Geophysical Research Abstracts
Vol. 13, EGU2011-6713, 2011
EGU General Assembly 2011

Paul traps: from a single levitated droplet to cloud microphysics

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An Electrodynamic Balance of a quadrupole type, also known as a Paul trap (after W. Paul, Nobel Prize in Physics 1989), is a powerful tool to study the physicochemical processes in the individual cloud droplets. Paul trap allows for detailed in-situ real-time research of the phase transition processes, uptake of the aerosol and trace gases by liquid droplet, elastic and inelastic light scattering, homogeneous and heterogeneous freezing of undercooled droplets, growth and sublimation of ice crystals, and various charge induced processes in the levitated droplets like evaporation stabilization or Coulomb instability of electrified microdroplets. Recently, the Paul trap research group at IMK-AAF (KIT) has achieved several important improvements concerning accuracy of the temperature and humidity control inside the trap, thus turning a Paul trap into a practical laboratory- scale instrument for studying the freezing behavior of undercooled droplets and ice nucleation activity of atmospheric aerosol comparable with large ice nucleation chambers. This presentation reviews the past and present achievements of the Paul trap group and gives an outlook into the future research activities.