Measurements of light extinction by single aerosol particle elevated by linear electrodynamic quadrupole

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A new experiment is presented for the measurement of single aerosol particle optical cross section combining laser-based cavity ring-down spectroscopy (CRDS) with a linear electrodynamic quadrupole (LEQ) ion trap in tandem with phase function measurements. The LEQ utilizes the quadrupole field created by four parallel rods spaced in a square pattern with an AC voltage applied to pairs of diametrically opposing rods. The time-varying field constrains charged particles to a point in the two-dimensional plane perpendicular to the rod axes, producing a line of stability along the geometric center [1]. This approach allows direct measurements of the changing optical cross sections of individual aerosol particles over indefinite time-frames facilitating some of the most comprehensive measurements of the optical properties of aerosol particles so far made.

The variation in ringdown time with the position of 1,2,6-hexanetriol particle within the CRD beam is measured. The particle can not only be translated vertically along the z axis by varying DC voltage at the bottom and air flow rate from the top of quadrupole but also along the x-y axis by translating the position of the quadrupole. The measurements illustrate the sensitivity in the ringdown time to the position of the particle within the Gaussian waist of the CRD beam, with the largest reduction observed only when the particle is carefully aligned to the center of the TEM00 mode profile. The radius of 1,2,6-hexanetriol particle at 532 nm is determined from PFs and optical cross section at 405nm is measured over a continuous radius range.

This facility can be also used to measure the optical properties of absorbing aerosols, including brown carbon particulates. These tiny particles affect both the optical properties and the temperature of the Earth's atmosphere. For example, brown carbon absorbs sunlight, can affect the warming of the atmosphere by solar radiation, and can reduce visibility in polluted environments [2–4].

References

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