Characterization of the dust and volatiles around C/2014 UN271 Bernadinelli-Bernstein at 19 au

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1. Background and Takeaways

Background

Long-period Comet C/2014 UN271 (Bernardinelli-Bernstein) provides an unusual opportunity for us to probe cometary history and behavior. It is very large (>100 km nucleus diameter [1,2]); it will be visiting the Saturnian area of our planetary region for possibly the first time [3,4]; it has a perihelion (11 au) that means it will never enter the water-sublimation zone; and it was discovered early enough that we may eventually establish a multi-decade record of its behavior. Our current goal is to use dust production behavior to constrain the activity driver (e.g. CO, CO2, NH3).

Takeaways

We have several datasets we are currently processing to assess dust production.

1. visible spectroscopy (not shown here),
   Dec. 8, 2021, rh = 19.56 au.
2. r' band imaging (Fig. 1),
   Dec. 10, 2021, rh = 19.55 au.
3. near-IR spectroscopy (not shown here),
   Dec 28, 2021, rh = 19.49 au.
4. multiband imaging (Figs. 2 and 3),
   Jan. 11, 2022, rh = 19.44 au.
   Mar. 28, 2022, rh = 19.16 au.

We also have forthcoming HST imaging and JWST NIRSpec spectroscopy.

References: [1] Lellouch et al. 2022, A&A 659, L1. [2] Hui et al. 2022, ApJL 929, L12. [3] CBET 4983. [4] Bernardinelli et al. 2021, ApJL 921, L37. [5] Farnham et al. 2021, PSJ 2, 236. [6] Kelley et al. 2022, ApJL 933, L44. [7] A'Hearn et al. 1984, AJ 89, 579. [8] Szabo et al. 2008, ApJ 677, L121. [9] Womack, M. et al., 2021, PSJ 2, 17.

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2. HST Imaging

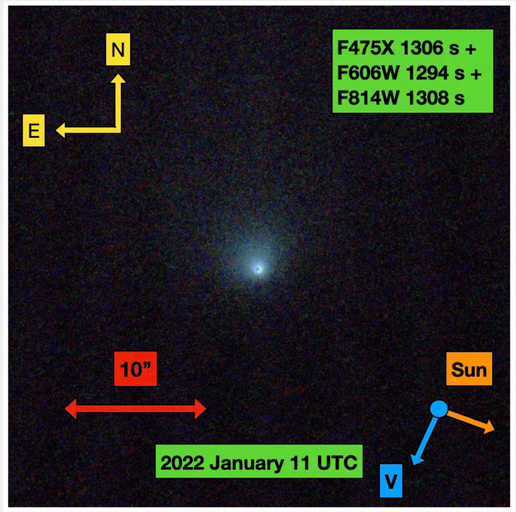

Figure 1. Three-color HST/WFC3 image of UN271 from January 11, 2022. Filter and exposure time info is in the upper right.

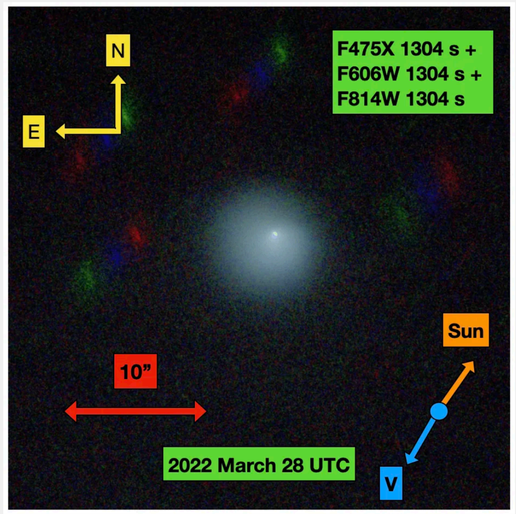

Figure 2. Same as Figure 1, but for 2 1/2 months later, on March 28, 2022.

3. Dust Dynamics

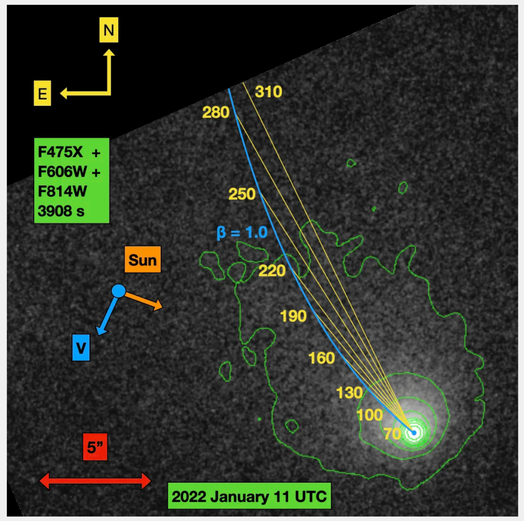

Figure 3. Syndynes and synchrones onverlaid on the image from Fig.1 . Blue line is the β=1 syndyne, so shows the axis for roughly ~1 μm grains. Yellow lines show synchrones from 70 to 310 days. UN271's tail seems to align fairly well with the syndyne.

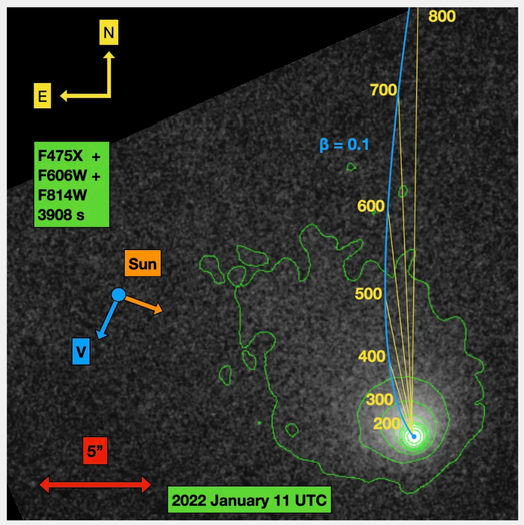

Figure 4. As Fig. 3, but the blue line is the β=0.1 syndyne, so represents roughly ~10 μm grains, and yellow lines show synchrones from 200 to 900 days.

4. Nucleus extraction

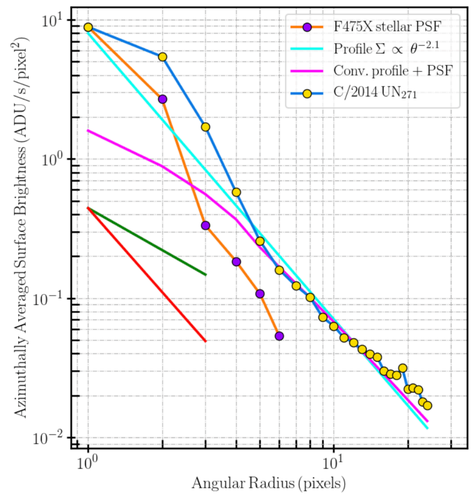

Figure 5. Average radial profile (yellow dots + blue line) of UN271 as seen in the F475X HST/WFC3 image that contributes to Fig. 2. Scale is 0.04 arcsec per pixel. Within the range plotted here, the power-law exponent of the coma's surface-brightness profile (outside the core) is -2.1 (light blue line), so it is steeper than canoncial. (For comparison, -1 and -2 power-law line segments are in the lower left.) The PSF's radial profile is also plotted (purple dots + orange line). The comet's radial profile is a combination of the coma plus the point-source nucleus, and an estimate of the coma's contribution to the radial profile is the magenta line. The difference between the comet profile and the coma profile is what we assign to the nucleus's contribution. Photometry of this residual yields an estimated nucleus diameter comparable to that reported by [1] and [2].

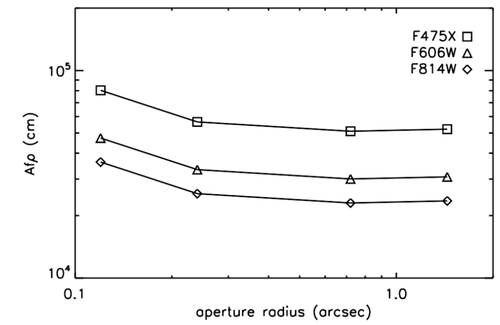

Figure 6. Afρ [7] in the three HST filters which correspond roughly to V, R, and I bands. For comparison, comet Hale-Bopp had Afρ of $3x10^5$ cm [8] when at 25.7 au from the Sun post-perihelion, and roughly 10^5 cm [9] when at 4-7 au from the Sun.