# Formation of complex organic molecules in prestellar cores: the role of non-diffusive grain chemistry

Ekaterina Borshcheva[1], Anton Vasyunin[2]

[1] Institute of Astronomy of RAS, 48 Pyatnitskaya str., Moscow, Russia, 119017

[2] Ural Federal University, 19 Mira str., Yekaterinburg, Russia, 620002

kath@inasan.ru

Complex organic molecules (COMs) are detected at all stages of star formation, including prestellar cores. We present the results of astrochemical modeling of COMs in the prestellar core L1544. Our updated rate equations model includes, in particular, non-diffusive processes [1], new suggested chemical routes for acetaldehyde [2] and methane [3] ice formation and changing of H and $H_2$ desorption energies according to the part of grain surface covered by $H_2$ molecules [4]. The agreement with the observational data is very good (fig. 1).

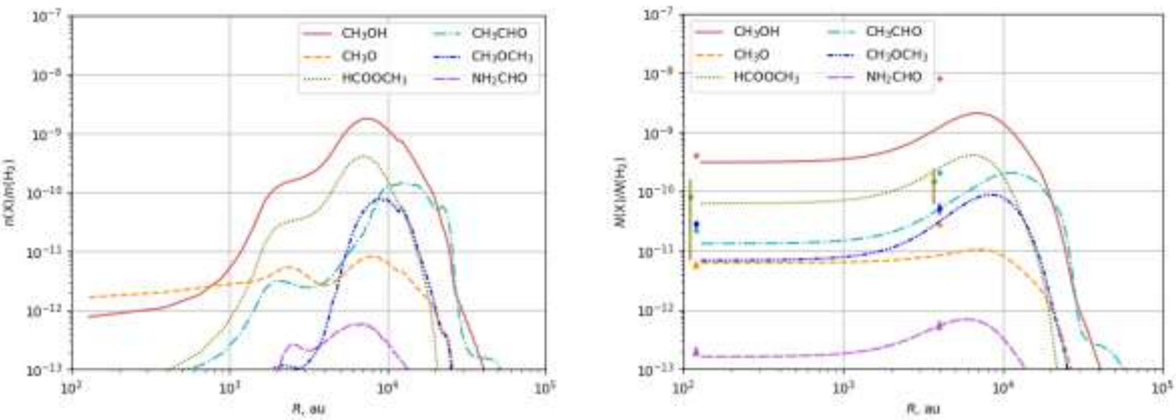


Figure 1. Radial profiles of modeled abundances (left) and abundances derived as column density ratios (right) of COMs obtained with our model. Dots indicate the observational abundances obtained by [5], arrows indicate observational upper limits, and vertical lines provide error bars.

Radical-radical reactions on grains surface between species such as $CH_3$, $CH_3O$ and HCO efficiently proceed non-diffusively and play the key role in the formation of COMs in the ice. COMs are delivered to the gas phase via chemical desorption amplified by the loops of H-addition/abstraction surface reactions. Abundances of COMs in the ice are in the range 1%–2% (for methyl formate ice) or some tenths of percent (for such COMs as acetaldehyde and dimethyl ether) with respect to the abundance of water ice. The choice of parametrization of the efficiency of chemical desorption significantly affects the gas-phase COMs abundances. We also make the comparison of our updated non-diffusive model with the diffusive-only model and provide the constraints for the ratios of species' binding energies to their desorption energies.

The authors acknowledge the support of RSF via the Project 23-12-00315.

## References

1. M. Jin, R.T. Garrod, *ApJS* **2020**, 249, 26.
2. G. Fedoseev, D. Qasim, K.-J. Chuang et al., *ApJ* **2022**, 924, 110.
3. T. Lamberts, G. Fedoseev, M.C. van Hemert et al., *ApJ* **2022**, 928, 48.
4. R.T. Garrod, T. Pauly, *ApJ* **2011**, 735, 15
5. I. Jiménez-Serra, A.I. Vasyunin, P. Caselli et al., *ApJL* **2016**, 830, L6