Methanol production through irradiation of low-energy CH_3^+ ions on an ice surface at low temperature

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To understand a variety of chemical species in molecular clouds, theoretical and experimental studies have been intensively performed. In a gas phase, it has been considered that ion-molecule reactions are indispensable. On the other hand, in a solid phase, it has been experimentally confirmed that reactions of hydrogen atoms adsorbed on an icy grain surface are essential for productions of hydrogen, water, methanol, and so on. Furthermore, reactions of other heavier radicals adsorbed on an ice surface attract many interests. Besides these reactions, recent theoretical investigations have suggested molecular formation through reactions of low-energy ions with an ice surface. In contrast to the theoretical investigations, little experimental investigations have been done because of difficulties in detecting the trace amount of reaction products with conventional methods. We have developed an experimental apparatus to sensitively detect those reaction products and performed experiments for the reactions of low-energy molecular ions with an ice surface. The CH_3^+ ions in the energy range of several electron volts impinged on an ice surface around 10 K. The reaction products on the surface were detected using pick-up reaction method by Cs^+ ions at ~40 eV. After CH_3^+ irradiation, methanol molecules were observed as the theoretically suggested. In addition, we also investigated ice-temperature dependence of methanol production. Little temperature dependence of detected methanol intensities was observed in the temperature range 12–60 K. We will also touch the results of our ab-initio molecular dynamics simulation with NVT ensemble and astrochemical model simulation in our presentation.