The thickness and UV absorption effect on UV photolysis of CH_4 ice

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The secondary UV light induced by cosmic rays has been seen as a dominant energetic source impinging on the ice mantles in the region of cold dense clouds and interstellar medium (ISM), contributing to the photodesorption of solid molecules. Among the ice mantle, CH_4 is one of the most abundant ice observed, and the UV irradiation of CH_4 ice is widely interesting. The UV emission spectra of microwave-discharged hydrogen-flow lamp (MDHL) generated in the laboratory has an analogous profile as the simulated one[1, 2]. In addition, the configuration of MDHL is influential on the photodepletion and photodesorption[3, 4], and this effect is molecule dependent since the absorption cross-section should be considered. The Ly-α (121.6 nm) photon plays a vital role in MDHL spectra, and the CH_4 ice also has a largest absorption around at Ly-α in the range of 114-170 nm. As long as the ice thickness becomes thicker, the absorption ratio increases but saturates at a certain thickness.

In this study, we investigate the photodepletion as well as photodesorption in three characteristic topics: thickness effect, light effect, and deposition temperature effect. We performed three different configurations of MDHL to investigate the destruction cross-section of CH_4 as a function of thickness from 50 to 400 ML (1 ML = 10^{15} molecules cm^{-2}), and the contribution from Ly-α line and H_2 emission band are defined. The depletion seems to be thickness dependent, but if we calculate the absorbed photons rather than incident photons, the destruction cross-section in different MDHL configurations have a great similarity. The photodesorption is also independent of the ice thickness, confirming that the process happens in the top layers.

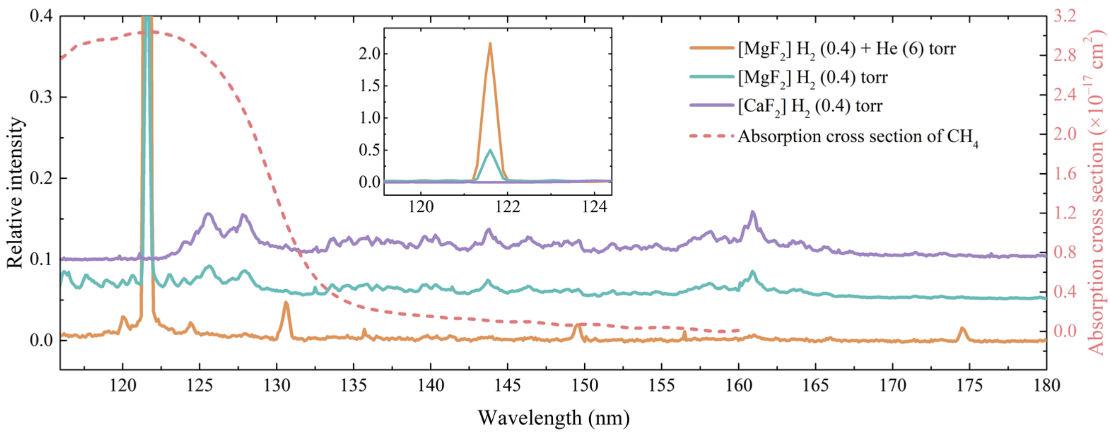

Figure 1: The MDHL spectra of 3 configurations and the absorption cross-section of solid CH_4.

References

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4. [4] Sie, N.-E., et al., ApJ, 2019. **874**(1): p. 35.