Astrochemistry: Recent Successes and Current Challenges
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Observations of pre-stellar cores

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Abstract. Dense cores in clouds like Taurus and Auriga represent the simplest and most nearby sites where stars like our Sun are currently been formed. Their physical properties and kinematics offer the cleanest view of the initial conditions of star formation, and their time evolution gives us clues on the physical processes at work when molecular cloud material contracts and becomes gravitationally unstable. Dense pre-stellar cores are also the simplest systems where chemical processes like molecular freeze out and deuterium fractionation occur. Thanks to the combination of dust continuum and molecular line observations, together with detailed modeling, the last several years have brought enormous progress in our understanding of the physical and chemical structure of dense pre-stellar cores. Most dense cores are now known to be extremely inhomogeneous in their chemical composition, due to the presence of steep central abundance drops of many species most likely caused by freeze out of molecules onto cold dust grains. This chemical inhomogeneity has important consequences for dense cores studies, as most molecular species (used to trace kinematics) are insensitive to the gas conditions of the star-forming gas. Chemical inhomogeneities, on the other hand, can provide important information on the evolutionary stages of different cores. Recent observations of cores with an unusually low degree of freeze out have started to reveal a population of chemically young starless cores, which are most likely the precursors of the better known cores with molecular freeze out. Cores with extreme degrees of deuteration, on the other hand, most likely represent evolved cores, which are closely approaching the moment of gravitational instability and the beginning of star formation. In this talk, I will present an update on current observational work aimed to characterize the internal structure of dense cores, and on our search for cores with chemical signatures of extreme youth or age. As we will see, the recent study of dense pre-stellar cores brings naturally together our efforts to understand the physical and chemical properties of the star-forming material.

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