UNDERSTANDING THE EFFECT OF ETHYLENE GLYCOL ON COMETARY WATER. W Khan1, R Ramachandran1, P Sundararajan1, J K Meka1, B N Rajasekhar2, S Ganesh1, A Bhardwaj1, N J Mason1, B Sivaraman1, 1 Physical Research Laboratory, Ahmedabad, India (ragav.kasak@gmail.com, bhala@prl.res.in), 2 Bhabha Atomic Research Center, Mumbai, India, 3 University of Kent, Kent, UK.

Introduction: In general comets are enriched with water (H2O), followed by CO2, CO etc [1]. A lot of organic molecules have been detected in ISM, Ethylene glycol [(CH2OH)2] is one of those molecules which is present in comets. Ethylene glycol (EG) was first detected in comet C/1995 O1 (Hale-Bopp)[2] and later in other comets like C/2012 F6 (Lemmon), C/2013 R1 (Lovejoy)[3], C/2014 Q2 (Lovejoy)[4] and 67P/Curyumov-Gerasimenko [5]. In terrestrial conditions, EG is used as an antifreeze to prevent liquid H2O from turning into ice. The temperature dependent IR spectral studies on the effect of EG on H2O ice in cometary and other astrochemical icy conditions are limited [6]. In this work, we present the temperature dependent IR study of EG and H2O mixed ice deposited at such extreme conditions. Since the OH peaks of H2O and EG overlap, it becomes very challenging to understand the effect of EG on H2O using IR spectroscopy. To overcome this challenge, we use D2O instead of H2O. It is also worthy to note that the deuterated water is also present in comets with deuterium-to-hydrogen ratio (D/H) values of the order of $10^{-4}$ [7][8].

Fig. 1: Schematic of the SALT chamber used to carry out the experiments.

Methodology: Ethylene Glycol (>99% purity, Merck) and D2O (>99% purity, Fisher scientific), available as liquid, were used. The experiments have been carried out under low temperature (7-300 K) and pressure (~$10^{-10}$ mBar) conditions using the SALT (Simulator for Astro-molecules at Low Temperature) setup housed at the Physical Research Laboratory, India (A schematic of the experimental chamber is given in Fig. 1). Mixtures of EG and D2O were deposited at 7 K for 20 minutes and warmed to higher temperatures at a constant rate 5 K min$^{-1}$. The ice was probed in-situ by FTIR spectroscopy using Thermo Scientific Nicolet iS-10 FTIR Spectrometer while the temperature was controlled using the Lakeshore 335. Similar procedure was followed for pure EG and pure D2O experiments.

Fig. 2: IR spectra of EG-D2O mixture at 10 K (blue) and 235 K (red), pure EG spectra at 10 K (dashed black) and pure D2O at 182 K (dashed green).

Results and Discussion: Selected IR spectra of a series of experiments are given in Fig. 2. We observe a strong interaction between EG and D2O even in such extreme conditions. From the present experiments, we see that even though complete sublimation temperature of pure D2O occurs at 182 K, the EG and D2O mixture doesn’t sublate even at 235 K. In fact, the complete sublimation of the mixture occurs at ~245 K. So from these experiments we have compelling evidence that H2O/D2O can be found on comets, containing EG, even at higher temperatures than previously known.