

# Comet 46P/Wirtanen Observing Campaign

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50<sup>th</sup> Division for Planetary Sciences Meeting  
23 October 2018



# Preliminary Announcements

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- 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

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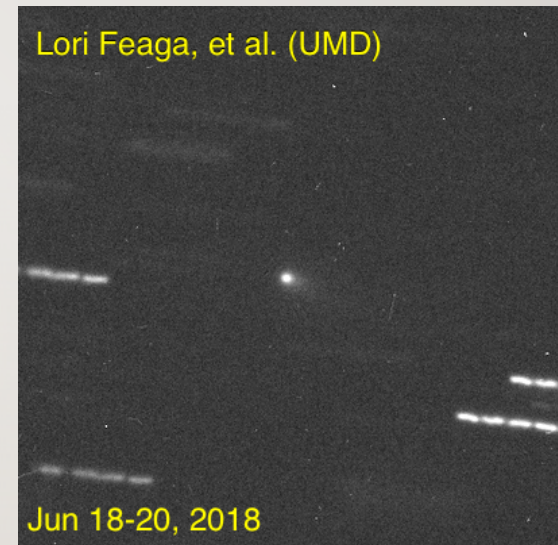
- Pronounced **WERE-tuh-nun**
  - Confirmed by multiple sources from Lick Observatory who worked with Carl and Edie Wirtanen



# Current Status

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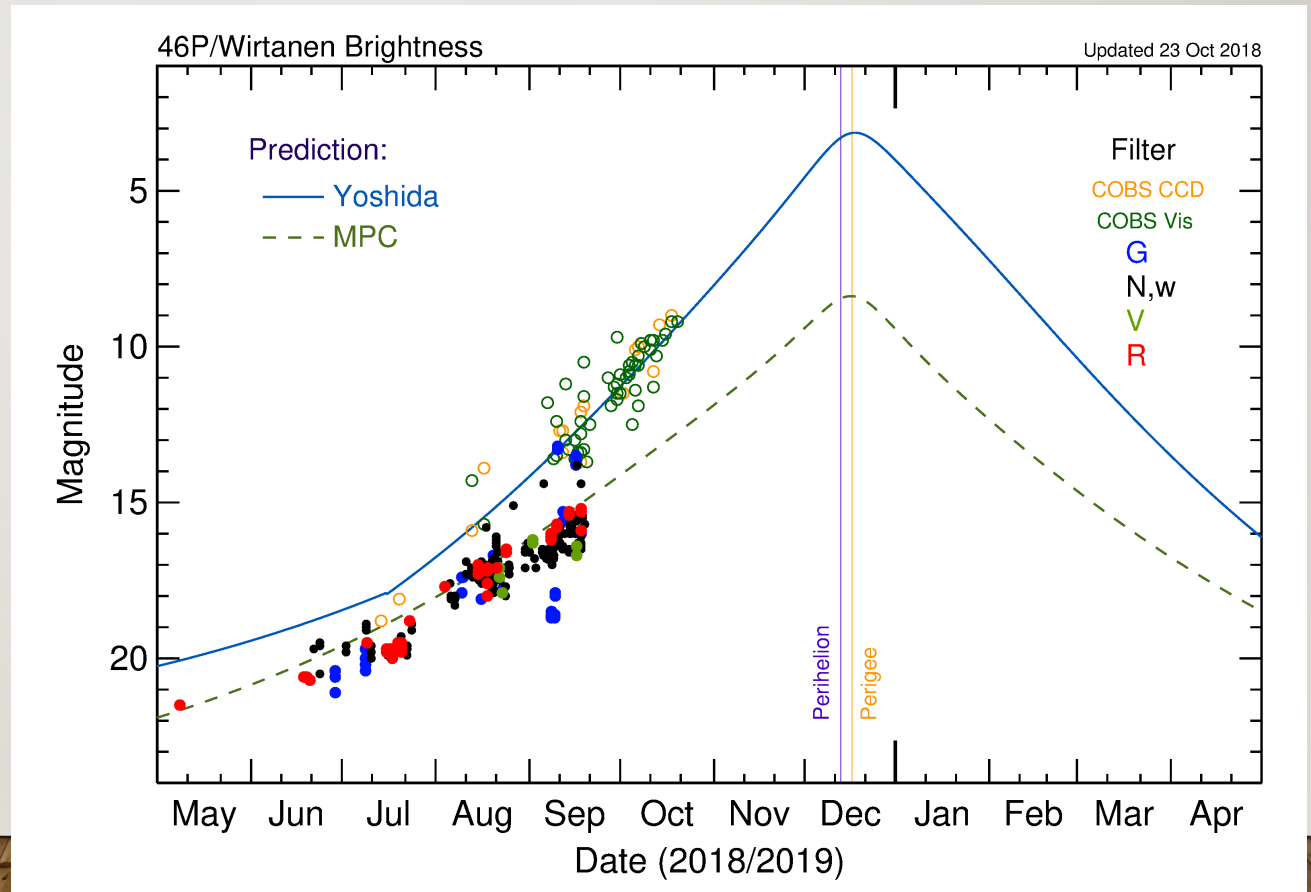
- Recovered 18 Jun 2018
- Now ~53 days to close approach
  - Moving South until early Nov ( $-33^\circ$ )
  - Rapidly accelerates North through C/A
  - Perihelion: 12 Dec 2018
  - C/A: 16 Dec 2018 (near opposition)
- Currently no non-gravitational forces detected





# 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

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- May be starting to exhibit coma structure

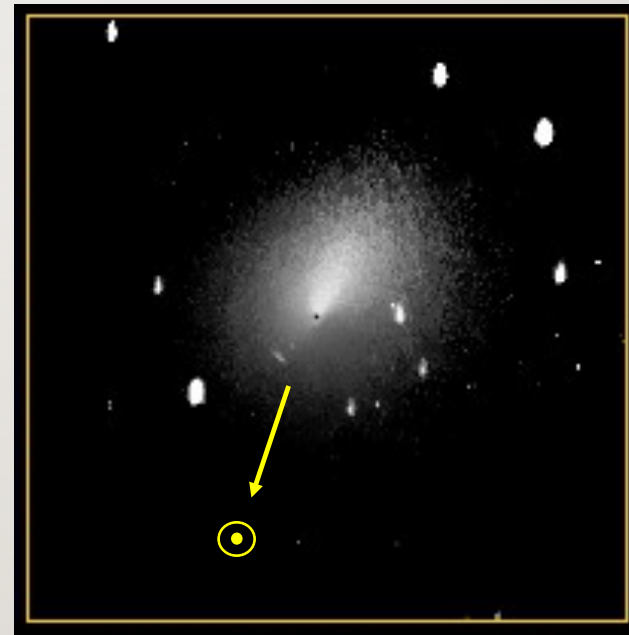
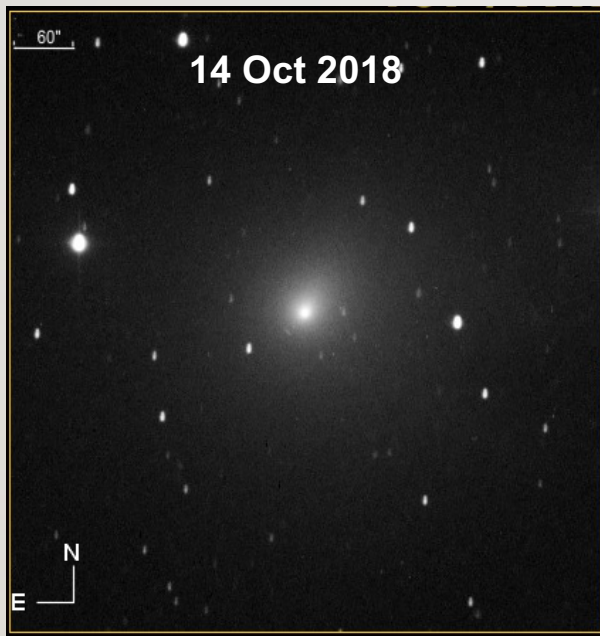


Image from Erik Bryssinck

# Dust/Gas Detections

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- 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, C<sub>2</sub>, NH<sub>2</sub>?, O(1D) and O(1S)
  - Mount Abu IR Obs. Spectra (Venkataramani) -- CN, C<sub>2</sub>, C<sub>3</sub>, NH<sub>2</sub>?, O(1D)?
  - DCT HB Filters (Feaga) -- CN, C<sub>2</sub>
- Currently: Diffuse, gas-rich coma

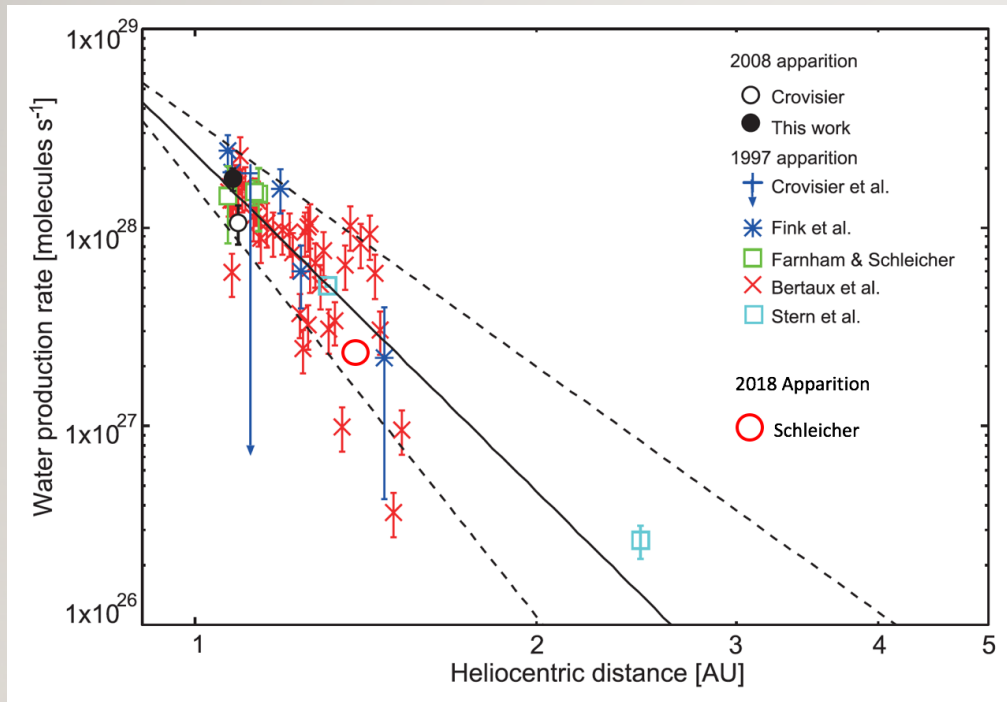
# Production Rates

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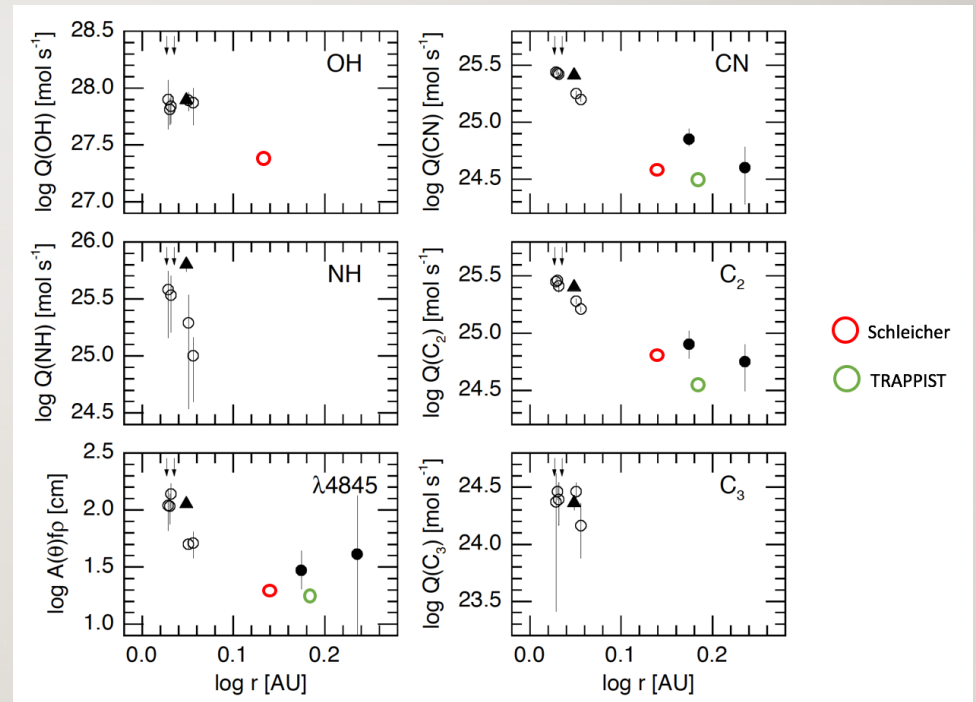
- TRAPPIST (Jehin) – 17 Sep 2018
  - $r_h = 1.53 \text{ AU}$ ,  $\Delta = 0.60 \text{ AU}$ , 5000 km aperture
  - $Q(\text{C}_2) = 3.4 \times 10^{24} \pm 5.9 \times 10^{22} \text{ mol/s}$
  - $Q(\text{CN}) = 3.2 \times 10^{24} \pm 5.6 \times 10^{22} \text{ mol/s}$
  - No OH detected
- Lowell Observatory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



# Production Rate Comparisons



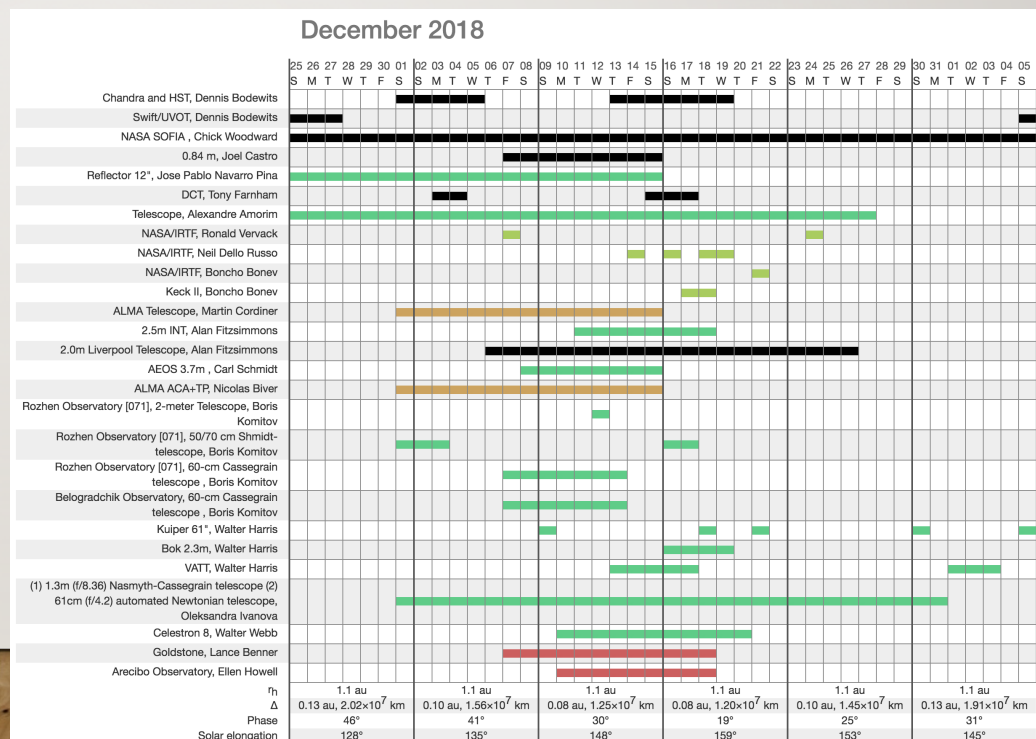
Adapted from Kobayashi and Kawakita 2010



Adapted from Farnham & Schleicher 1998

Campaign – [wirtanen.astro.umd.edu](http://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

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- 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

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- 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

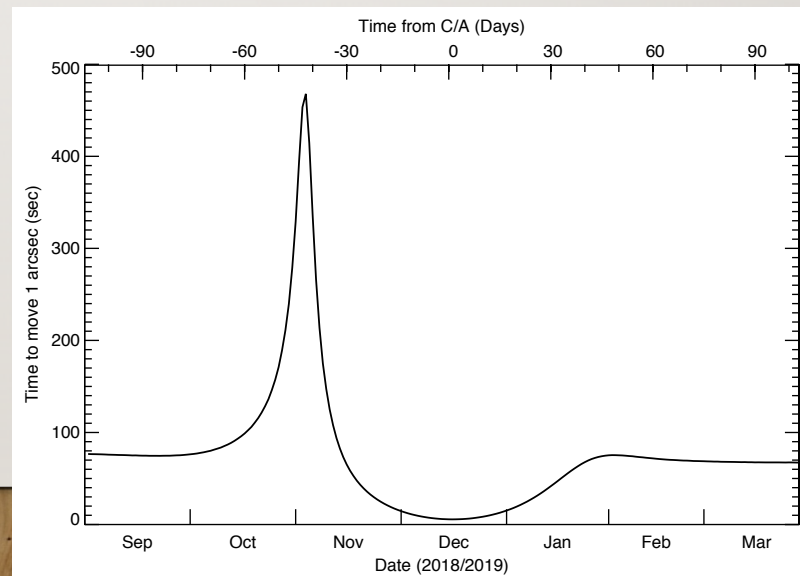
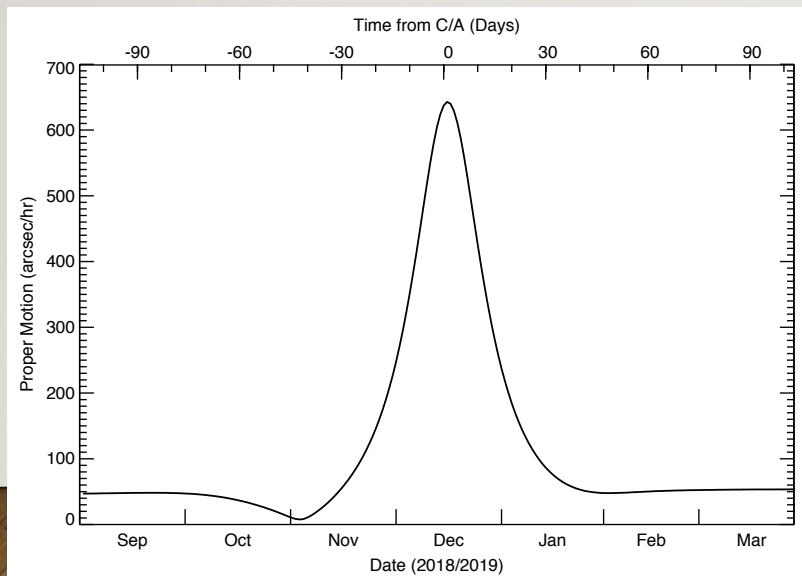


J. Tilbrook, The PACA project



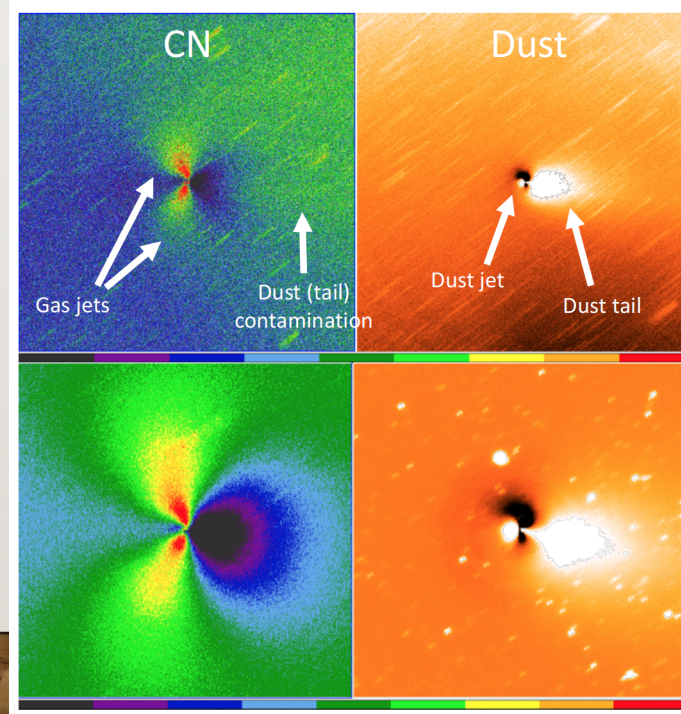
# Citizen Science Contributions

- 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

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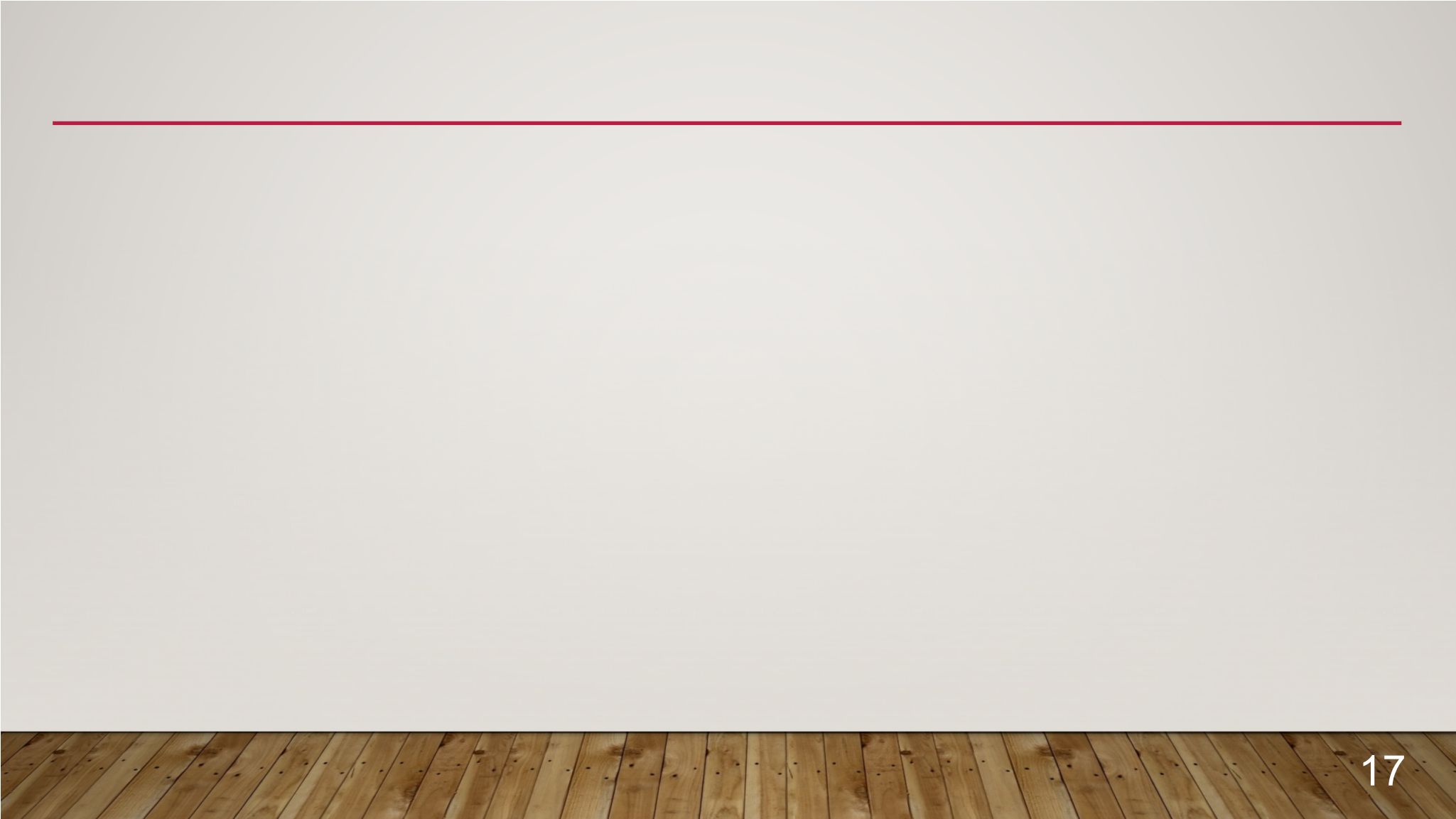
- 4\*P/ Coma Observing Campaign ([www.psi.edu/41P45P46P](http://www.psi.edu/41P45P46P) Nalin Samarasinha)
  - Professional and high level amateurs contribute images of the coma for long duration monitoring of the coma morphology
- Amateur Observers' Campaign ([aop.astro.umd.edu](http://aop.astro.umd.edu)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

# Discussions / Comments

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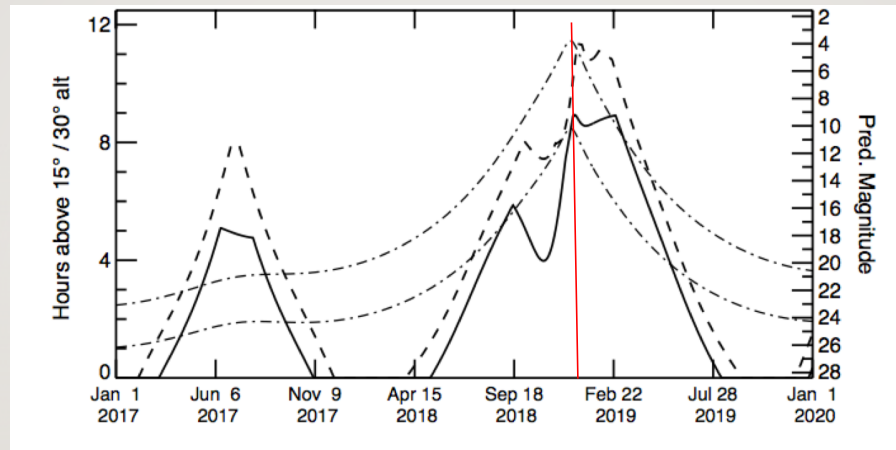
- Remember to input your observing plans to the campaign website
  - [wirtanen.astro.umd.edu](http://wirtanen.astro.umd.edu)
- Questions
- Support observations
  - Context observations
  - Need/want contemporaneous observations to maximize science?



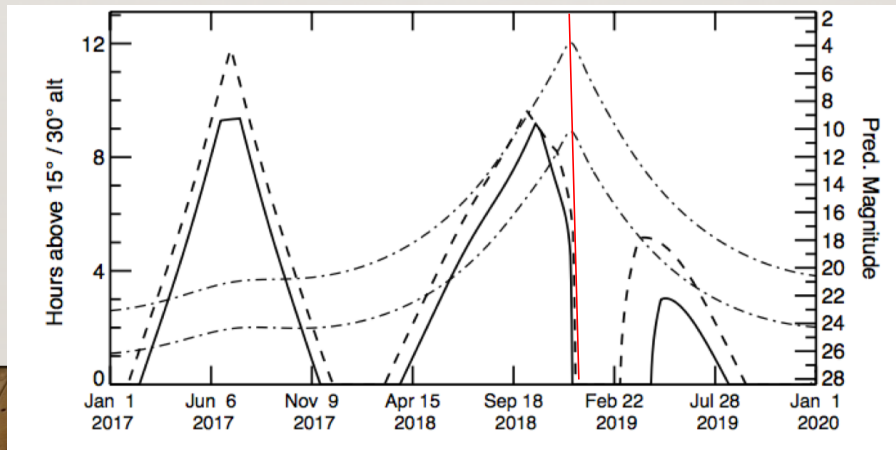


# Wirtanen Visibility

MKO  
(North)

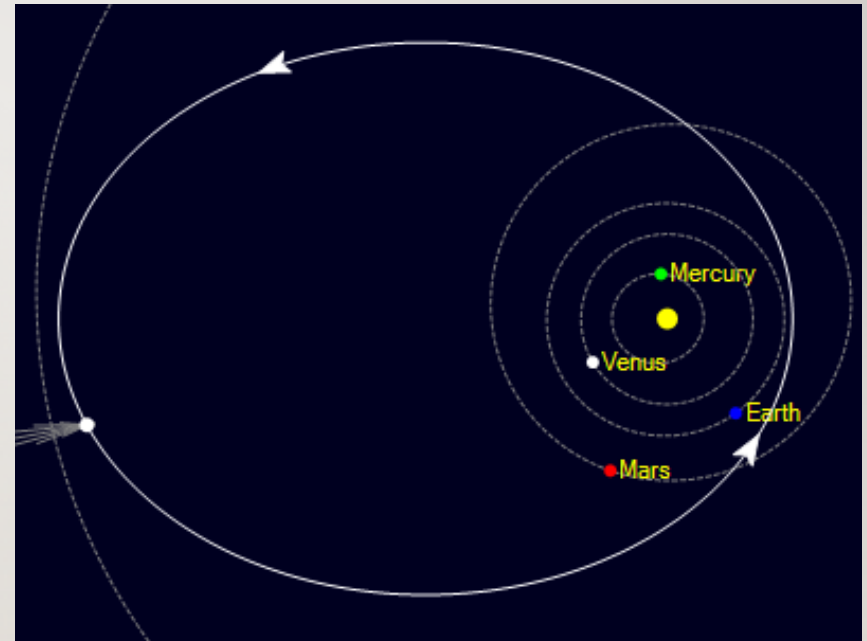


CTIO  
(South)



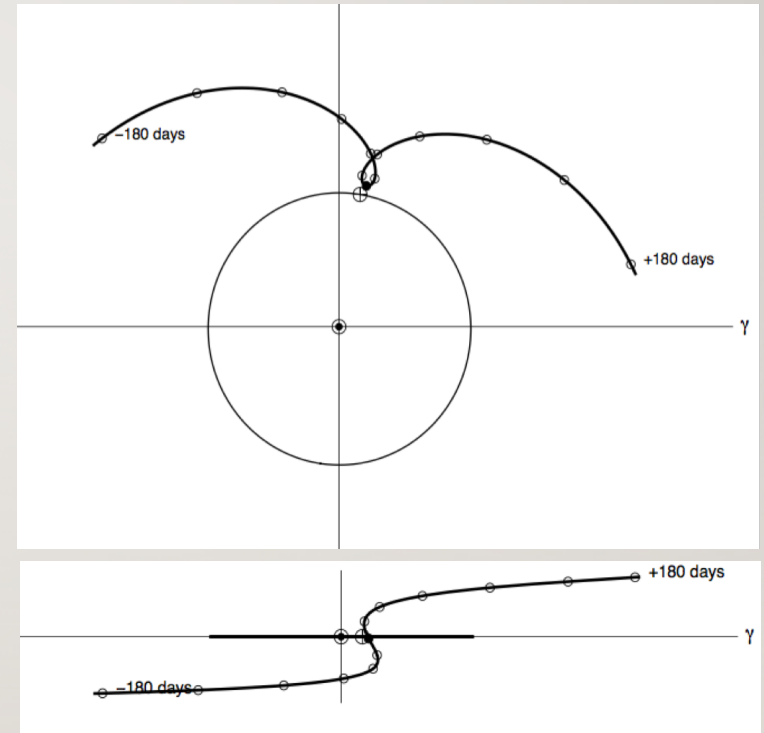
# Why is Comet Wirtanen Special?

- 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?

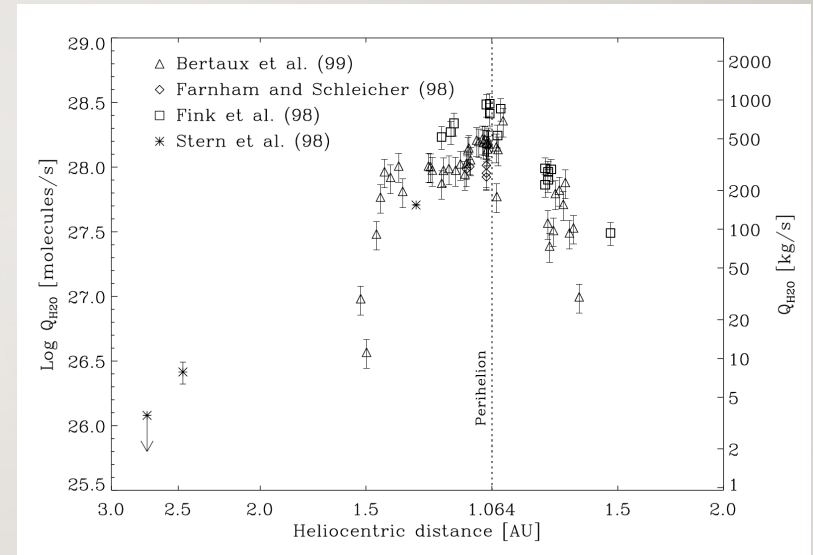
- 2018 is an historic apparition!
- Close approach to Earth - 0.077 AU
  - 16 December 2018
  - One of the closest comets in modern era
  - Observing conditions are better than for other comets
- Comet will be bright
  - Predicted to reach naked eye brightness
- Geometric conditions allow long-duration 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!





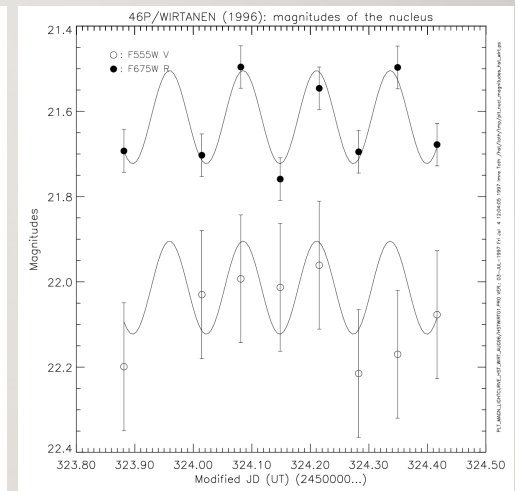
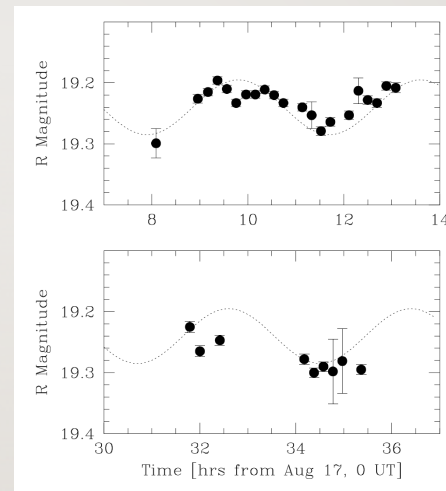
# What do we know now?

- 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  $\sim 50\text{--}100\%$
  - $A_{\text{fp}}_{\text{peak}} \sim 150 \text{ cm}$  (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

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- 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](http://wirtanen.astro.umd.edu) **Live now!**
  - Developed and tested using 45P, 41P and especially 2012 TC4

# Web site content

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- 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

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- 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

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- 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

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- 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

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- 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)