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Investigations of ice nanoparticles and aerosols in molecular beams[1]

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We have recently set up a versatile experiment which allows for different experiments with molecular clusters and nanoparticles in molecular beams. Here we concentrate on the experiments with ice nanoparticles (large water clusters $(H_2O)_N$, $\bar{N} \approx 10^2$-10^3) doped with atmospherically relevant molecules, e.g., hydrogen halides, CFCs, nitric acid, N_xO_y, etc. Such species are relevant to ozone depletion and other atmospheric processes. We investigate (1) the UV-photochemistry using velocity map imaging techniques, and (2) the uptake cross section for the molecules on the ice nanoparticles from velocity measurements. In addition, we record (3) mass spectra of the particles implementing different ionization methods: electron ionization (EI) at variable electron energies, photoionization, and special method of electron photodetachment after Na-doping (NaPI). The unique combination of all these different methods performed with the same nanoparticles provides detailed molecular level information about the studied species and their (photo)physics and chemistry. In particular, an investigation of mixed water-nitric acid particles by means of EI and NaPI revealed the prominent role of the HNO_3 molecule as the condensation nuclei.[2] The uptake of atmospheric molecules by ice nanoparticles has been studied, and the pickup cross sections for some molecules exceed significantly the geometrical sizes of the ice nanoparticles. It has been argued that the large particles composed of several hundred water molecules which grow in the supersonic expansions tend to have highly irregular shapes -*nanosnowflakes*.[3] Photodissociation of hydrogen halides on ice nanoparticles has been investigated, and shown to proceed via excitation of acidically dissociated ion pair and subsequent biradical generation and H_3O dissociation.[4] The photodissociation of CF_2Cl_2 molecules in clusters leads to efficient Cl-fragment caging caused by formation of halogen bond.[5]

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[2]J. Lengyel et al. **J. Phys. Chem. Lett.** 3, 2012, 3096

[3]J. Lengyel et al. **J. Chem. Phys.** 137, 2012, 034304, **Phys. Rev. Lett.** 112, 2014, 113401

[4]V. Poterya et al. **J. Chem. Phys.** 126, 2007, 071101, **J. Chem. Phys.** 141, 2014, 074309

[5]V. Poterya et al. **J. Phys. Chem. A** 118, 2014, 4740