

## COM's and Their Formation in Assorted Sources

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Complex organic molecules (COM's) are partially saturated molecules with six or more atoms [1] found in the gas phase of assorted interstellar sources such as hot cores and corinos, cold dense cores, and infra-red dark clouds. Perhaps the best-known molecule of this class is methyl formate (HCOOCH<sub>3</sub>). Although these species are detected in the gas, their formation involves both grain surface and gas-phase chemistry. In hot cores and corinos, COM's are most likely formed during the warm-up phase of protostellar sources as gas and dust collapse towards the central protostar or towards a growing protoplanetary disk [2]. Here the rising temperature is necessary to allow fragment radicals, formed by photolysis, to diffuse on grain surfaces and recombine with each other rather than with hydrogen atoms, and to allow the newly formed COM's to desorb into the gas phase. In cold cores, the formation of COM's likely depends upon transitory heating of grains allowing both reactions and desorption of the products before cooling. In protoplanetary disks, COM's can be formed even on cold icy grains because of the high densities compared with interstellar clouds, which result in a reduction of the normally significant amount of atomic hydrogen on cold surfaces [3]. In these sources, however, most of the COM's remain in the ice because the temperature never rises to their sublimation points and photodesorption is generally inefficient. In infrared dark clouds, the mechanism for formation of these species, which have been newly detected, is unclear although one possibility is shock desorption from grain surfaces, as has also been posited for the galactic center.

In the talk, I will discuss how COM's are formed and how abundant they can become in both the gas and in granular ices for assorted sources. New work on their possibly high abundance in protoplanetary disks will be emphasized with the goal of understanding the original organic inventory of planets and other objects such as comets.

### References

- [1] E. Herbst & E. F. van Dishoeck, 2009, ARAA 47, 427.
- [2] R. T. Garrod, S. L. Widicus Weaver, & E. Herbst, 2008, ApJ 682, 283
- [3] C. T. Walsh, T. J. Millar, H. Nomura, E. Herbst, S. L. Widicus Weaver, & Y. Aikawa, A&A, in preparation