Distributed sources of semi-volatile material in the coma of comet 67P/Churyumov-Gerasimenko

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Rosetta has detected the presence of the hydrogen halides HF, HCl, and HBr in the coma of comet 67P/Churyumov-Gerasimenko. Analysis of the abundances of HF and HCl as a function of cometocentric distance suggests that these hydrogen halides are semi-volatile compounds released both from the nucleus surface and off dust grains in the inner coma. We present three lines of evidence. First, the abundances of HF and HCl relative to the overall neutral gas in the coma appear to increase with distance, out to ∼200 km, indicating that a net source must be present; since there is no hint at any possible parent species for HF and HCl with sufficient abundance, dust grains are the likely origin. Second, the amplitude of the daily modulation of the halide density due to the rotation and geometry of 67P's nucleus and the corresponding surface illumination is observed to progressively diminish with distance; this can be understood from the roughly omnidirectional outgassing from grains as well as from the range of grain speeds well below the neutral gas expansion speed, which both tend to smooth the coma density profiles. Third, strong halogen abundance changes detected locally in the coma cannot be easily explained from composition changes at the surface, while they can be understood from differences in local gas production from the grains near the spacecraft.