Status and outlook: Sophia RF trap and collisions involving coulombic crystals

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Cold ion-molecule reactions play important roles in the synthesis of molecules in interstellar clouds. Recently, it was pointed out that the rate coefficients of ion-polar molecule reactions are not sufficiently well known to understand the chemical evolution in interstellar clouds [1]. In this connection, we plan to perform measurements of cold ion-polar molecule reactions between sympathetically cooled molecular ions and cold polar molecules [2, 3].

Figure 1 shows an overview of our experimental setup. The left side of the setup is a Stark velocity filter for producing slow polar molecules. We have successfully produced slow ND_3, NH_3 and CH_2O with a peak velocity of lower than 30 m/s. The number density of the extracted slow molecules was determined by calibrating the signals with a vacuum pressure gauge. In front of the exit of the Stark velocity filter we placed a cryogenic linear RF ion trap where cold molecular ions are prepared as a reaction target. The liquid nitrogen vessel connected with the ion trap evacuates efficiently an unavoidable polar gas leaked from the upstream so as to reduce unavoidable reactions between a cold molecular ions and a stray polar gas. Using the cryogenic ion trap we have demonstrated sympathetic Coulomb crystallization of CaH^+ by laser-cooled Ca^+ ions (see Fig.1). The number of ions in the two-species crystal and the ion temperature can be determined by molecular dynamics simulations [4]. The crystallized molecular ions will be used to study the cold ion-polar molecule reactions. In this talk, we will report on the present status and future outlook of the experiment.

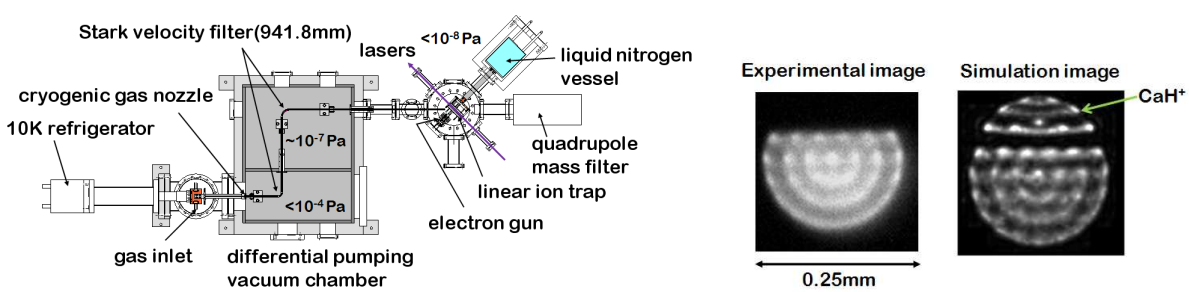

Figure 1. **(**Left) Schematic layout of the experimental setup. (Right) A fluorescence image of a two-species Coulomb crystal including 134 Ca^+ ions and sympathetically crystallized 40 CaH^+ ions, and a simulation image reproducing the observation.

References

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