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LABORATORY MEASUREMENTS OF LIGHT SCATTERING BY SINGLE ICE PARTICLES

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Ice Particles, Light Scattering, Electrodynamic Balance

The radiative impacts of ice crystals are important over many regions of the atmosphere. One major source of error in radiative transfer models is the uncertainty in small ice particle concentrations and the angular distribution of light scattered from these particles (Vogelmann and Ackerman, 1995). Until now, few laboratory measurements from single ice particles have been made and climate models have used either Mie theory or the results of ray-tracing algorithms. It is not well known how well these theories represent the scattering from actual atmospheric ice particles. We present measurements of the intensity of light scattered by single ice particles of hexagonal habit suspended electrodynamically.

The apparatus consists of a temperature-controlled diffusion chamber that allows for crystal growth from vapor (Swanson et al, 1998). Endcap dc electrodes and ac ring electrodes levitate and stabilize the particle. The suspended particle is illuminated by both white and laser light. Top and side view images of the particle are obtained using video telemicroscopes; simultaneously, scattering measurements are made using a 2.5 cm long 1024-element photodiode array. The scattering angle and scattering cross section calibrations were done using a diffraction grating and by levitating and measuring the scattering intensity of microspheres (PSL and glass) of known size. The geometry of the setup is sketched in Fig. 1.

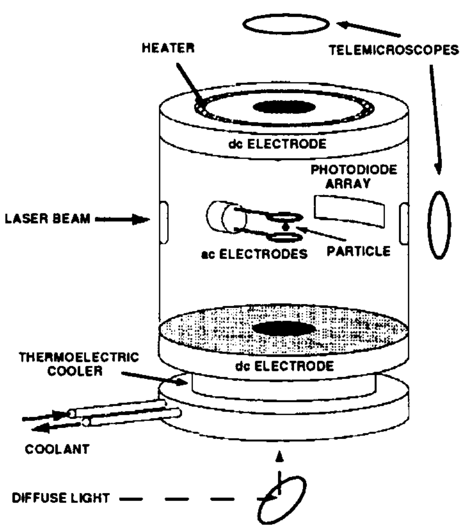

Fig. 1. Diagram of the electrodynamic balance and the scattering geometry.

Crystals of hexagonal habit were produced by vapor growth of "seed" particles. The initial seed particle was formed by sublimating frost particles to 10 μm or smaller in diameter. Particles larger than about 20 μm having either platelike or columnar habits appear to remain relatively motionless at the center of the balance, typically with their basal face oriented vertically, although some reorientation could be induced by adjusting the balance voltages and ac frequency. Figure 2 shows a logarithmic plot of the scattering intensity from a 50 μm hexagonal crystal grown at -7° C. The particle was oriented with an angle of 52.8° between the prism-face normal and the incident laser beam. The angle between the basal-face normal and the scattering plane was 90°. Two higher-intensity features are evident in the scattering intensity (i) the 22° halo (in this case the diode array was partially saturated) and (ii) a pattern near 50°, probably caused by coherent scattering.

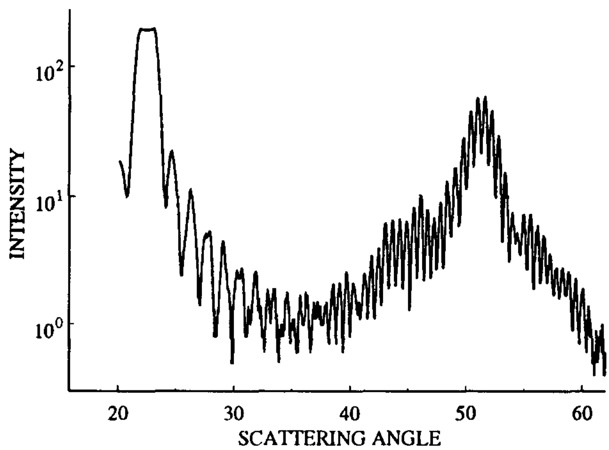

Fig.2. Scattering intensity from a hexagonal ice particle.

The electrodynamic balance is shown to be a useful tool for single particle light-scattering measurements.

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REFERENCES

Swanson, B.D., N.J. Bacon, E.J. Davis and M.B. Baker, (1998) Electrodynamic trapping and manipulation of ice crystals, submitted to *Quart. J. Roy. Met. Soc.*

Vogelmann, A.M. and T.P. Ackerman, (1995) Relating cirrus cloud properties to observed fluxes: a critical assessment, *J. Atmos. Sci.*, **52** 4285-4301.