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Atmospheric Measurement Techniques Discussions

Interactive comment on "Method to measure the size-resolved real part of aerosol refractive index" *by* G. Zhao et al.

Anonymous Referee #2

Received and published: 10 April 2019

General comments:

The present manuscript describes a method for deriving the real part of the refractive index by means of a differential mobility selector (DMA) and scattering intensities measured with a SP2. The derivation of the real part of the refractive index of a quasi mono disperse aerosol is not completely new. What is new, however, is the application with the use of the SP2, which in a unique way can also determine the mixing state of the aerosol within certain limits. This ensures that errors caused by unknown imaginary parts of the refractive index are minimised. The method shown is limited to non-absorbent particles.

The reviewer thinks that the current limitations and consequences have not been adequately presented. In particular, a consideration of the uncertainties in violation of the

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restrictions (weakly absorbing particles) is lacking.

In laboratory experiments, as shown with ammonium sulfate and ammonium chloride, this is easily possible. The application to a complex ambient aerosol, on the other hand, was not treated sufficiently. The example shown in chapter 4.1 shows results of measurements in Beijing, where a complex mixed aerosol is present (that measurement place was characterised as urban roadside; line 96).

An error estimation is missing: a) what happens with weakly absorbing organic droplets, b) what happens with internally mixing particles with a small soot core when the incandescence signal is below the detection threshold of SP2. How large are the expected errors in the real part of the refractive index?

The reviewer believes that this work can make a good step in the optical characterisation of sub-micrometer particles using the SP2, and that subsequent work can build on it. Therefore, the reviewer thinks that the manuscript can be published after a major revision.

Specific comments:

Title: The method shown is very general, but applied to SP2 in the present study. The study is thus adapted to the size range, the size resolution and the optical geometry of the SP2. The author should consider whether the application of the method to SP2 should be mentioned in the title.

Introduction: Can the author give a first estimate on the accuracy of RRI measurements required to make statements on the chemical composition?

Line 36: Typo: “Hänel”

Lines 89, 90: The measurements provide the necessary data in five minute intervals. However, no conclusion can yet be drawn that the RRI can be derived with a time resolution of five minutes.

Line 121: to be precise, the power is about 1 W/m2 circulating power in cavity

Line 131: what is the unit of the peak height H.

Lines 133,134: How were BC containing particles ruled out for ambient measurements.

Section 3.1: Shouldn't the signals be the same value at 45° and 135° due to the circulating wave in the cavity?

Line 145: To avoid misunderstandings: The SP2 can determine the scattering signal in a certain scattering angle range. But not the scattering coefficient!

Figure 2: Is the scattering strength the same as the scattering intensity S? Please use consistent notations.

Line 151: monotonously instead of homogeneously

Line 159: Establishing the threshold value at 1000 seems somewhat arbitrary. Is there a justification for this?

Line 165: It would be better to read to bring figure S2 und figure 3 together.

Lines 166 and 167: Refer to figure S1

Line 175: Please check that sentence. I can't see different marker for different diameters. Is fig. 2 the correct figure?

Line 177: What is "PH0"?

Line 180: Shouldn't it be Fig 3.

Lines 180,181 and Figure 3: Check if the peak height is plotted versus the mobility diameter Zp and not versus the geometric diameter Dp?

Line 184: "Dp superscript tilde" not defined

Line 184: There is no dashed line in figure 2

Lines 194 and 200 : Please bring references for the refractive index

Figure 4a: Should be scattering intensity instead of scattering strength

Lines 192 – 208, Figure 4: For the reader it is not obvious at first sight which value was calibrated! What is the value of the calibration factor C? The reviewer thinks it is worth giving a short summary list of all steps necessary for deriving RRI. For an absolute calibration, the slope of about unity is more important than the references to the correlation coefficient. The high correlation coefficient is, as written, a good indicator for the potentially high accuracy of this method.

Line 211: It would be good to have some additional information, e.g. the mean BC concentration and the number of fractions of internally/externally mixed particles and coated particles provided by SP2. How was it ensured that the purely externally mixed non-absorbent particles were used in the calculation of the RRI?

Line 216: Can the authors estimate the fraction of the light scattering size distribution that is covered.

Lines 22ff: The uncertainty of the transfer function is covered by the H fitting, since the transfer function is a system function and relatively stable and also covered by a DMA calibration with size standards. How are other influences taken into account, e.g. uncertainties in sheath air flow or CPC counting efficiency?

Line 225: HW not defined

Line 227 to 229: Does this mean that the additional broadening by the H distribution function is 1.073?

Lines 230,231: Can the authors give more details about the uncertainty analysis?

Lines 243, 244: How can it be ensured in a mixed aerosol that BC containing particles are excluded and how big would the error be if small amounts of BC affect the measurement?

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