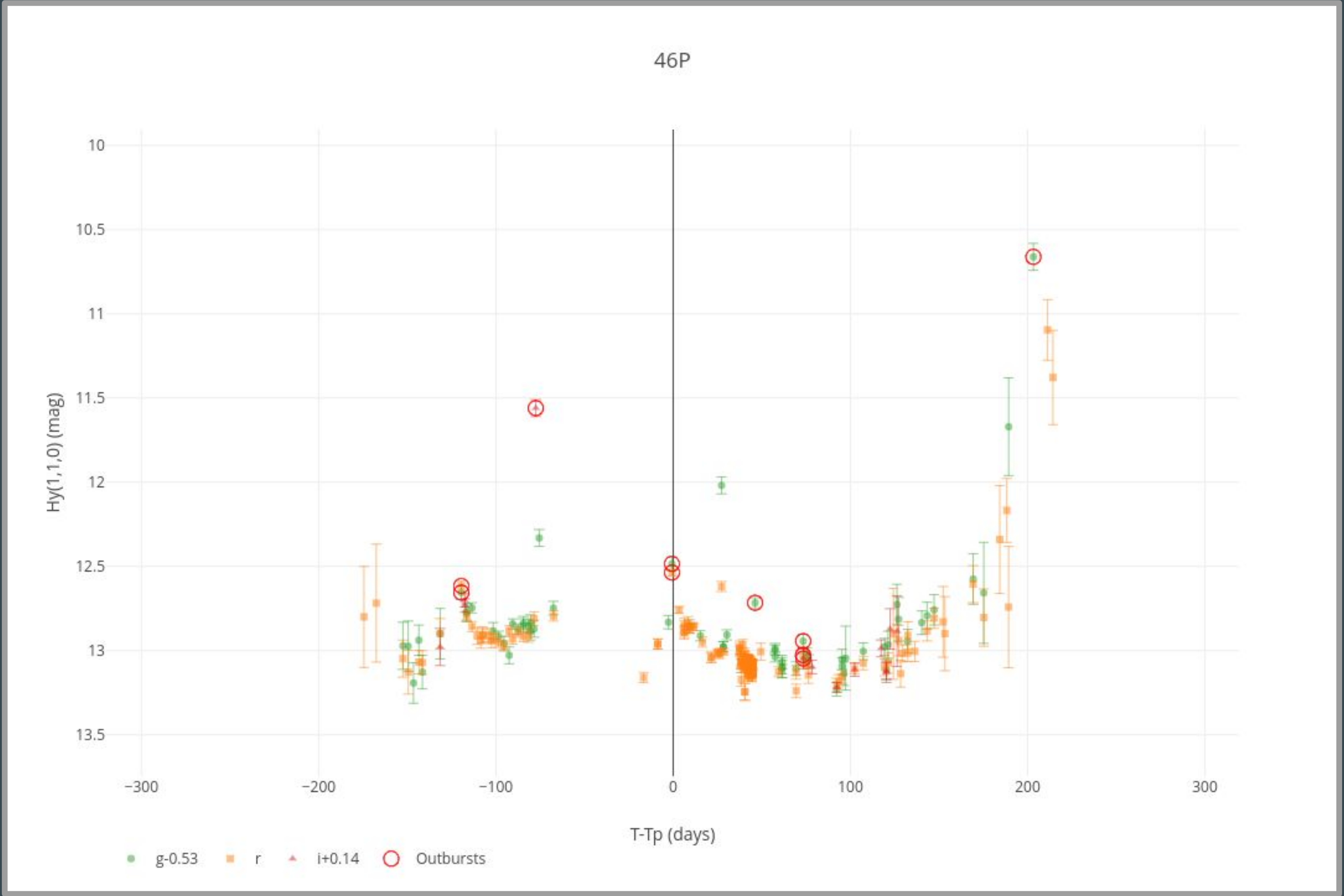
ZTF Cometary Lightcurve Tool (Mike Kelley)

ZBrowser2 is an interactive lightcurve exploration tool designed for visualizing Zwicky Transient Facility photometry of comets (and asteroids).

Runs in a web browser (Javascript). Could be a browse tool for SNAPS or other broker.

Features:

- Estimate coma colors automatically or interactively.
- Configurable photometric aperture radius.
- Lots of plot options!
  - Apparent magnitude
  - Absolute magnitude: H(1, 1, α) or H(1, 1, 0)
  - Cometary absolute magnitude: Hy(1, 1, 0)
  - Afρ, A(0°)fρ, or A(0°)fρ × r_h^k
  - Centroid offset
  - Seeing
  - Outburst metric
  - Geometrical circumstances: r_h, Δ, phase angle
  - Time: MJD or $T\text{-}T_P$

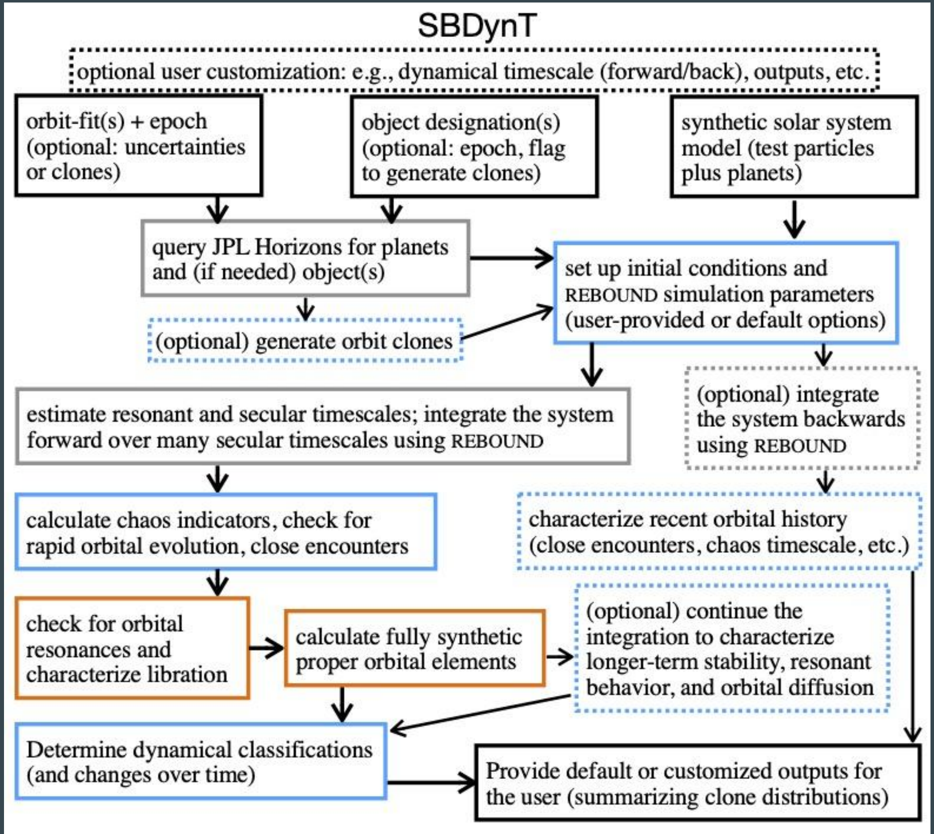


An example of how flattening the lightcurve helps identify outliers.

Comet 46P/Wirtanen photometry:
Kelley et al. 2021, PSJ

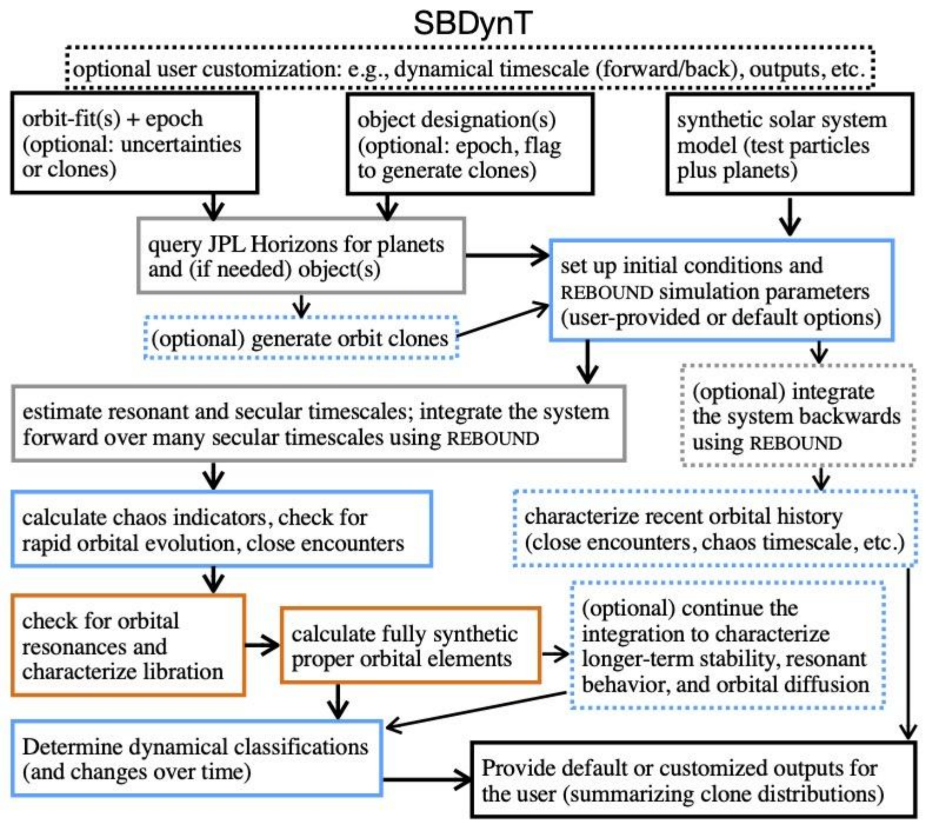
Dynamical Characterization Software (Kat Volk)

- Small Bodies Dynamics Tool (SBDynT) - developing a user-friendly python tool for dynamical characterization of solar system small bodies
    - Initial development funded by LSST kickstarter grant
    - Now also funded by a PDART grant (Co-Is: Ragozzine, Malhotra)
- Will have a public GitHub sometime this summer!



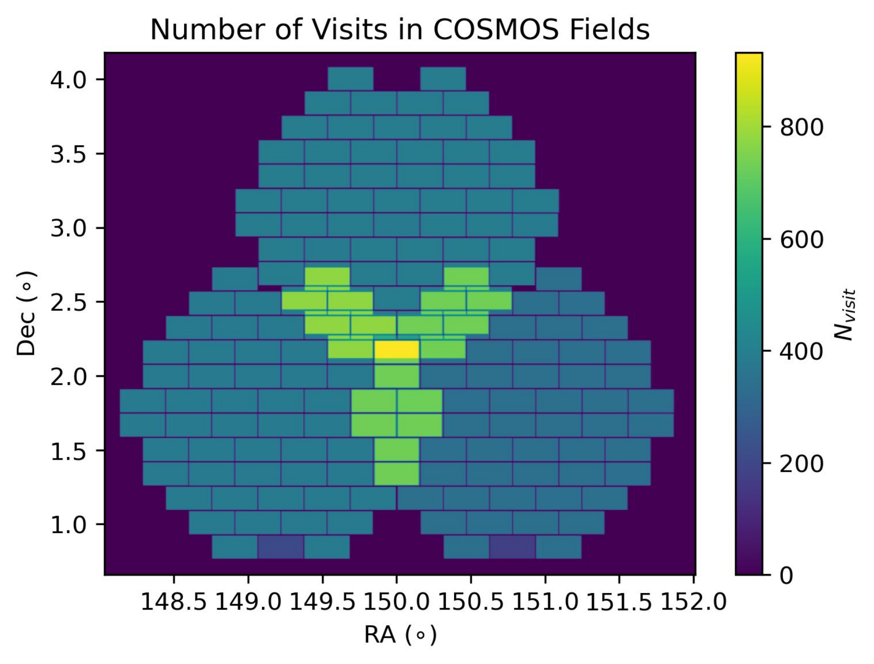
Dynamical Characterization Software (Kat Volk)

- Planned outputs:
  - Proper/free orbital elements
  - Identification of mean motion resonances
  - Orbital stability assessments
  - Dynamical classes
- Looking for:
  - Other dynamical outputs people want!
  - Anyone who wants to contribute



Solar System Science with the DECam DDF Survey (Steven Stetzler)

- The DECam DDF Survey: 4 pointings within 10 deg of the ecliptic, observed every 3 nights with 5 exposures in gri+z to r~23.5 from March-June + in-progress
- Discovery of Main Belt Asteroids, characterization of rotation periods and colors (Heinze+Chowdhury/LSST Kickstarter)
- Digital tracking for potential TNO discovery to r~26+ over 3-6 month time baselines
- Eventually release processed data to lsst.dirac.dev for open access and collaboration



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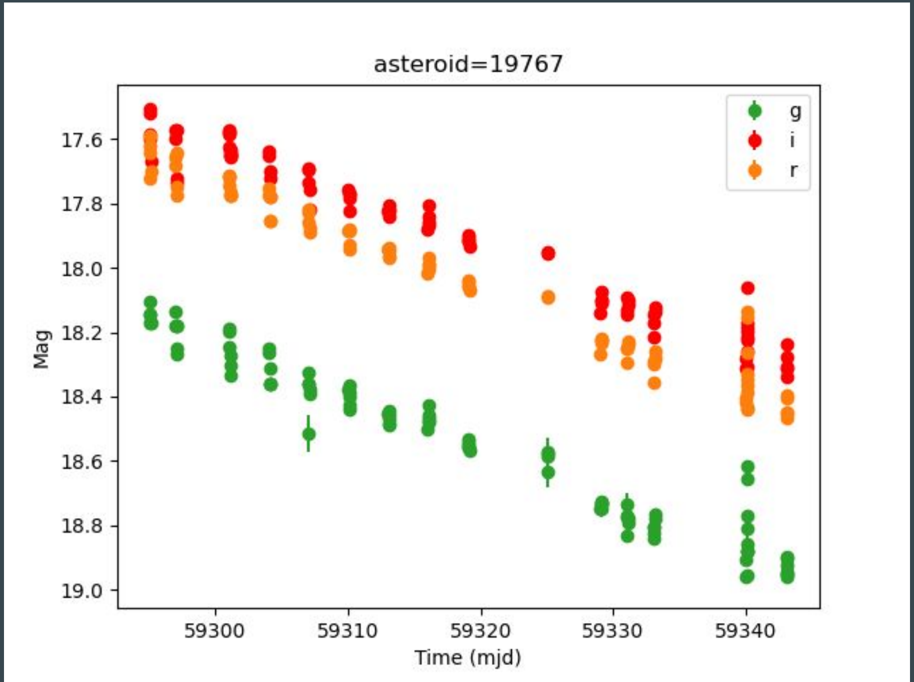


A Bayesian Inference Engine for Solar System Science
(Rosemary Dorsey)

🔭 PhD student
💻 Survey simulators

⭐ LSSTC Enabling Science 2021 award recipient
Bayesian inference engine:
- General-purpose
- Python, open-source
- Available to SSSC prior to 1st light

🔎 **Why?** Model comparison and parameter constraint

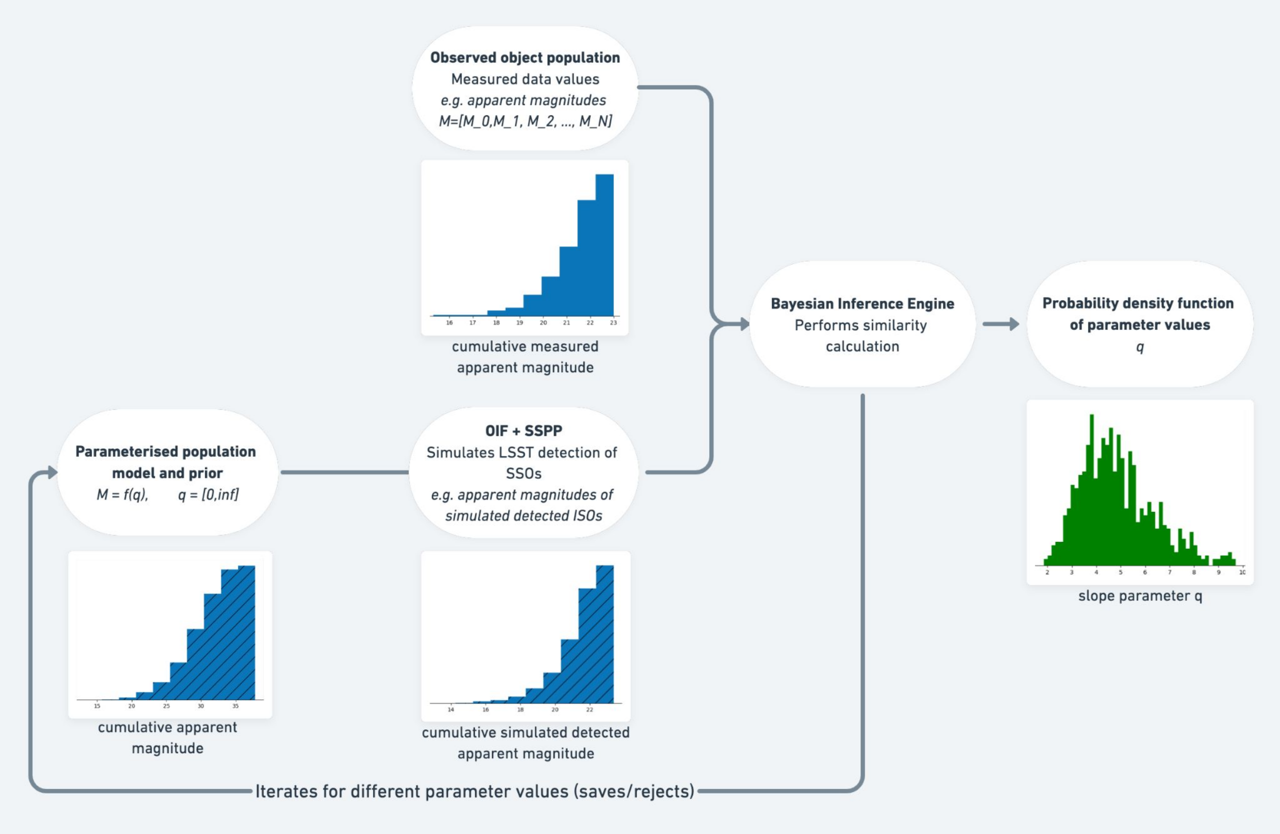
Me   Michele Bannister

Alex Parker   Samantha Lawler

UC
UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

LSST CORPORATION

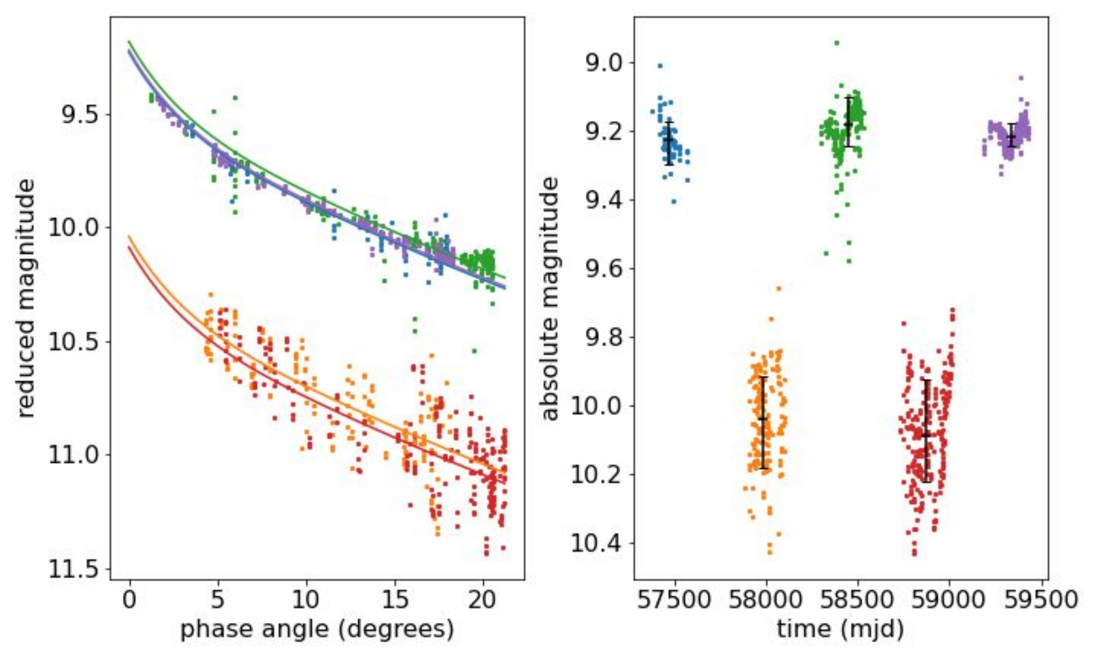
A Bayesian Inference Engine for Solar System Science



rosemary.dorsey@pg.canterbury.ac.nz

- Currently demoing on ISOs
- Can add additional layers of complexity without starting over
- Very generalised

Tools for Derived Photometric Data Products
(Jamie Robinson)



Asteroid 766 Moguntia as observed with ATLAS (o filter)

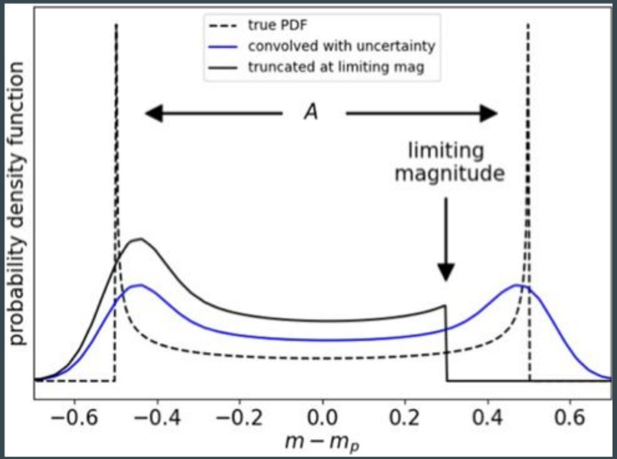
Asteroid phase, colour and rotation

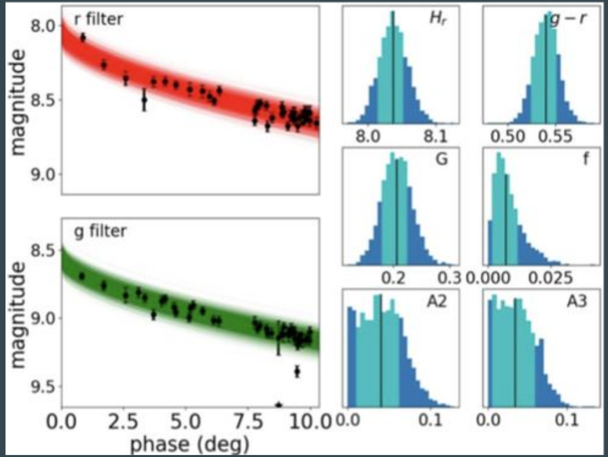
ISSUES:

- Sparse photometry: limited coverage dependent on cadence (+ choice of filters)
- Changing aspect angle + rotational brightness variation
- How to extract **accurate** phase parameters, colours, lightcurve properties?

Tools for Derived Photometric Data Products
(Jamie Robinson)

- Derived Photometric Data Products (DPDP): sub-working group of the SSSC Software group
- Coordinate efforts and implement methods to extract additional science from LSST data
- Contact me james.robinson@ed.ac.uk to join the mailing list sssc-dpdd@lists.lsst.org (not a typo!)
- Find us on slack: LSSTC #sssc-dpdp





Schemel and Brown 2021: MCMC accounting for photometric uncertainty and lightcurve amplitude

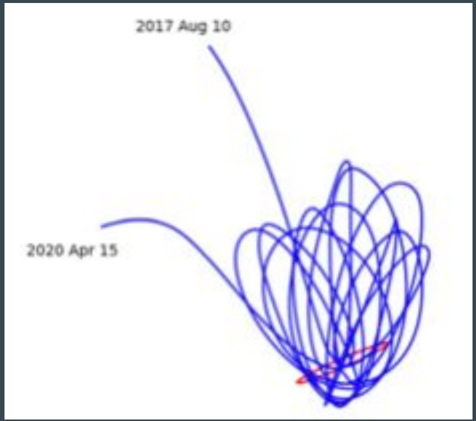
See also Alvarez-Candal et al. 2022, Lindberg et al. 2021, Martikainen et al. 2021 - please suggest more!

Improving the detectability of Earth's temporarily-captured satellites with LSST
(Grigori Fedorets, Queen's University Belfast, UK)

Earth's temporary captured satellites

-resolving the undersampled 1-10 m size-frequency distribution of NEOs
-Outstanding low-Δv space-mission candidate targets, also for asteroid mining
-Two known so far, both discovered by Catalina Sky Survey 14 years apart

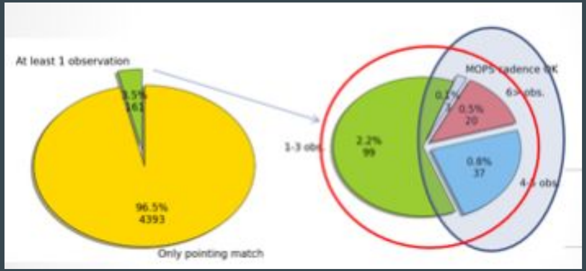
How many can LSST detect?



Naidu et al. (2021)

Improving the detectability of Earth's temporarily-captured satellites with LSST

- The largest of those that are captured at any given time are on the edge of LSST detectability
- Baseline approach can detect a few (once 1-2 years)
- Goal: enhance detectability by an order of magnitude



Fedorets et al. (2020)

- **Questions for the sprint:**
-
- Is it possible to make a test alert stream data from simulated database?
- What would be the best way to assert the suitability of different linking algorithms?

A follow-up question on the properties of the trailed detections – is only the centre coordinate measured?

Early detection of interstellar objects using LSST (Tansu Daylan)

with Laura Inno and Antonio Vanzanella (Parthenope University of Naples)

LSSTC Enabling Science #2021-39

Interstellar objects give us a direct, potentially close-in or in-situ probe of the compositions of the material that make up exoplanetary systems and the interstellar medium itself. They offer observational probes to test models of planet formation and evolution.

1I/‘Oumuamua and 2I/Borisov have been the only two detections so far. But they were detected too late for optimal study.

Can we easily intercept an interstellar object after discovery? Yes, if we can detect them early enough!

Our project aims to construct an image processing pipeline based on machine learning to detect slow-moving, distant, and faint (close to detection threshold) objects.

Once such an early-time detection is made, they could be followed-up with spectroscopy as well as stellar occultations using fast optical telescopes. Finally, an activity model can be used to constrain the distances to them and their shape.

NASA, ESA, and D. Jewitt (UCLA)

ESO/M. Kormesser

Early detection of interstellar objects using LSST (Tansu Daylan)

with Laura Inno and Antonio Vanzanella (Parthenope University of Naples)

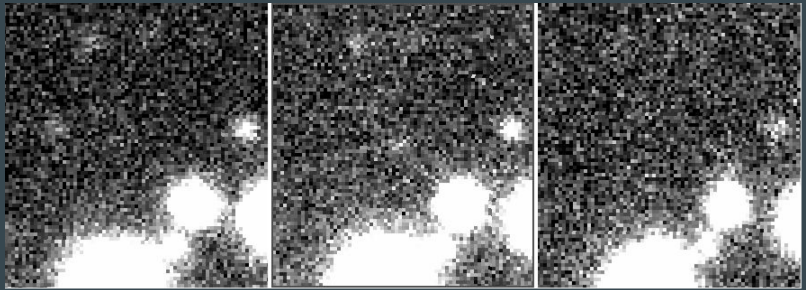
LSSTC Enabling Science #2021-39

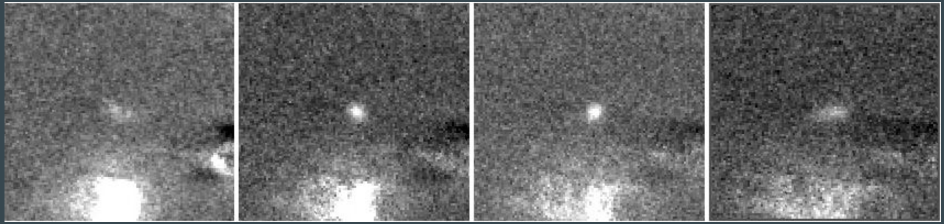
The pipeline:

- Use the Rubin Science Platform
- Align and interpolate small (~15x15 pixel) cut-out images of a given region onto common grid.
- Use a three-dimensional convolutional neural network trained on simulated events to detect slowly-moving (~1 PSF FWHM per year) position variations over year time scales.

Machine Learning and Shift'n'stack

Wes Fraser





- Sequence of many short exposures of a single field
- Shift at rates of motion consistent with moving bodies of interest
- Stack! (GPU with KBMod, Smotherman et al. 2021)
- Filter with ML networks
  - Various possible architectures.