EPSC Abstracts
Vol. 13, EPSC-DPS2019-1035-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Narrowband Observations of Comet 46P/Wirtanen During its Exceptional Apparition of 2018/19: Gas Jet Morphology and Rotation Period

Matthew M. Knight (1), Tony L. Farnham (1), David G. Schleicher (2), Lori M. Feaga (1), Dennis Bodewits (3), Josephine Schindler (2), Brian A. Skiff (2);
(1) University of Maryland, Maryland, USA, (2) Lowell Observatory, Arizona, USA, (3) Auburn University, Alabama, USA (mmk8a@astro.umd.edu)

Abstract

An extensive observing campaign was successfully conducted for Comet 46P/Wirtanen during its excellent recent apparition of 2018/19 using several telescopes at Lowell Observatory. Narrowband imaging was obtained over a three-month interval, revealing two CN gas jets throughout the apparition. Their motion and repetition allowed us to determine a rotation period near 9 hr in early November. We continued to obtain sufficient data to constrain the rotation period through early February and detect little to no change. We see no rotational variation in dust images. C_3 exhibits a similar morphology to CN, while OH shows a different spatial distribution. Analyses are ongoing and new results will be presented.

1. Introduction

In late 2018, Comet 46P/Wirtanen had its best apparition since its discovery in 1948, approaching to within 0.08 AU of Earth at closest approach and remaining within 0.20 AU for two months. As ESA's original *Rosetta* target, Wirtanen attracted further interest due to attempts to characterize its properties at earlier apparitions. Our own goals for this apparition included (1) obtaining narrowband photometry to determine gas and dust production rates over a much larger range of heliocentric distances than ever before and to look for possible secular trends, (2) acquire narrowband imaging to look for possible jet morphology and, if present, determine Wirtanen's rotation period and inter-compare the morphology of different species, especially in the inner coma at high spatial resolutions, and (3) perform modeling of any jet morphology to determine other physical properties such as the orientation of the rotation pole, the location of source regions producing the observed jets, and outflow velocities (and acceleration in the inner coma due to the very small geocentric distance) as a function of distance from the nucleus. In this talk we present imaging results; the photometry studies and preliminary jet modeling are presented in the associated talk by [6].

2. Observations

We obtained imaging useful for morphological assessment on 43 nights from 2018 October 28 through 2019 February 9 using Lowell Observatory's 4.3-m Discovery Channel Telescope (DCT), Hall 42-inch (1.1-m) telescope, and 31-inch (0.8-m) telescope. Broadband images using *R* or *SDSS-r'* and narrowband images using a CN filter from the standard HB comet set [2] were acquired on all nights. Additional observations were acquired in one or more narrowband gas (OH, NH, C_2, C_3), ion (CO+), and/or continuum (UC, BC, RC) filters on a total of 15 nights when the comet was brightest and conditions were favorable.

3. CN Coma Morphology

As expected, given their presence in most bright comets viewed at moderate spatial scales, gas jets were detected in Wirtanen and the species having the most evident jets was CN. Two jets were distinguished throughout the apparition and their motion during a night and repetition from night to night allowed us to determine a rotation period near 9 hr during November 1–4 [3]. We have sufficient data to determine the rotation period during numerous epochs from early November through early February. These observations span perihelion, allowing us to look for changes with the comet's activity.

Preliminary analyses suggest little to no change in the rotation period during this interval. We tentatively do not find a rotation period as long as the 9.19 hr reported from a CN lightcurve during December 9–10 [4], though the rapid change in viewing geometry at this time has not yet been taken into account

in our imaging analyses. This rapid viewing geometry change is extremely helpful for our ongoing Monte Carlo jet modeling analyses which will be presented by [6] and should yield the underlying sidereal period.

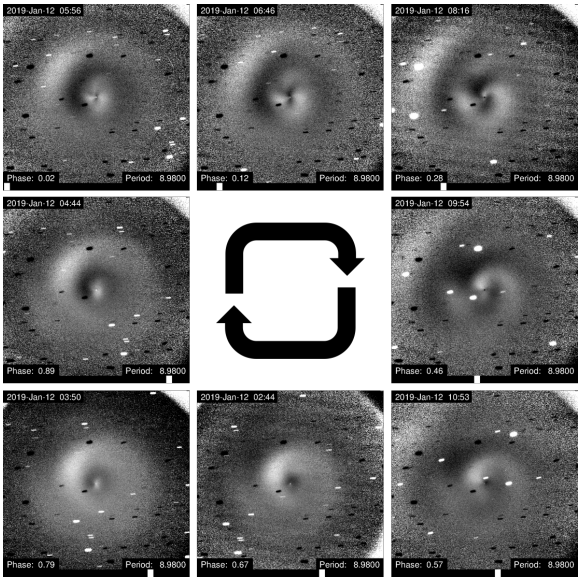

Figure 1: Rotational sequence of CN images enhanced by removal of an azimuthal average from 2019 January 12 phased to a preliminary period of 8.98 hr. Each image is 30,000 km across at the comet and is centered on the nucleus. North is up and east is to the left.

4. Comparison of Morphology of Dust and Other Gas Species

In addition to our extensive CN imaging, we acquired observations of dust, OH, and C_3 sufficient to investigate their spatial distributions. The dust morphology, as assessed in both broadband *R* and narrowband continuum filters was dominated by the dust tail and did not resemble any gas species. We did not detect rotational variation in the dust images, which is surprising given that the spatial resolution was as high as $\sim$57 km/arcsec. This suggests that the CN jets lack dust, that the dust is not accelerated to very high velocities, or that some other mechanism is smearing out any jet signatures.

High quality images of OH and C_3 are harder to obtain than for CN because they are generally much fainter (OH) and because they require photometric conditions in order to be properly decontaminated (C_3), while CN generally does not. C_3 exhibited similar morphology to CN, with two jets evident and at similar position angles. OH did not exhibit obvious jets, but instead displayed a diffuse, nearly hemispheric brightness enhancement near the tailward direction that we attribute to the presence of icy grains. We have found similar morphology between the carbon-bearing species and a very different OH distribution in other recent comets (103P/Hartley 2 by [5]; C/2007 N3 Lulin by [1]), suggesting that these behaviors are associated with evolutionary processing at or near the surface of the nucleus.

5. Conclusions

A highly successful observing campaign was conducted by our team on comet 46P/Wirtanen during its recent apparition. Imaging revealed two CN gas jets that we have used to measure the rotation period over three months. The spatial distributions of CN and C_3 are similar to each other but very different from OH or dust. These and other results will be presented.

Acknowledgements

We gratefully acknowledge Uwe Konopka, Carrie Holt, and Larry Wasserman for assisting with some of the observations. This work was supported by NASA Solar System Observations Program grant 80NSSC18K0856, NSF award AST1852589, and Cycle 25 Chandra/HST Program GO-15372. These results made use of the Discovery Channel Telescope at Lowell Observatory.

References

[1] Bair, A.N., Schleicher, D.G., and Knight, M.M. Coma Morphology, Numerical Modeling, and Production Rates for Comet C/Lulin (2007 N3). AJ, 156, 159 (2018)

[2] Farnham, T.L., Schleicher, D.G., and A'Hearn, M.F. The HB Narrowband Comet Filters: Standard Stars and Calibrations. Icarus 147, 180–204 (2000)

[3] Farnham, T.L., Knight, M.M., and Schleicher, D.G. Comet 46P/Wirtanen. CBET 4571 (2018)

[4] Jehin, E., et al. Comet 46P/Wirtanen. CBET 4585 (2018)

[5] Knight, M.M., and Schleicher, D.G. The Highly Unusual Outgassing of Comet 103P/Hartley 2 from Narrowband Photometry and Imaging of the Coma. Icarus, 222, 691–706 (2013)

[6] Schleicher, D.G., et al. Narrowband Observations of Comet 46P/Wirtanen During its Exceptional Apparition of 2018/19: Photometry, Jet Morphology, and Modeling Results. EPSC-DPS Joint Meeting 2019