H_2S, why you no solid at 10 K? -Nonthermal desorption from interstellar icy grains

*大場 康弘[1]
*Yasuhiro Oba[1]

1. 北海道大学低温科学研究所
1. Institute of Low Temperature Science, Hokkaido University

Hydrogen sulfide (H_2S) is one of the most abundant sulfur-bearing species in interstellar molecular clouds, which are the birthplaces of stars and planets. Since H_2S cannot be efficiently produced by reactions in the gas phase, it is widely accepted that grain-surface reactions are necessary for the synthesis of H_2S in those environments. Nonetheless, H_2S has been identified in the gas phase only, indicating that desorption processes for H_2S from the grain are required. Since the typical temperature of interstellar grains (10 K) is far below the desorption temperature of H_2S (>90 K), some non-thermal desorption mechanism(s) should work well at such low temperatures. In the present study, we performed laboratory experiments on the non-thermal desorption of H_2S from the surface of interstellar ice analogues at 10 K. We focus on the so-called chemical desorption, which is proposed to be one of the non-thermal desorption mechanisms induced by the heat of reaction, through the reaction of H_2S with atomic hydrogen (H) on amorphous solid water (ASW) as follows: $H_2S + H \rightarrow HS + H_2$ (1), $HS + H \rightarrow H_2S$ (2). We observed a clear decrease of H_2S after reactions with H by infrared spectroscopy; the desorption efficiency far exceeded that for other non-thermal desorption mechanisms such as photon and cosmic-ray induced desorption in molecular clouds. Since the heat of reactions (1) and (2) exceeds the binding energy of physisorbed H_2S and HS on ASW, chemical desorption in principle may occur in both reactions. Nevertheless, we expect that reaction (2) is the dominant process for the chemical desorption of H_2S because the heat of reaction (2) is significantly larger than that of reaction (1). Since reaction (2) is the final step for H_2S formation interstellar grains, a large fraction of H_2S is likely to desorb upon the formation, which does not contradict with the non-detection of H_2S in the solid state so far and the detection of abundant H_2S in the gas phase. Moreover, the present results have a potential to improve the current chemical modeling studies which typically incorporate the H_2S desorption efficiency of 0 to 1%.

キーワード：アストロケミストリー、硫化水素、反応熱による脱離、星間分子雲
Keywords: Astrochemistry, Hydrogen sulfide, Chemical desorption, Molecular cloud