Molecular Deuteration:  
a Tool to Track Down the History of Forming Solar Type Stars

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Stars like the Sun form from cold (~10 K) and dense (10^5-10^6 cm^-3) condensations inside molecular clouds, called Pre-Stellar Cores. Under the gravitational pressure they collapse towards the center and form the so-called Proto-Stars. At this stage, matters accumulates into the central object, the future star, from the surrounding envelope at first, and from the circumstellar Proto-Planetary Disk at the end, when the envelope is mostly dispersed. Ultimately, along with the star, a planetary system will form, with planets, comets and meteorites, maybe similar to the Solar System. Thus, studying the process of the Sun-like star formation is tightly linked to studying the origin of our Solar System.

The sequence that brings matter from the molecular cloud to the planetary system phase is a unique and rich laboratory where, step after step, molecular complexity increases. A distinct hallmark of this era is the molecular “super-deuteration” phenomenon in Sun-like protostars. This is an abnormal enhancement of molecules containing D atoms instead of H atoms, by up to 13 orders of magnitude with respect to the cosmic elemental D/H ratio. In this contribution I will review what we know about the molecular deuteration, observationally and theoretically, throughout the early phases of Sun-like star formation: Pre-Stellar Cores, Proto-Stars and Proto-Planetary Disks. Particular emphasis will be given to the history of deuterated water, HDO and D_2O, which may be a direct link between the early eras of the Solar System and the cometary ices up to the terrestrial oceans.