

Interactive comment on “A new electrodynamic balance design for low temperature studies” by H.-J. Tong et al.

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The manuscript describes an electrodynamic balance (EDB) designed for low temperature studies and demonstrates its capabilities by reporting water droplet evaporation rates and immersion freezing rates at temperatures between -35°C and 0°C .

The EDB consists of coaxial cylindrical segments in a design introduced by Heinisch et al. 2006, which facilitates the exposure of the levitated particle to and core/sheath gas flow. The novel aspect is the utilization of the gas flow for particle cooling, while the trap electrodes and housing are not actively cooled. Some of the characteristics of the apparatus are detailed by describing measurements of droplet evaporation rates and immersion freezing rates performed with this setup.

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General comments: I feel that in its current form, the manuscript is not suitable for publication in AMT.

Even though the idea of cooling a levitated particle purely by gas flow is interesting and worth exploring, this manuscript does neither assess the merits and disadvantages of such a design nor does it give the necessary information for this.

Below follow some important points, which should have been addressed in much more detail:

There is too little detailed information on the overall experimental setup (sizes, materials, measures) apart from the cursory figure 1.

There is too little experimental characterization on the EDB performance:

No information is given on the stability of particle trapping under the various experimental conditions, or on the admissible range of gas flow, and how it affects the performance of the EDB.

The axial and radial temperature profile inside the EDB is qualitatively discussed but no measured data (ideally at various set temperatures) are given.

The main drawback of the chosen design is the use of an integrated liquid nitrogen cold trap for the precooling of the gas flow, which inevitably results in an extremely dry gas flow around the droplet. This excludes experiments at environmentally relevant conditions and leads to a rapid evaporation of the droplet even at low temperatures. This effect is aggravated by the fact that the droplet evaporates not into a stagnant atmosphere, but into a gas flow. The authors mention this fact briefly but do not discuss its implications or possible remedies.

A rapidly evaporating droplet will assume a temperature that is lower than its surrounding. This effect is neither discussed in the manuscript nor is it considered in the following experiments on evaporation and immersion freezing.

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Even though I understand that the experiments described are to illustrate the capabilities of the EDB, I am missing important information, which the authors should provide: Evaporation rates of water droplets: How do the measured evaporation curves compare to theoretical expectations? Why is the time for evaporation proportional to the radius? What does this tell us about the flow characteristics? How do the measured evaporation rates compare to droplet evaporation into a stagnant atmosphere of zero RH? What are the expectations based on the literature on evaporation into an laminar gas flow?

Immersion freezing of birch pollen washing water: How do the evaporative cooling and the continuous volume reduction affect the freezing rate? How were the ice fractions in Fig. 7 determined? Why are there no vertical error bars? How many droplets have been investigated at each temperature? When comparing to published data, the authors have to take into account the sample volume, not just the concentration of active material.

Presentation quality: I enjoyed the introduction. The rest of the manuscript concentrates too much on minor issues but misses many important points.

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