Water production rates and activity of interstellar comet 2I/Boriosv

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Background

+ 2I/Borisov is the first known active comet from outside the solar system. In late 2019, astronomers had a big observation "party" to explore similarities and differences between it and solar system comets.
+ NASA's Neil Gehrels Swift Observatory (Swift) has rapid response time and unique UV capabilities, which captured the comet's water production rates.

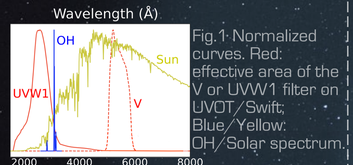


Fig.1 Normalized curves. Red: effective area of the V or UVW1 filter on UVOT/Swift; Blue/Yellow: OH/Solar spectrum.

+ For cometary study, water measurements always provide a very important context for other observations.

Observation

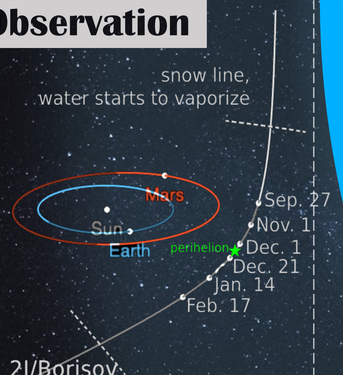


Fig.2 Swift observed 2I/Borisov for six times around the perihelion.

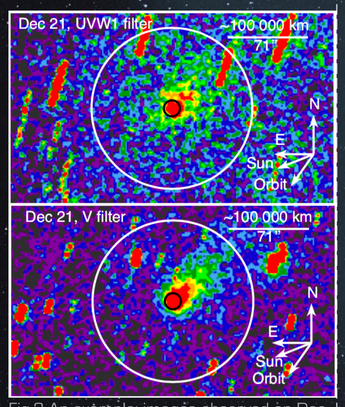


Fig.3 An example: images observed on Dec. 21. Up: UVW1 filter (to detect OH and dust), symmetric OH coma is obvious; Bottom: V filter (to detect dust), dust tail can be clearly seen.

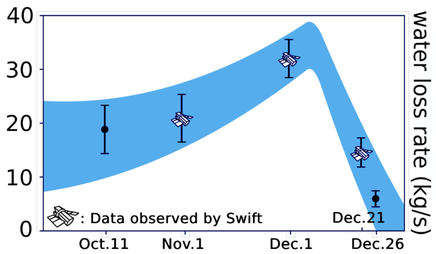
What does the first known active comet from another star look like?

We measured the comet's released water, and found it does not fit neatly into any class of solar system comets, also does not stand out exceptionally from them.

Detailed results...

① When closest to the Sun, the comet lost enough water to fill a bathtub in about 10 seconds, *a typical rate* of solar system comets.

② The comet's rise in water production as it approached the Sun is *similar* to previously observed objects.



③ When closest to the Sun, at least 55% of the surface was releasing water, which is about 10 times more than most solar system comets.

○ When moving away from the Sun, the comet's water production rate fell off faster than any other comet yet observed.

○ During its trip through the solar system, the comet lost enough water to fill over 92 Olympic-size swimming pools.

○ The comet's chemical inventory and most of abundances are *similar* to carbon-depleted comets, a kind of home-grown comets.

Methods

+ For every visit and each filter, we co-add images to increase signal-noise ratio;
+ Obtain OH images by image subtraction: UVW1 (OH+dust) – V (dust) = OH;
+ Convert OH signals to OH column density profiles (Fig. 4);
+ Compare the profiles with the vectorial model (Fig. 4) to determine water production rates and dust color (reddening);

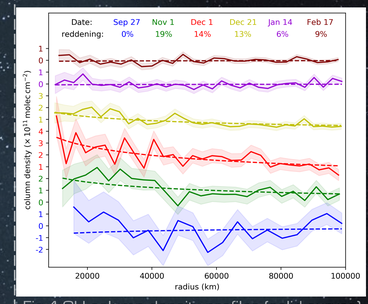


Fig.4 OH column density profiles (solid curves) and the vectorial model (dashed curves).

+ Determine minimum active area from water production rates; Estimate mass loss rate;
+ Calculate dust content (Afρ) by V-band aperture photometry.

Results&Conclusions

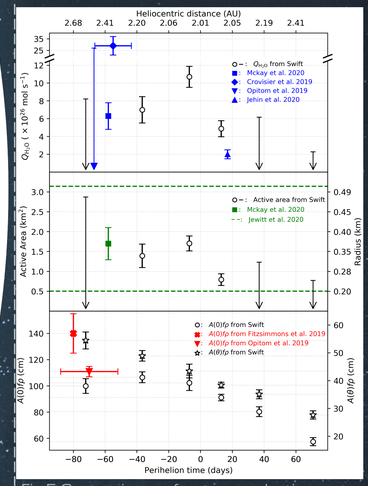


Fig.5 Comparisons of water production rates (Q_{H_2O}, top), active area (middle), and Afρ (bottom) among different observations.

+ 2I/Borisov is in many regards similar to solar system comets;
+ Its specific properties do not firmly place it within any single dynamical family;
+ Solar system comet taxonomy is generally biased towards brighter objects; 2I/Borisov is faint, and this may complicate comparisons.

References

1. Compared observations: shown in labels of Fig.5; 2. Orbit diagram: JPL/Horizons; 3. ① ③ graphics: Scott Wiessinger (NASA);

Thank you Swift!

Paper