

Comet 46P/Wirtanen Observing Campaign

50th Division for Planetary Sciences Meeting

23 October 2018



Preliminary Announcements

- Toast to Mike Belton tonight (5:00 in the Hilton Hotel bar ?)

New Cometary Insights from the Close Approach of 46P/Wirtanen: A Symposium in Celebration of Michael A'Hearn

- 6-8 August 2019
 - University of Maryland campus
 - Center around first results from the Wirtanen Campaign
 - Updates will be posted to a link on the website
- Sign up for the Wirtanen campaign mailing list if you haven't already

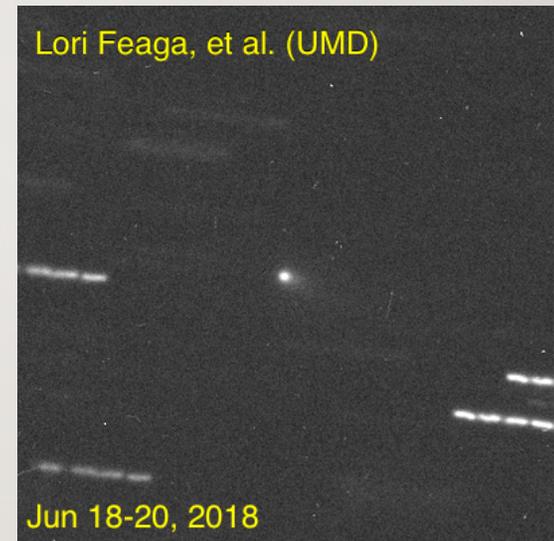
Comet Wirtanen – The Name

- Pronounced **WERE-tuh-nun**
 - Confirmed by multiple sources from Lick Observatory who worked with Carl and Edie Wirtanen



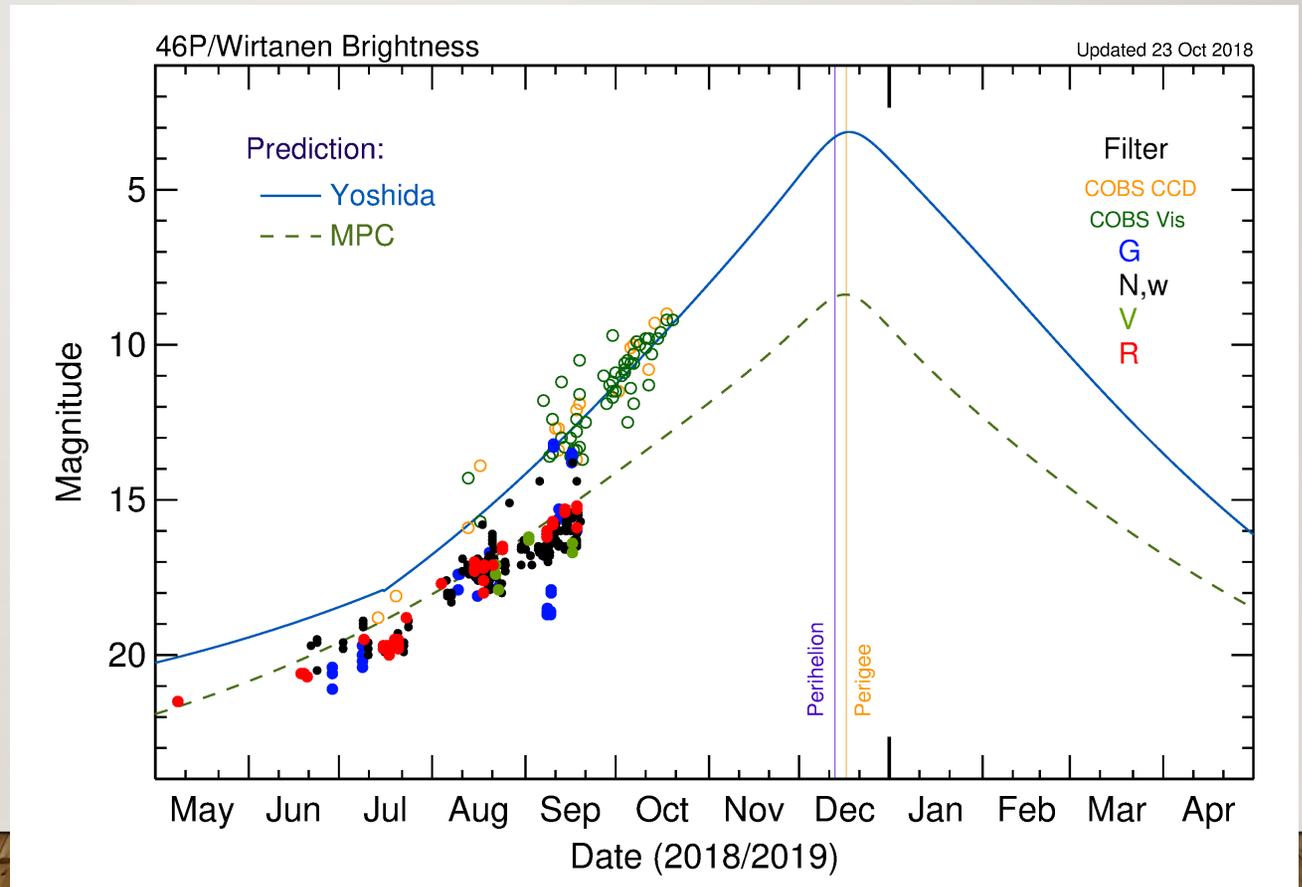
Current Status

- Recovered 18 Jun 2018
- Now ~53 days to close approach
 - Moving South until early Nov (-33°)
 - Rapidly accelerates North through C/A
 - Perihelion: 12 Dec 2018
 - C/A: 16 Dec 2018 (near opposition)
- Currently no non-gravitational forces detected



Current Status

- Nuclear brightness slightly fainter than MPC/JPL prediction
- Total brightness roughly following the Yoshida prediction
 - Not clear how this will play out near close approach



Current Status

- May be starting to exhibit coma structure

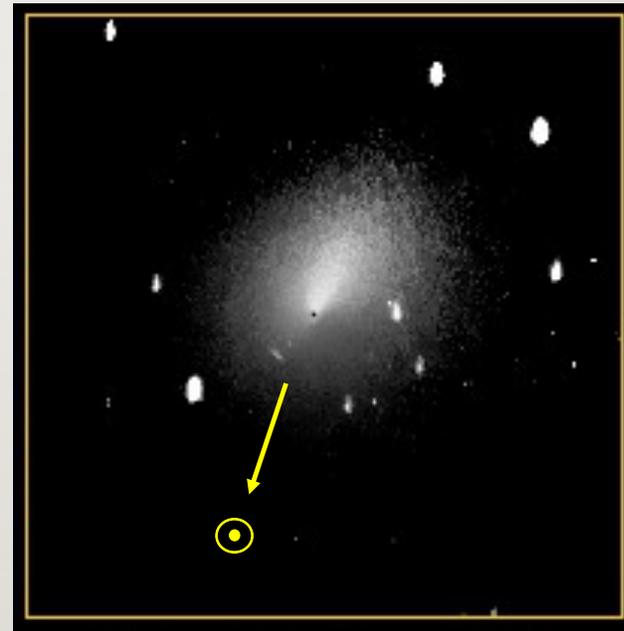
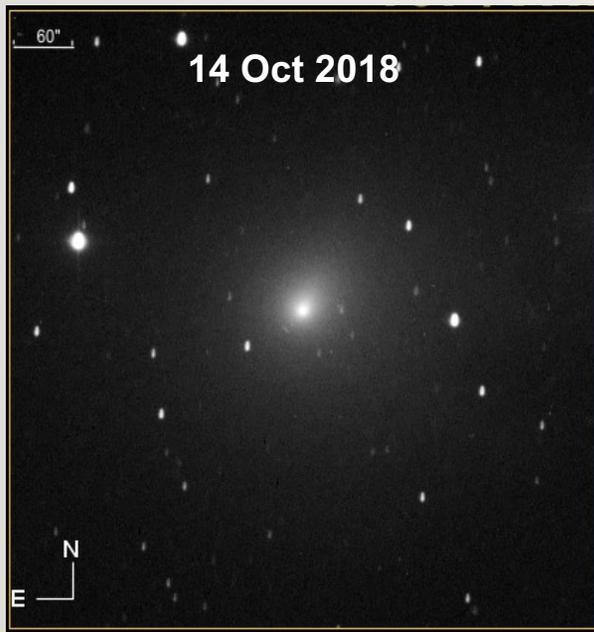


Image from Erik Bryssinck

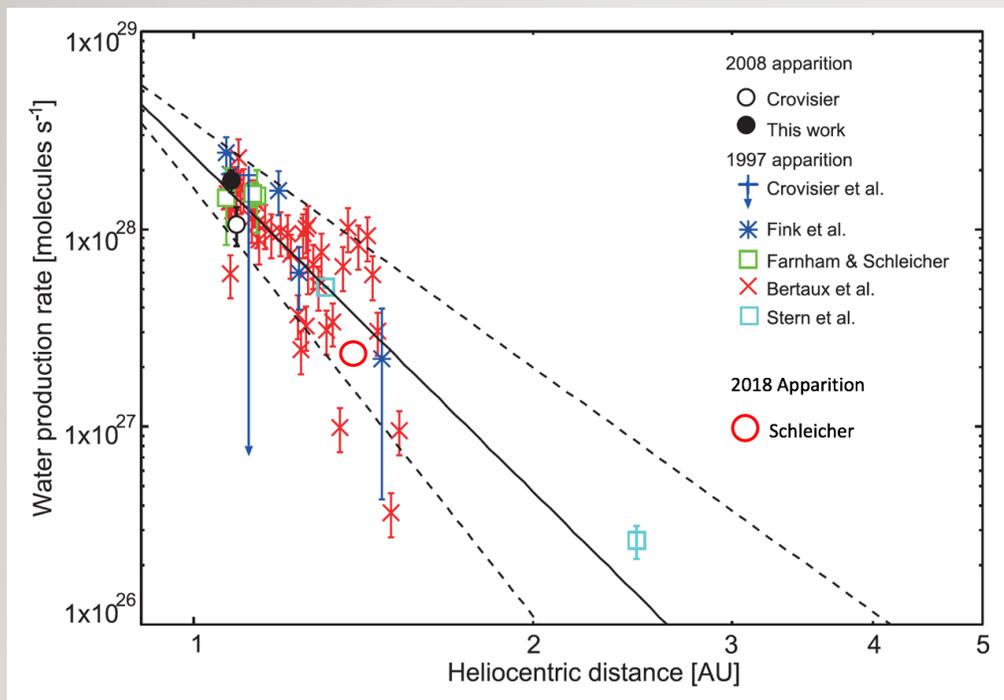
Dust/Gas Detections

- Numerous reports of Afp (typically ~15-25 cm)
- Several reports of detections of different gas species in last few weeks
 - McDonald Obs. Spectra (Cochran) -- CN, C₂, NH₂?, O(1D) and O(1S)
 - Mount Abu IR Obs. Spectra (Venkataramani) -- CN, C₂, C₃, NH₂?, O(1D)?
 - DCT HB Filters (Feaga) -- CN, C₂
- Currently: Diffuse, gas-rich coma

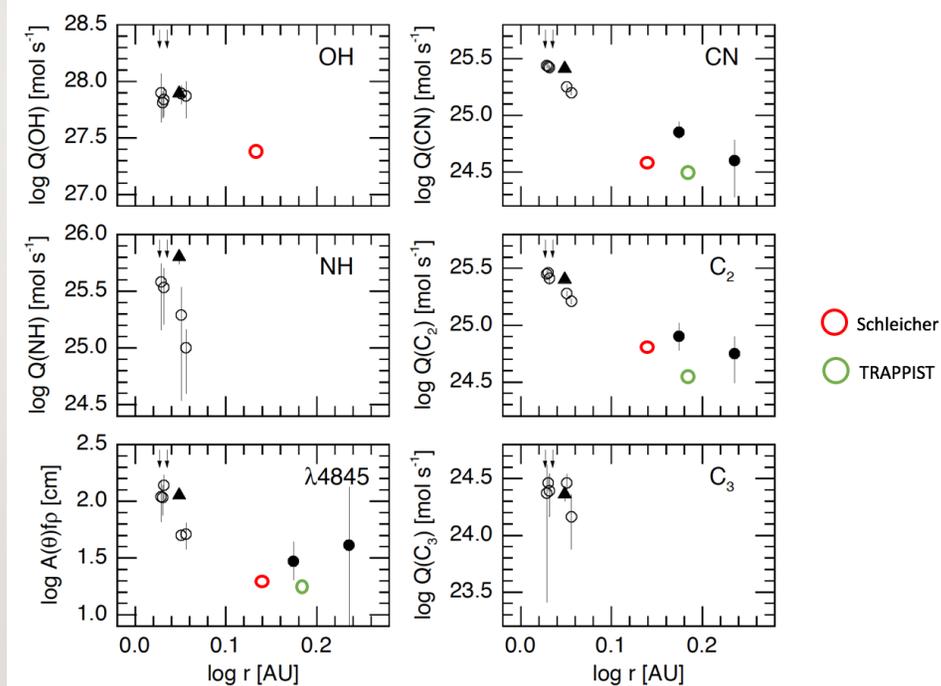
Production Rates

- TRAPPIST (Jehin) – 17 Sep 2018
 - $r_h = 1.53$ AU, $\Delta = 0.60$ AU, 5000 km aperture
 - $Q(\text{C}_2) = 3.4 \times 10^{24} \pm 5.9 \times 10^{22}$ mol/s
 - $Q(\text{CN}) = 3.2 \times 10^{24} \pm 5.6 \times 10^{22}$ mol/s
 - No OH detected
- Lowell Observatory (Schleicher) – 6 Oct 2018
 - $r_h = 1.38$ AU, $\Delta = 0.44$ AU
 - $Q(\text{OH}) = 2.0 \times 10^{27}$ mol/s \rightarrow $Q(\text{H}_2\text{O}) = 2.3 \times 10^{27}$ mol/s
 - $Q(\text{C}_2) = 6.3 \times 10^{24}$ mol/s
 - $Q(\text{CN}) = 4.5 \times 10^{24}$ mol/s

Production Rate Comparisons



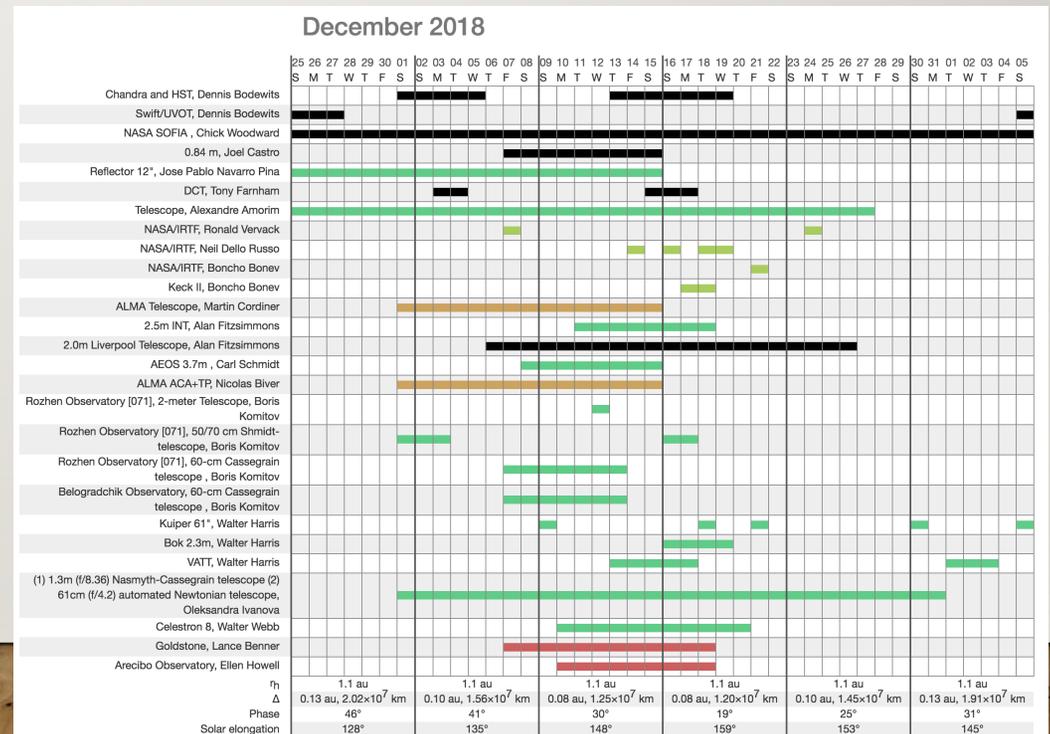
Adapted from Kobayashi and Kawakita 2010



Adapted from Farnham & Schleicher 1998

Campaign – wirtanen.astro.umd.edu

- 100 participants on the mailing list
- 43 telescope/observers registered in the observation log
 - Mostly professionals,
 - Variety of instruments
 - A few high-level amateurs
 - Mostly imaging, monitoring
- 27+ plans to observe in December



Other Potential / Future Content

- Expand the campaign as warranted
 - Additional website content
 - References list of published papers
 - Discussion of brightness
 - Finder charts
 - Telecons/blogs to discuss recent events
 - Suggestions from the community are welcome

Citizen Science Contributions

- Amateur astronomers are eager to participate
 - Excellent observers that take scientific quality data
 - Many plan to observe every clear night
 - Provide extensive monitoring and context imaging
 - Valuable for complex rotation, outburst characterization, etc.
 - Also willing to step up if we have specific requests they can fulfill

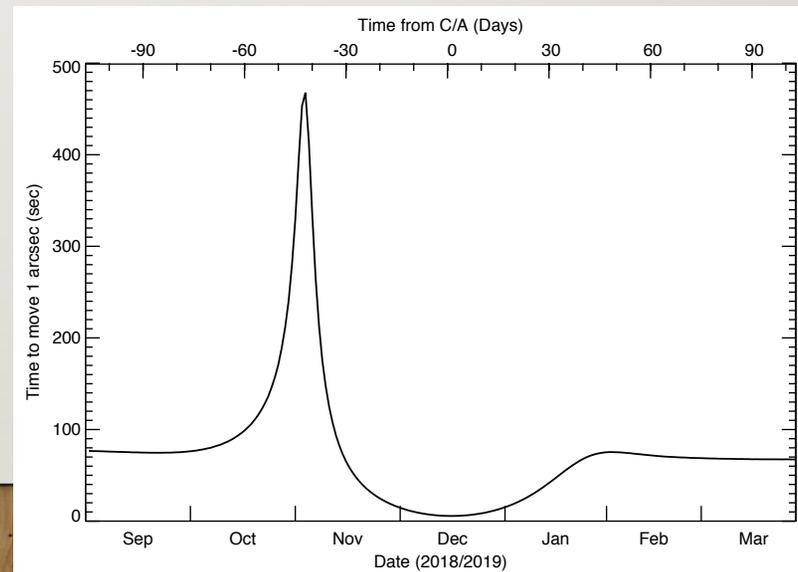
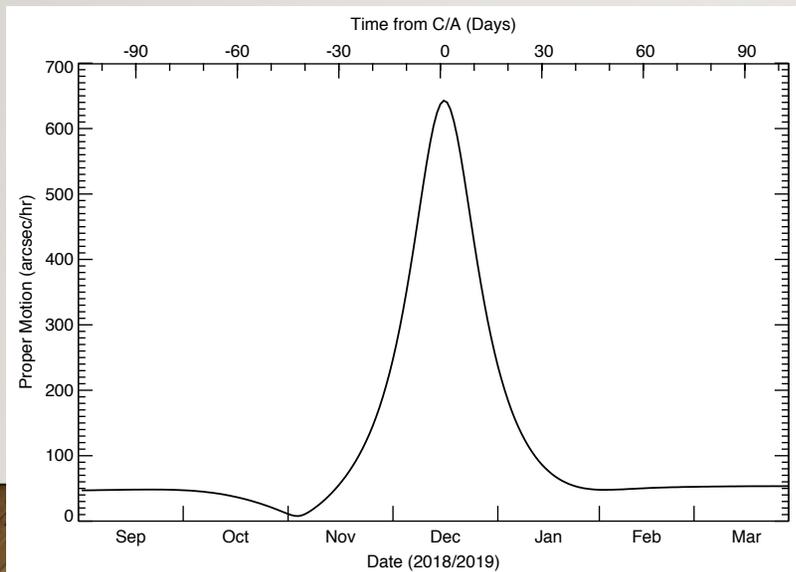
15 Sep – 18 Oct 2018 Coma development



J. Tilbrook, The PACA project

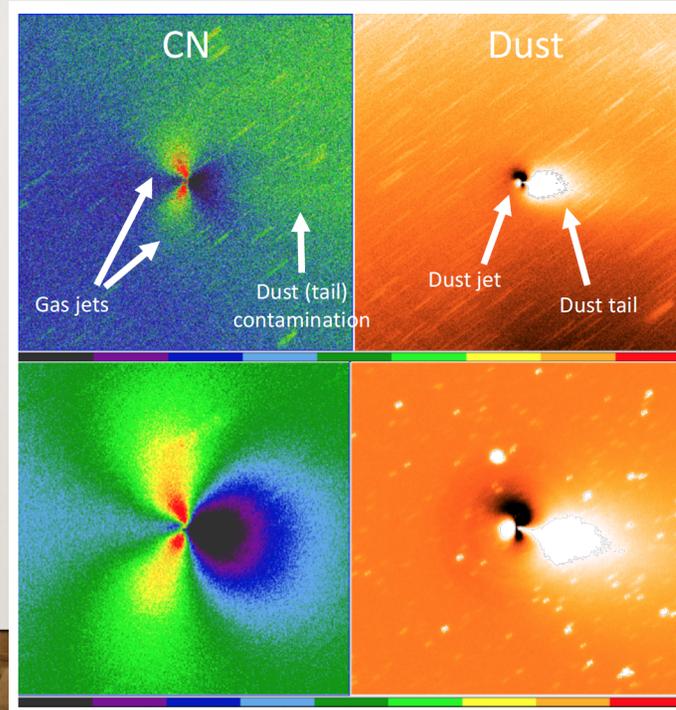
Citizen Science Contributions

- Observing conditions offer unique opportunities
 - Around close approach, $1 \text{ arcsec} < 100 \text{ km}$ at the comet
 - Even small telescopes can access inner coma – a region usually restricted to spacecraft or large telescopes with adaptive optics
- Also challenges (professional and amateur alike) – Diffuse, fast-moving



CN Filter Update

- We previously reported our tests with the Semrock CN filter were unsatisfactory
- Jorma Ryske showed that with larger telescope and brighter comet (comparable to Wirtanen), results are better
- So for those with the proper observing setup, CN filters may be worth purchasing
- Semrock FF01-387/11-25
 - 20 to 32 mm sizes, \$299 to \$490
- Edmund #84-094
 - 25 mm, \$255



2018-08-21
Ryske

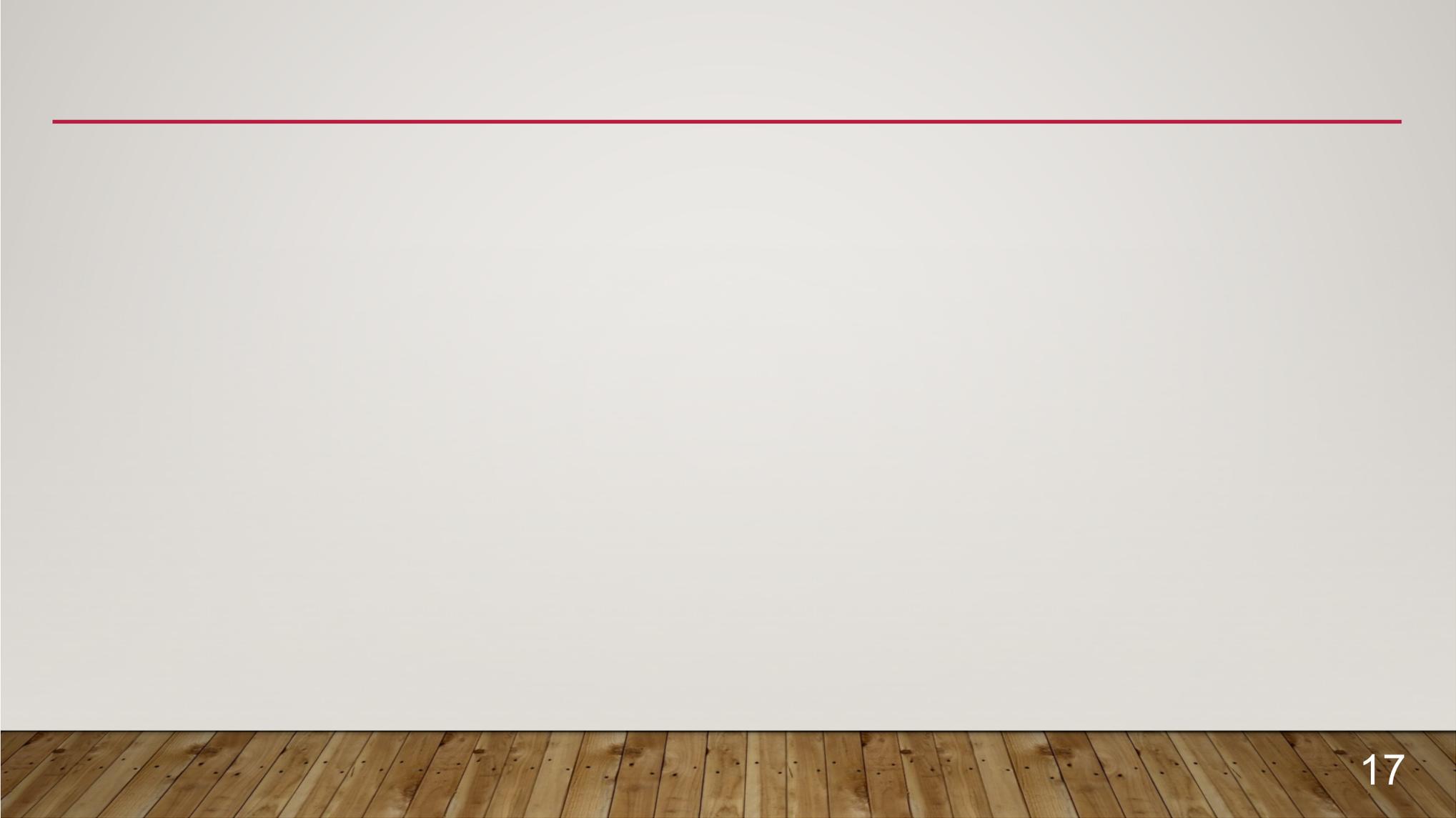
2018-08-21
Lowell 42in

Associated Campaigns

- 4*P/ Coma Observing Campaign (www.psi.edu/41P45P46P Nalin Samarasinha)
 - Professional and high level amateurs contribute images of the coma for long duration monitoring of the coma morphology
- Amateur Observers' Campaign (aop.astro.umd.edu Elizabeth Warner)
 - Public interest website
 - Promotes interaction between all levels of amateur observers and offers instruction and advice on improving observing capabilities

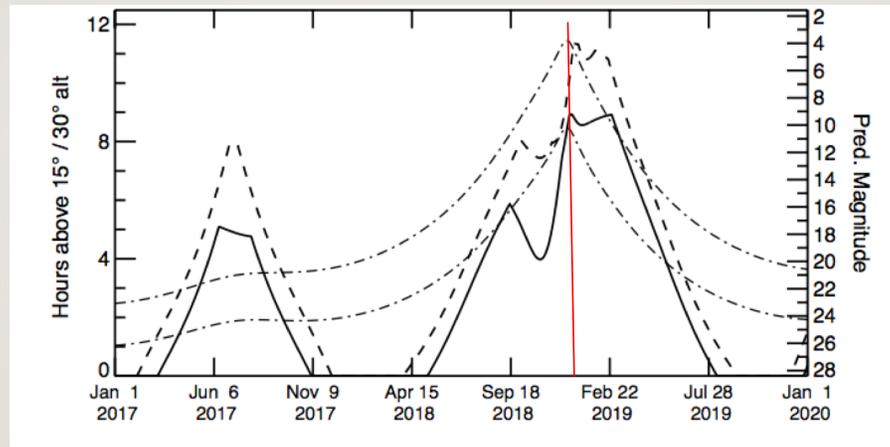
Discussions / Comments

- Remember to input your observing plans to the campaign website
 - wirtanen.astro.umd.edu
- Questions
- Support observations
 - Context observations
 - Need/want contemporaneous observations to maximize science?

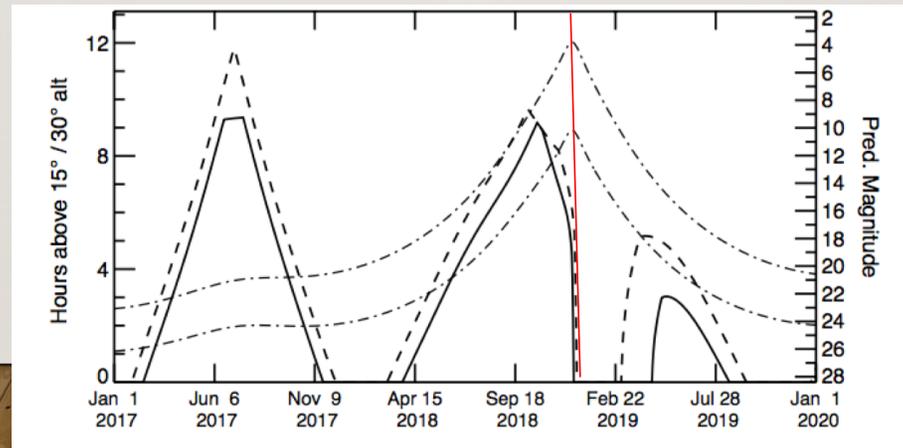


Wirtanen Visibility

MKO
(North)

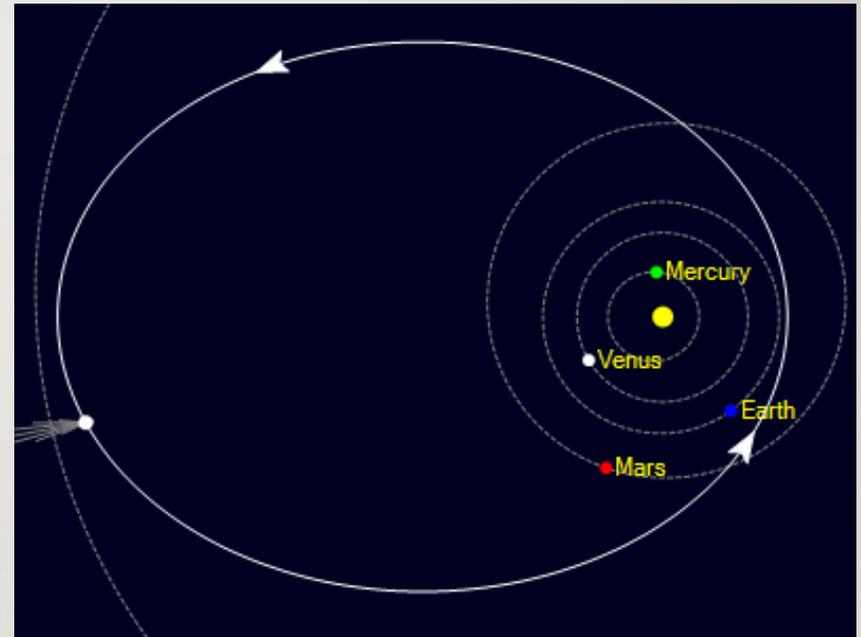


CTIO
(South)



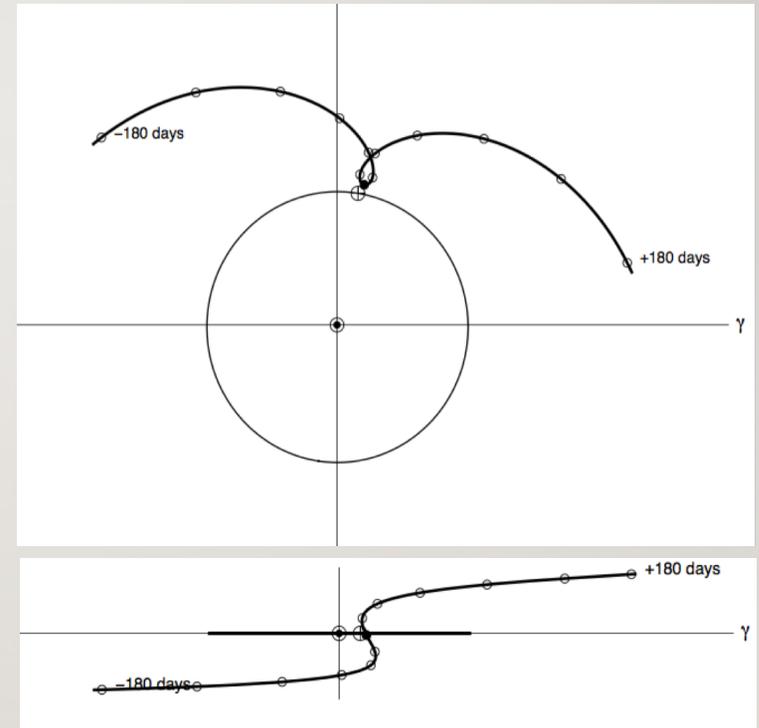
Why is Comet Wirtanen Special?

- Interesting comet
 - Small, hyperactive nucleus
 - “Twin” of Hartley 2
 - Could evolve into a PHO
- Potential (likely?) spacecraft mission target
 - Orbit is very favorable
 - $q = 1.055 \text{ AU}$, $i = 11.7^\circ$,
 - $Q = 5.13 \text{ AU}$, $P = 5.43 \text{ yr}$
 - Already selected as a target:
 - Rosetta, Comet Hopper, Others?
 - Strong possibility of being a future target



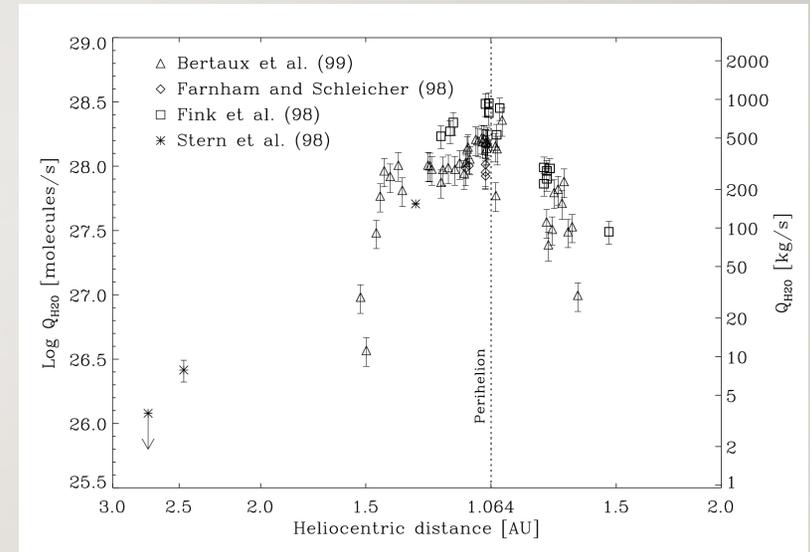
Why Now?

- 2018 is an historic apparition!
- Close approach to Earth - 0.077 AU
 - 16 December 2018
 - One of the closest comets in modern era
 - Observing conditions are better than for other comets
- Comet will be bright
 - Predicted to reach naked eye brightness
- Geometric conditions allow long-duration observations
 - Up for many hours over most of a year,
 - Pre- and post-perihelion, North and South
- Excellent opportunity to characterize its behavior, learn about the comet and reduce risk and cost of future comet missions
- **Observing proposal deadlines are coming up!**



What do we know now?

- Effective radius 0.58 km [Schulz & Schwehm 1999]
 - Axial ratio > 1.4 (HST lightcurve amplitude)
- Activity
 - $Q(\text{H}_2\text{O})_{\text{peak}} \sim 1\text{-}3 \times 10^{28} \text{ sec}^{-1}$
 - Suggests Wirtanen is a hyperactive comet
 - Active fraction $\sim 50 - 100\%$
 - $A_{\text{fp}}_{\text{peak}} \sim 150 \text{ cm}$ (less dusty than Hartley 2)
 - No secular changes over last few apparitions
 - Carbon-chain taxonomy: “Typical” [Farnham & Schleicher 1998]



What do we know now?

- Rotation (Aug 1996, ~200 days pre-perihelion)

- 7.6 hr [Meech et al. 1997]

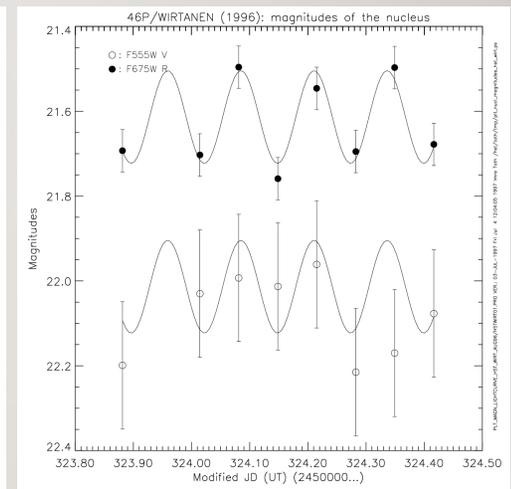
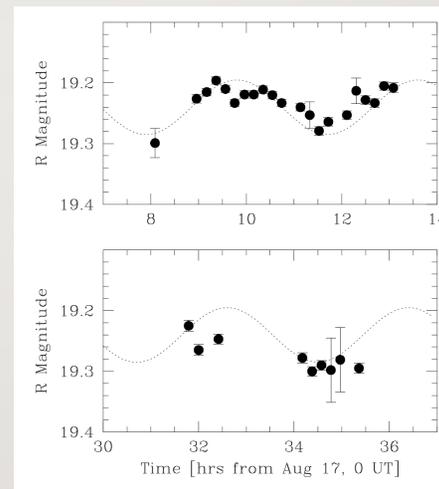
- “Possible rotation”, double peaked
- Amplitude 0.045 mag

- 6.0 hr [Lamy et al. 1998]

- Large uncertainty – 8 data points
- Amplitude 0.22 mag

- Not enough data to evaluate details

- No spin pole orientation
- Samarasinha et al. (1996) suggest it is likely to be in a NPA rotation state



Wirtanen Campaign

- Objective:
 - **Provide a central clearinghouse for basic information regarding comet 46P/Wirtanen to encourage and facilitate the acquisition, analysis and interpretation of observations, and to promote collaborations between researchers.**
- Based on the 2012 S1 ISON and 2013 A1 Siding Spring observing campaigns
- 46P Campaign Home Page: wirtanen.astro.umd.edu **Live now!**
 - Developed and tested using 45P, 41P and especially 2012 TC4

Web site content

- General history as well as highlights about the 2018 apparition
- Currently known physical characteristics of 46P/Wirtanen
- Geometric observing conditions for different sites
- Current events, status and secular lightcurve (when observed again)
- Interesting results and events that might be of interest to the community
 - Gallery of submitted images and plots
- Text that can be used as a basis for justification in observing proposals (planned)
- Links to other relevant sites of interest
- Information about Wirtanen observations

General Observation Strategies

- Maximize temporal coverage throughout the apparition
 - Obtain measurements as a function of time, whenever possible
 - Characterize long-term secular behavior
 - Characterize rotational phase dependence
- Exploit close approach
 - Obtain very high spatial resolution measurements
 - Obtain data that require a bright comet
 - Investigate the inner coma environment

Observation Plan Log

- Record of the planned and collected observations of comet Wirtanen
 - Allow proposals to complement other observations
 - Prompt collaborations and interaction between observers
- Linked from the main Campaign web page
 - Collect information about Wirtanen observations (voluntary submission)
 - Dates, observatories, instruments etc.
 - Status (proposed, scheduled, and/or completed)
 - Different formats for displaying the information (list, calendar, etc)

Current Observing Plans

- Awarded time:
 - Chandra/HST coordinated observations (Bodewits) Dec 2018
 - Zwicky Transient Facility (ZTF, UM group + others)
 - Images the sky every 3 days, providing long-term monitoring of comets
- Proposed
 - SWIFT (Bodewits) Dec 2018
 - Transiting Exoplanet Survey Satellite (TESS, Farnham)
 - Monitors $24^\circ \times 96^\circ$ sectors of sky with 30 min cadence for 27+ days

Current Observing Plans

- Other plans that I'm aware of (no details)
 - Goldstone (Lance Benner)
 - TRAPPIST (Emmanuel Jehin)
 - Ultraviolet and Visual Echelle Spectrograph (UVES, Emmanuel Jehin)
 - LCOGT (Bodewits et al.)
 - DCT (Lowell & UM groups)