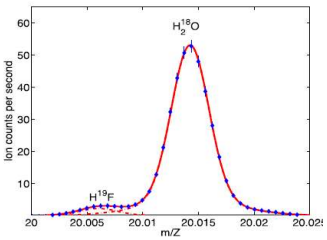
Hydrogen halides at Comet 67P/Churyumov-Gerasimenko & what they tell us about molecular clouds

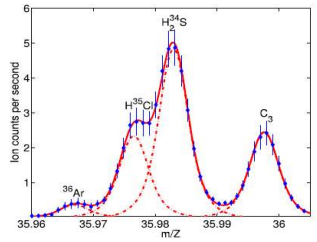
Johan De Keyser (1,2), Frederik Dhooghe (1), Andrew Gibbons (1,3)

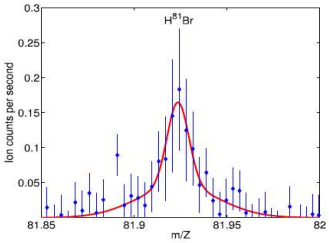
(1) Space Physics Division, Royal Belgian Institute for Space Aeronomy, Brussels, Belgium
(2) Center for mathematical Plasma Astrophysics, KULeuven, Heverlee, Belgium
(3) Service de Chimie Quantique et Photophysique, Université Libre de Bruxelles, Brussels, Belgium

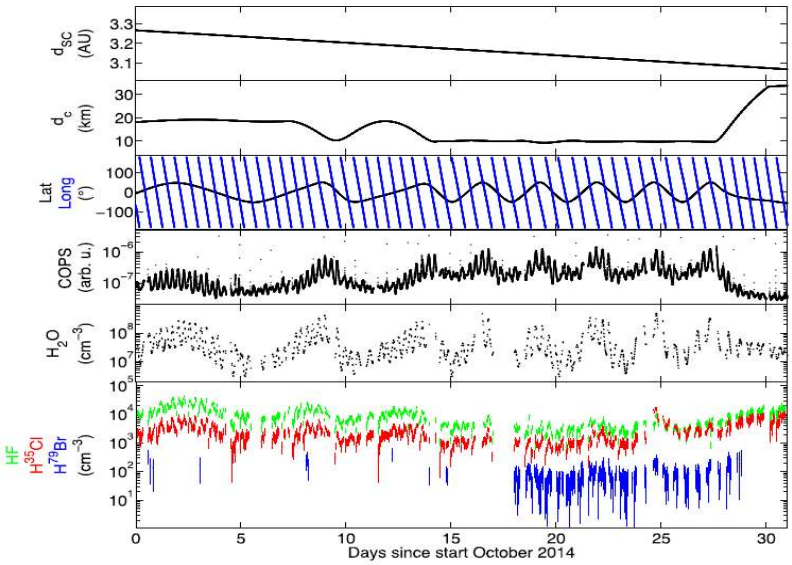
Observations

Rosetta studied comet 67P/Churyumov-Gerasimenko up close in 2014-2016. With the ROSINA/DFMS mass spectrometer we analyzed the coma gas. We discovered halogens in the form of the hydrogen halides HF, HCl, and HBr. $^{37}Cl/^{35}Cl$ = 0.29 ± 0.02 and $^{79}Br/^{81}Br$ = 0.92 ± 0.08 are typical solar system isotopic ratios.

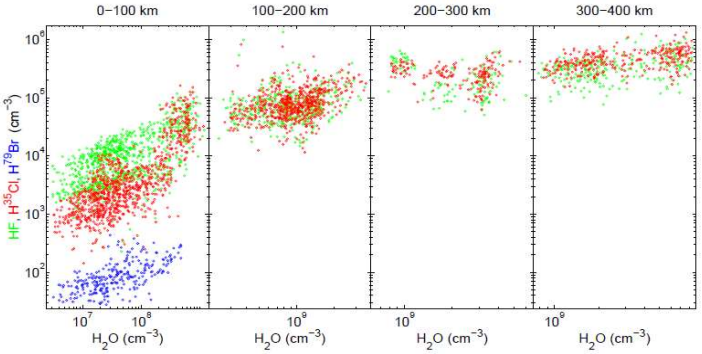








The halogen-to-oxygen ratio increases with cometocentric distance. Far from the comet the amplitude of the daily variations is less for the hydrogen halides than for water. This points to a distributed source: hydrogen halide-enriched gas progressively sublimates from the icy dust grains that are released by the comet nucleus.



Interpretation

- 67P contains icy dust grains that formed in a molecular cloud (MC) from which the solar system formed and were incorporated into the comet nucleus with little modification (beyond the snow line, no melting).
- The halides in the MC gas rapidly adsorb onto water ice deposited on grains (strong polar bonds), leading to a depletion of halides in the MC gas phase (as observed) and halogen-enriched inner ice layers on the dust.
- These enriched layers sublimate relatively late in the coma since the halogen-poor ice has to sublimate first, thus leading to the distributed source.

Contact
Johan.DeKeyser
@aeronomie.be

References

- Dhooghe, F. et al.: Halogens as tracers of protosolar nebula material in comet 67P/Churyumov-Gerasimenko, MNRAS, 472, Issue 2, 1336, doi 10.1093/mnras/stx1911, 2017.
- De Keyser, J. et al.: Evidence for distributed gas sources of hydrogen halides in the coma of comet 67P/Churyumov–Gerasimenko, MNRAS, 469, Issue Suppl_2, S695, doi 10.1093/mnras/stx2725, 2017.