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Atmospheric
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Discussions

Interactive comment on “Optical properties of absorbing and non-absorbing aerosols retrieved by cavity ring down (CRD) spectroscopy” *by* A. A. Riziq et al.

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General Comments

This paper presents laboratory measurements of aerosol extinction at low relative humidity by cavity ring-down spectroscopy at 532 nm (Nd:YAG second harmonic). Although there are several precedents for this type of measurement (as reviewed nicely by the authors in the introduction), the current paper presents or combines several new aspects. The paper examines extinction by several different aerosol types and mixtures of aerosol types. These include polystyrene spheres as a test aerosol, as well as ammonium sulfate, glutaric acid, sodium chloride, rhodamine 590 and mixtures of these substances. The latter is a prototype for an absorbing substrate (strong absorption maximum at 532 nm). Measured extinctions agree well with the predictions of Mie theory for purely scattering aerosol, particularly for larger sizes ($>$ 350 nm). Derived refractive indices agree with those in the literature. Furthermore, the authors demonstrate determination of both the real and complex parts of the refractive index from Mie theory fits to the size dependence of the extinction of absorbing aerosol. The most novel aspect of the current paper is the comparison of the refractive indices determined from Mie theory to those derived from different mixing rule parameterizations. Although many of the mixing rules tested gave similar results in this particular study, the methodology clearly has the potential for further study to test different mixing parameterizations used in climate models.

The paper is clearly written and merits publication in ACP. The specific comments below are relatively minor, although the authors should take them into consideration prior to publication of the final manuscript.

Specific Comments

1. Page 12352. Equations 3 and 4 are identical and appear numerous times in the recent literature. One could be eliminated for a more concise presentation. In equation 5, it is worth noting (unless I missed it elsewhere), that Qext is the ratio of the Beer's law extinction cross section to the geometric area of the particle.

2. Page 12354, line 6. It is not clear from the description why 4 tubes are needed to ensure mixing of particles within the sample flow in the CRD apparatus (as opposed to a simpler design with a single input and output). It would seem that there is greater potential for particle loss in the flow split that precedes the 4 tube introduction than there would be in a single flow tube.

3. Page 12354, section ii, CRD description. Excitation of multiple modes is almost unavoidable in pulsed cavity ring-down spectroscopy, and although it is in principle desirable to suppress them, the measures described in this section (e.g., spatial filter and

pinhole) do not likely avoid population of multiple cavity modes. It is also not clear why a tight focus on the detector should be beneficial - typically one tries to fill the full surface area of the photocathode. Since it is not possible to ensure the precise population of cavity modes in pulsed CRDS, the only metric of value is how well the ring-down trace matches a single exponential, as the authors describe. The authors should also note that the decay time of 16 microseconds for the empty cavity is not consistent with the specified reflectivity and equation (2), even if Rayleigh scattering losses are taken into account. Finally, is the input energy really as low as 50 microjoules? This is small for a 10 Hz YAG laser. Was there a reason to attenuate the pulse energy to this level?

4. Page 12356, line 7. Standard deviation should be clarified. Is it from repeated measurements of the same quantity, or the errors from linear fits such as those in figure 3? It seems that the merit function itself is very similar to a variance (and could be described as such).

6. Page 12357-8, section ii. Refractive indices here and throughout the manuscript are quoted to 4 significant digits, but no error bars are given. Is there a relationship between the merit function and an error bar estimate for real or imaginary parts of the refractive index? Because refractive indices are compared to literature values, an uncertainty estimate would be helpful. Does the measurement precision support determination to 4 significant figures?

Also, the justification given for the deviation of fits from Mie theory for particles smaller than 350 nm is selection of multiply charged particles by the DMA. The authors could give some estimate of the number of doublets required to give a deviation from the Mie fits in this size range to test this hypothesis. The authors may also wish to consider the possibility of surfactant coatings affecting the smaller particles, as described in the Pettersson et al. reference. For the R590 aerosols, residual methanol could have a similar effect that would be more severe for the small aerosol.

7. Page 12359, line 20. There is a previous exploration of the optical properties of

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mixed organic/inorganic aerosol by Baynard et al. (Geophys. Res. Lett., L06813, doi:10.1029/2005GL024898). This reference is concerned mainly with RH dependence, but uses aerosol generation and analytical methods similar to the current paper.

8. Page 12360, section iv. The presentation of the data in tables 2,3,5 and 6 could be clarified. If I understand this correctly, the numbers in the tables are those predicted from the mixing rules. The refractive indices obtained from the retrievals should be given for comparison rather than just the merit function values.

Typographical Errors

1. Page 12354, line 3. 3/3" tubing.

2. Figures 8a and 8b listed in the text are given as Figures 8 and 9.

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 12347, 2006.

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