

A Comet Active Beyond the Crystallization Zone

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Abstract

We discuss activity of the in-bound long-period comet C/2017 K2 (PANSTARRS) at record heliocentric distances of 16 and 24 AU [1, 2, 3]. At these distances, nucleus temperatures are too low either for water ice to sublime or for amorphous ice to crystallize, requiring another source for the observed activity. Using the Hubble Space Telescope we find a sharply-bounded, circularly symmetric dust coma 10^5 km in radius, with a total scattering cross section of $\sim 10^5$ km². The coma has a logarithmic surface brightness gradient -1 over much of its surface, indicating sustained, steady-state dust production. A lack of clear evidence for the action of solar radiation pressure suggests that the dust particles are large, with a mean size > 0.5 mm. Using a coma convolution model, we find a limit to the apparent magnitude of the nucleus $V > 25.2$ (absolute magnitude $H > 12.9$). With assumed geometric albedo $p_V = 0.04$, the limit to the nucleus circular equivalent radius is < 9 km. While neither water ice sublimation nor exothermic crystallization can account for the observed distant activity, the measured properties are consistent with activity driven by sublimating supervolatile ices such as CO₂, CO, and N₂. Survival of supervolatiles at the nucleus surface is likely a result of the comet's recent arrival from the frigid Oort cloud.

References

- [1] Jewitt, D., Hui, M.-T., Mutchler, M., et al. 2017, Ap. J., 847, L19
- [2] Hui, M.-T., Jewitt, D., & Clark, D. 2018, A. J., 155, 25
- [3] Meech, K. J., Kleyana, J. T., Hainaut, O., et al. 2017, Ap. J., 849, L8

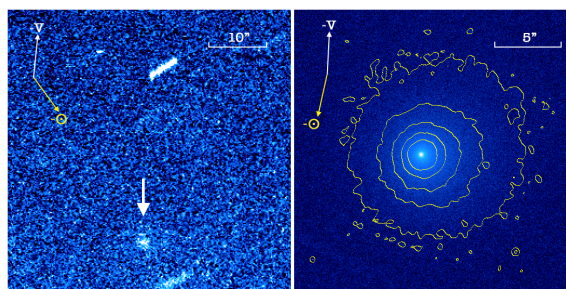


Figure 1: Left: Predisccovery CFHT image of C/2017 K2 (arrow) from UT 2013 May 12 at 23.765 AU. Right: HST image from UT 2017 Jun 27 at 15.874 AU. The antisolar ($-\odot$) and negative velocity ($-V$) vectors are marked. Both images have North to the top, East to the Left).

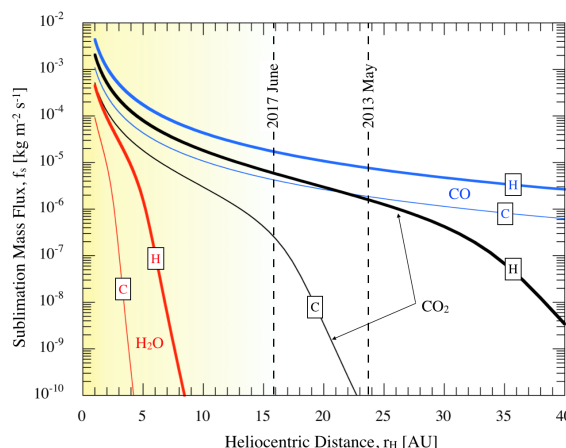


Figure 2: Specific sublimation rates as a function of heliocentric distance for three ices: (red) H₂O, (black) CO₂ and (blue) CO. Sublimation rates for the minimum (labeled C for “cold”) and maximum (H for “hot”) possible temperatures are indicated by thin and thick lines. The shaded region shows the heliocentric distances where crystallization is possible.