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The organics on the nucleus of 67P/C-G and how they might have gotten there

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On the comet: In November 2014 the ROSETTA spacecraft successfully deployed its lander Philae to the surface of comet 67P/Churyumov-Gerasimenko[1]. In the first 63 hours after its triple-landing on the comet, the 10 instruments on-board provided a wealth of ground-truth data of the composition and properties of the comet nucleus. Among the instruments, the COmetary Sampling and Composition (COSAC)[2] instrument took a mass spectrum of the gas phase evolved from the dust that the landing kicked up[3]. In this mass spectrum, 16 small organic molecules could be identified, some of which had not previously been identified in comets. They form a family of inter-related species.

In the lab: The more complex molecules identified in the COSAC data are known to form from the smaller ones during high-energy irradiation. A tool which has proven very valuable in elucidating the reaction mechanisms of this high-energy radiation-driven chemistry, is the irradiation of ices with low-energy electrons[4]. Thermal desorption mass spectrometry after irradiation has been used in a number of studies to identify fundamental reaction mechanisms in cometary ice chemistry: Amines will form during electron-irradiation of olefins and ammonia[5,6], alcohols from olefins and water[7], and short amides like formamide from carbon monoxide and ammonia[8].

At the conference: The complex and rich chemistry on the comet and the intricate inter-relations between the substances found on the comet will be presented in detail, as will approaches to a re-evaluation of the COSAC data set based on known ties between certain compounds and data from other instruments aboard Philae/ROSETTA.

References: [1] Bibring J-P et al. (2015) *Science* 349(6247):aac5116. [2] Goesmann F et al. (2007) *Space Science Reviews* 128:257-280. [3] Goesmann F et al. (2015) *Science* 349(6247):aab0689. [4] Böhler E et al. (2013) *Chemical Society Reviews* 42(24):9219-9231. [5] Hamann T et al. (2009) *Angewandte Chemie International Edition* 48(25):4643-4645. [6] Böhler E et al. (2014) *Journal of Physical Chemistry C* 118:6922-6933. [7] Warneke J et al. (2015) *Angewandte Chemie International Edition* 54(14):4397-4400. [8] Bredehöft JH et al. (2017) *ACS Earth and Space Chemistry* 1(1):50-59.

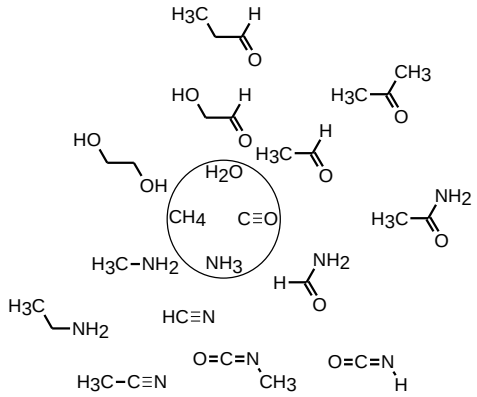

Figure 1 – The 16 molecules that COSCAC identified on the nucleus of comet 67P/Churyumov-Gerasimenko (NH_3 was not unambiguously identified). The molecules are organized from simple in the middle to increasingly complex towards the edge. Many of the complex molecules are known to form from the simpler ones.