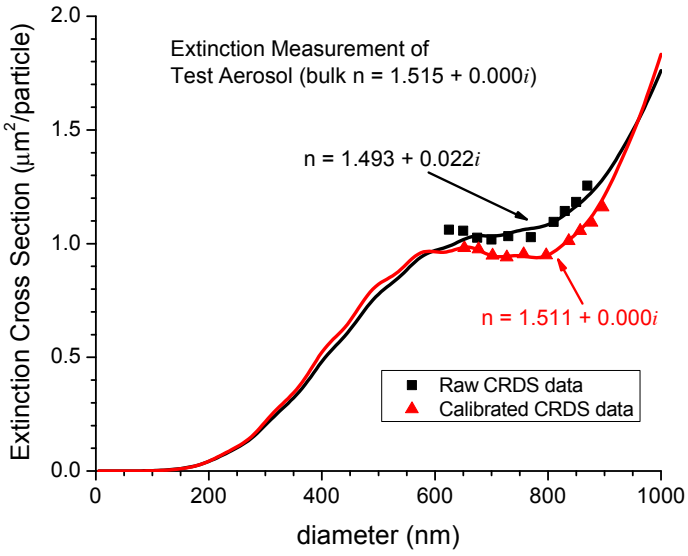
Reducing Uncertainties in Using Cavity Ring-Down Spectroscopy to Measure Aerosol Optical Properties

Justin R. Toole,[1] Lindsay H. Renbaum,[2] and Geoffrey D. Smith[3,*]

[1] Now at the United States Military Academy, West Point, NY, USA
[2] Now at the University of British Columbia, Vancouver, BC, Canada
[3] University of Georgia, Athens, GA, USA
* Corresponding author: gsmith@chem.uga.edu

Cavity Ring-Down Spectroscopy (CRDS) is a highly-sensitive tool for measuring extinction (i.e. absorption and scattering) by gas-phase species as well as aerosols. It has found use in field measurements and increasingly-sophisticated laboratory studies of light absorption and scattering by particles at wavelengths from the UV to the near-IR. It has become possible to use CRDS to examine the influences of particle morphology, coatings and chemical composition on light extinction. However, these influences are often subtle requiring highly-precise and accurate measurements of particle diameter and concentration, and the associated uncertainties can dominate the uncertainties in using CRDS to measure aerosol optical properties.

Here, we present a method for calibrating a CRDS instrument using size-selected aerosols of squalane ($C_{30}H_{62}$), an inert, low-volatility, hydrophobic branched alkane that is liquid at room temperature. Using the known index of refraction of squalane and Lorenz-Mie theory, the distribution of particle sizes selected by the differential mobility analyzer (DMA) and the counting efficiency of the condensation particle counter (CPC) are characterized. This calibration makes it possible to measure particle extinction to within 1% with uncertainties of ± 0.003 on both the real and imaginary parts of the retrieved index of refraction.



Particle extinction cross sections are fit by Lorenz-Mie theory much better when the CRDS instrument is calibrated with squalane (red) compared to when it is not calibrated (black).

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