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Narrowband Observations of Comet 46P/Wirtanen During its Exceptional Apparition of 2018/19: Photometry, Jet Morphology, and Modeling Results.

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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. Gas and dust production rates were determined throughout the apparition, while narrowband imaging was obtained over a three-month interval. Two CN gas jets were detected, and modeling of these jets is on-going.

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 results from the photometry studies and preliminary jet modeling; imaging results are presented in the associated talk by [4].

2. Photometry Observations and Results

A total of 39 sets of narrowband photoelectric photometry were obtained over nine nights for comet Wirtanen, beginning on 2018 Oct 6 ($r_{\rm H}$ = 1.38 AU) and concluding on 2019 Mar 26 ($r_{\rm H}$ = 1.66 AU) using the Hall 42-inch (1.1-m) telescope at Lowell Observatory. Standard HB comet filters [3] were utilized to isolate emission from OH, NH, CN, C_3, and C_2, along with reflected light from dust grains with the UC, BC, and GC continuum filters. The three carbon-bearing species all exhibit similar heliocentric distance dependencies, with little to no asymmetry before/after perihelion. Dust behavior is also similar, after adjusting for aperture trends and phase angle effects. In contrast, both OH and NH exhibit steeper $r_{\rm H}$-dependencies, along with a pre-/post-perihelion asymmetry where these production rates were systematically lower as Wirtanen moved away from the Sun. Overall, these results strongly imply a compositional heterogeneity between the two source regions identified in our modeling. However, the derived compositional class remains "typical" throughout (as defined by [1]), the same category as we found during the 1990s [2]. Finally, when comparing our gas production rates with those we obtained at three previous apparitions (1991, 1997, 2007/08), it is clear that gas production rates were significantly lower in the most recent apparition, and there is some evidence for a continuing downward trend over nearly 30 years, suggesting a possible loss of volatiles (see Figure 1).

3. CN Jet Modeling

As expected, given their presence in most bright comets viewed at moderate spatial resolutions, gas jets were detected in Wirtanen and the species having the most evident jets was CN. As discussed in detail by [4], two jets were distinguished throughout the appari-

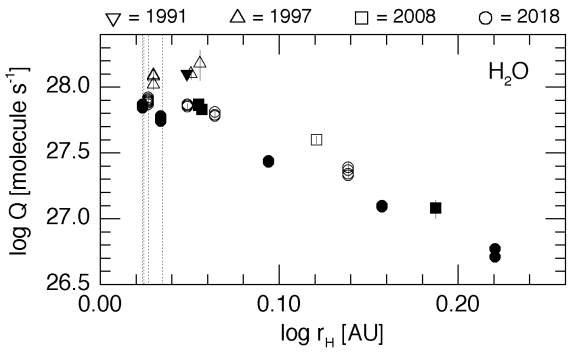

Figure 1: The logarithm of water production rates, based on OH measurements, are plotted as a function of log of the heliocentric distance. Four apparitions of comet Wirtanen, all obtained at Lowell Observatory, are shown. Note the general secular decrease, by just a factor of 2 in less than 30 years. Also note the pre-/post-perihelion asymmetry evident at this most recent apparition (open symbols are prior to perihelion, filled symbols following).

tion and a rotation period near 9 hr was determined. The very close approach to Earth provided a rapid change in viewing geometry in the weeks surrounding perigee (2018 December 16), with a slower variation near either end of the apparition. This combination was nearly ideal for modeling, and we utilized the Monte Carlo jet model created by Schleicher and Farnham (cf. [5]) to attempt to match the observed jets over a three-month interval. A preliminary solution for the orientation of the rotation axis has been determined, along with the location of two large source regions. Gas outflow velocities and acceleration will be tightly constrained. Modeling is continuing, and final results are anticipated by the time of the meeting.

4. Conclusions

A highly successful observing campaign was conducted by our team of Comet 46P/Wirtanen during its recent apparition. Production rates were determined over a much larger range of heliocentric distances than ever before, and clear evidence of secular fading is seen over our nearly 30-year interval of observations covering multiple apparitions. Imaging revealed two gas jets that we have used to tightly constrain the orientation of the nucleus and the location of the source regions that produce the observed jets. These and other results will be presented.

Acknowledgements

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References

[1] A'Hearn, M. F., Millis, R. L., Schleicher, D. G., Osip, D. J., and Birch, P. V. (1995) The Ensemble Properties of Comets: Results from Narrowband Photometry of 85 Comets, 1976–1992. *Icarus* 118, 223–270.

[2] Farnham, T. L., and Schleicher, D. G. (1998) Narrowband Photometric Results for Comet 46P/Wirtanen. *Astron. Astrophys.* 335, L50-L55.

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

[4] Knight, M. M., Farnham, T. L., Schleicher, D. G., Feaga, L. M., Bodewits, D., Schindler, J., and Skiff, B. A. (2019) Narrowband Observations of Comet 46P/Wirtanen During its Exceptional Apparition of 2018/19: Gas Jet Morphology and Rotation Period. EPSC-DPS Joint Meeting 2019.

[5] Schleicher, D. G., and Woodney, L. M. (2003) Analyses of Dust Coma Morphology of Comet Hyakutake (1996 B2) Near Perigee: Outburst Behavior, Jet Motion, Source Region Locations, and Nucleus Pole Orientation. *Icarus* 162, 190–213.