VOLATILES IN EARLY SOLAR SYSTEM : ASTRONOMICAL OBSERVATIONS AND EXPERIMENTAL SIMULATIONS. E. Quirico[1], [1]Laboratoire de Planétologie de Grenoble CNRS/INSU Univeristé Joseph Fourier BP 53 38041 Grenoble Cedex 9 France eric.quirico@obs.ujf-grenoble.fr

Chondrites do not provide clues on volatiles which were present in the Early Solar System. Therefore we must seek them in icy small bodies located in the Outer Solar System, namely : comets, TransNeptunian Objects (TNOs) and Centaurs. Volatile species in cometary atmospheres are the result of the sublimation of the icy nucleus, when the comet get close enough to the Sun. They are identified by radio-astronomical and infrared observations, and the isotopic composition of the more abundant (D/H and $^{15}N/^{14}N$ ratio) is also determined. Along the last 30 years, a wide inventory of cometary molecules has been made [1]. In contrast, direct observations of cometary nucleus do not provide significant data. TNOs and Centaurs have stable orbit far away from the sun, therefore their bulk material cannot be studied in the gaseous state. Several simple molecules have been so far detected onto their surfaces (H_2O, N_2, CH_4, CO), and are of help to establish links with comets.

The study of our Solar System is also enlightened by the understanding of stellar and disk formation. The main stages have been confidently established along the last 20 years : (1) pre-stellar core ; (2) hot corino phase ; (3) T-taury disk ; (4) debris disk and (5) planetary systems. In the first two, ices covering mineral dusts are characterized by infrared spectroscopy (e.g. IRAS, ISO) [2]. Gaseous species, and the abundance of their isotopomers, is also assessed by radio-astronomy, and allows to better understand the key role of dust in the global chemical evolution in circumstellar environments [2].

This oral presentation will present different aspects of this broad topic. First, fundamentals on ice physics and chemistry. Second, we will present observational methods, along with the experimental studies required to interpret the spectral properties of ices. We will emphasize the ability and intrinsic limitations of such observations. In a third sections, we will make a review of the ices and volatiles which have been detected in these small bodies and circumstellar environments. The origin of the volatiles in the Solar System will be discussed, in terms of place of formation (presolar cloud, T-Tauri disk), and the constraint from isotopic data (in aprticular deuterium) will be detailed. In a last section, we will review some experimental studies focused on physico-chemistry of ices : (1) ices irradiation, leading to complex organic solids [3] ; and (2) solid-state chemistry, including isotopic fractionation [4].

References: [1] Crovisier et al. (2004) *A & A*, 418, 1141-1157 [2] Dartois E. (2005) *Spac. Sci. Rev.*, 119, 293-310 [3] Strazzulla et al. (2001) *Spec. Acta A*, 57, 825-842 [4] Watanabe et al. (2008) *Prog. Surf. Sci.*, 83, 439-489