Electrodynamic trapping and manipulation of particle clouds

R. Vehring,[a] C. L. Aardahl, and E. J. Davis
Department of Chemical Engineering, University of Washington, Seattle, Washington 98195-1750

G. Schweiger
Ruhr-Universität Bochum, Maschinenbau, Laseranwendungstechnik und Messsysteme, 44780 Bochum, Germany

D. S. Covert
Department of Atmospheric Sciences, University of Washington, Seattle, Washington 98195-4235

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Apparatus and techniques were developed to electrodynamically trap and manipulate groups of microparticles. The equipment consists of a vibrating orifice aerosol generator, an inductive particle charger, a plenum chamber, and a double-ring electrodynamic balance. Salt particles ($NaNO_3$) of controllable and measurable mass and charge were produced and introduced into the balance in nitrogen at flow rates up to 25 cm^3/min. Ordered arrays of any number of particles up to 26 were assembled and manipulated. Methods for compressing the arrays are presented, and controlled ejection of single particles from a trapped array is demonstrated. Particles of opposite polarity were successfully levitated and kept apart, and aggregation of these particles was then induced by changing the electric field. Raman spectra were recorded for multiple salt particles, each having a diameter of 3.5 μm, by aligning them in a laser beam. The enhanced Raman signal is compared with that from a single particle isolated from the array. From the results, a detection limit of 0.4 pg per particle was estimated. [S0034-6748(97)00501-7]