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Solar Wind sputtering from the surface of Comet Churyumov-Gerasimenko

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While the European Space Agency's Rosetta spacecraft is orbiting close to the comet 67P/Churyumov-Gerasimenko (67P/C-G) we performed continuous measurements of the chemical inventory of its coma with the the Rosetta Orbiter Spectrometer for Ion and Neutral Analysis (ROSINA) instrument suite. ROSINA consists of two mass spectrometers, the Double Focusing Mass Spectrometer (DFMS) and the Reflectron-type Time-Of-Flight (RTOF), as well as the COmet Pressure Sensor (COPS). Most of the observed species in the coma are volatile material that are released from the comet's surface by sublimation, for example H_2O, CO, CO_2 and many others. The number densities in the coma of these species show temporary variation compatible with the solar illumination (diurnal cycle), with seasonal variation (summer and winter hemispheres), and with compositional heterogeneity of the surface. We can trace back the measurements of the observed species to the cometary surface to create maps of their probable origin on the surface.
In addition to the volatile material we detected atoms of Na, K, Si, S, and some more, which cannot or only partially be set free via sublimation. Again, we project these measurements down onto the surface of the comet. These maps for the sputtered atoms differ significantly from the maps for volatile species, like the water map, in some cases they are almost the opposite. Our present understanding is that these atoms are the result of solar wind sputtering of refractory material, i.e. of dust located on the cometary surface. Since the release of material from the surface by sputtering is almost stoichiometric we can infer the chemical composition of major elements for the areas affected by sputtering and the average mineralogy of these locations can be derived. The sputter signal will disappear with the comet getting closer to the Sun and becomes more active. Once the coma is dense enough, the solar wind will be absorbed by the gas layer above the surface and will not propagate to the surface anymore.