SAVIOUR OF PRESOLAR GRAINS – ICE MANTLE : MYTH OR TRUTH.

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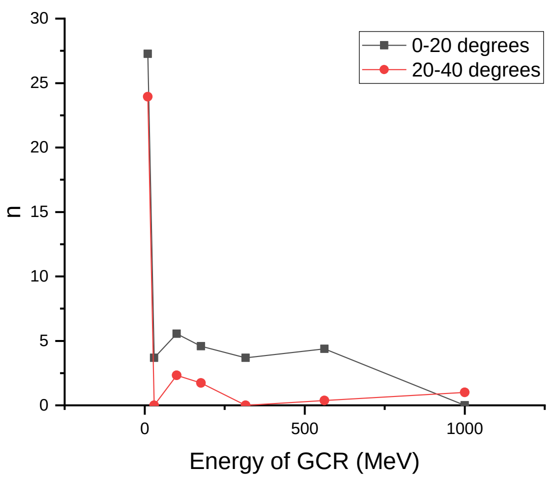
Introduction: Presolar grains travelling in interstellar medium(ISM) at low density and temperature region allow molecules to be adsorbed on the grain, forming an ice mantle on the grain. The composition of ice in a molecular cloud varies with the local conditions depending on various factors like shock waves, the collision of grains, absorption of photons etc.Model calculations have been carried out to show the destructive nature of the ice mantle when exposed to the high energy galactic cosmic rays (GCR). Preliminary results indicate that ice mantle increases the effect of GCR on the Presolar core of the grain. Also, the ice mantle absorbs the energy of the ejected atoms from the core. According to observations on the lifetime estimates of large grains analyzed by Hirashita [1], SiC grains with radius ≥ 1µm seems to survive for more than 1 Gyr in the interstellar medium. For ice composition, we use the data obtained in [2] for Elias 16, a quiescent region, and compared it with a hypothetical case of a grain having no ice thickness. For ice thickness, we used extrapolated the data provided by [3].

Approach: We report calculations using recoil and energy data obtained from SDTrimSP (Version 5.07) for a given set of inputs over Vikram 100 (HPC Supercomputing Facility at PRL, Ahmedabad). Data obtained by [4] for the composition of galactic cosmic rays at several points has been considered in this work.

Results: We compared the data for recoils generated due to collision of grain core with GCRs for two types of SiC grains having diameter 1µm and same temperature conditions, one with no ice mantle and another for an ice mantle 0.02µm thick, for GCRs having energy between 10MeV – 1GeV and incidence angle between 0-89.9°. The difference in the number of recoils due to GCRs incident at an angle between 0-40° ranges between 27 - 0. The results for angles greater than 40° are highly ambiguous mainly because the GCR, when it enters the ice mantle at large incident angles, experiences a strong deflection and the angle becomes less or more than the incident angle. Following graph shows the plot between the Average difference in the number of Recoils per GCR(n) and the incident energy of the GCR.



According to preliminary data, the possible explanation for the difference in the number of recoils is that the sputtering yield and the energy transferred by GCRs to the target atoms decreases with increase in energy for GCR having energy in range 10MeV to 1GeV, at which the abundance of GCR is maximum. Therefore, as the GCRs pass through the ice mantle, they loose a significant amount of energy in transit. Thus, in the grain with ice mantle, the GCR enters the core part with lower energy and therefor experience more recoil and sputtering.

Upon further analysis, it is established that the ice mantle retains most of the Si and C atoms which are ejected from the core of the grain and their Kinetic Energy (KE) which increases the temperature of the mantle. The energy lost, for instance, due a GCRs travelling at 100MeV which entered a grain at angles between 40°-60° was calculated to be 166KeV. This represents a small fraction of total number of GCRs entering the grain and therefore the total K.E lost to ice mantle is enough to partially destroy it due to thermal energy.

References: [1] Hirashita (2016) PSS 133 (2016) 17–22. [2] Gibb et al. 2004 ApJS, 151:35–73. [3] Pauly & Garrod 2016, 817:146. [4]Webber and Higbie (2008) JGR, volume. 113, A11106.