

Interactive comment on “Electrodynamic balance measurements of thermodynamic, kinetic, and optical aerosol properties inaccessible to bulk methods” by S. S. Steimer et al.

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Received and published: 20 April 2015

The authors would like to thank Referee #1 for the comments and queries. We address the reviewer’s comments in our response given below. We will incorporate corresponding changes and clarifications in a revised version of the manuscript.

Referee #1: “The method becomes difficult to apply if the rate of size change is small”. What is the rate of change limit?

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Authors’ response: The ‘rate of change’ limit refers to measurements performed with fixed wavelength, i.e. one of the techniques used traditionally. It relies on a monotonic change of size to convert the temporal appearance of resonances to size versus time. In our approach with a wavelength tunable light source there is no general ‘rate of change’ limit other than that it is convenient for the analysis if the size during a scan can be assumed to be constant. But if the rate of size change becomes large and this assumption is no longer valid, the size can be still retrieved taking the change during the scan into account. We did discuss this problem in some detail in Zardini et al. (2006).

Referee #1: What is the particle size limit of detection, several resonances are used to accurately size, but at what point does this method start to become unfeasible?

Authors’ response: Yes, we do need several resonances for particle sizing. Since we measure both polarizations the lower limit in size is about 4–5 μm radius for the tunable range of the laser we use. Of course a laser with a broader tuning range and /or a shorter wavelength would allow to measure smaller particles. We will add a corresponding sentence to the revised manuscript.

Referee #1: How do you know you are at 78-101deg scattering angle? As light collection is slightly off-centre did the authors use a shifted angular range that repetitively gave a better particle size and refractive index fit, or was this angle measured with respect to 90 degrees?

Authors’ response: A rough estimate of the scattering angle range can be made by pure geometrical considerations. We do record the scattering phase function through the same optics we use for measuring the resonance spectra, i.e. also the same

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scattering angle range. We used PSL spheres of known sizes to compare measured with computed phase functions to determine the scattering angle more precisely. However, the spectral position of the sharper resonances does not depend strongly on scattering angle, hence the retrieval does not suffer severely for the precision in size we aim for if there is a slight offset in scattering angle. More precise size retrievals do require a very precise knowledge of scattering angle [see e.g. Huckaby et al., 1994].

Referee #1: Page 693. Section 25. “..and measure both polarizations sequentially”. How long between measurements from the two polarizations? Would this affect measurement of highly volatile compounds?

Authors’ response: The spectra shown in Fig. 1 of the paper were recorded with a scanning speed of 0.04 nm/s, i.e. a spectral scan took a little less than 6 minutes. The measurement of the other polarization follows immediately. This requires that at the times when we take high resolution spectra, the humidity within the glass chamber is constant. But we can take the low resolution spectra at much higher rate (up to several Hz) so that constant humidity is only required at few selected humidities. Measuring high or even moderately high volatility compounds is however difficult, because this adds another unknown for the retrieval of composition from size or mass change. We have restricted our measurements to low volatility compounds so far and will add a corresponding sentence to the revised manuscript.

Referee #1: Fig 2 caption (a). “Relative humidity measured close to the droplet”. Is the RH probe taking measurements inside the cell or on the RH line before the chamber?

Authors’ response: As we write on page 692: ‘Relative humidity (RH) is measured by a capacitive RH probe with an integrated temperature sensor (U.P.S.I., France,

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model G-TUS.13R) mounted in the upper end cap of the EDB in close proximity to the levitated particle (< 10 mm distance).’ In addition we measure RH before and after the chamber with additional probes of the same type. See also our corresponding reply to referee #2.

Referee #1: Page 694. Section 20. The authors state the $m(\text{TDL})$ real part of the refractive index has an accuracy of better than 0.005. But the values quoted in figure 4 are noted as $m(\text{TDL}, \text{H}_2\text{O}) = 1.3292$, $m(\text{TDL}, \text{s}) = 1.541$, $m(\text{D}, \text{H}_2\text{O}) = 1.3334$ and $m(\text{D}, \text{s}) = 1.574$. This accuracy does not match with the limits of the experimental detection. Why is there such a difference for the two $m(\text{TDL})$ values? Is the 0.005 accuracy a conservative value?

Authors’ response: The values stated in the caption of Fig. 4 are from literature (for pure water) and are the values from the regression line of Fig. 4 for the pure solute. We consider to be more precise than our individual high resolution measurements.

Referee #1: Fig 7 Caption. Should include, “three different shikimic acid particles”, in the description.

Authors’ response: We will add ‘shikimic acid’ to the description in the caption in the revised manuscript.

References:

Huckaby, J. L., Ray, A. K., and Das, B., Appl. Opt. 33, 7112–7125, (1994). Zardini, A. A., Krieger, U. K., and Marcolli, C., Opt. Express 14, 6951–6962 (2006).

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