A new mobility analyzer for routine measurement of atmospheric aerosol in the diameter range of 0.4−7.5 nm

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A new instrument called the Symmetric Inclined Grid Mobility Analyzer SIGMA was developed for applications in atmospheric aerosol nucleation research with special attention to long-term routine measurements in natural atmospheric conditions. The instrument was elaborated using the experience of the preceding scanning mobility analyzers IGMA (Inclined Grid Mobility Analyzer, Tammet, 2003) and BSMA (Balanced Scanning Mobility Analyzer, Tammet, 2006). The mobility range of 0.032−3.2 $cm^2V^{-1}s^{-1}$ includes charged clusters and fine nanometer particles called air ions. Different of the previous instruments the positive and negative ions are sampled simultaneously from the same inlet air flow. The ions are canalized by the electric field into two symmetric sections of the aspiration condenser explained in Figure 1.

The configuration of the aspiration condenser was optimized using a numerical model, which was a crucial tool allowing to discover the possibility to separate positive and negative ions entered from the common inlet. The ions are independently distributed into the mobility fractions and the size fractions in the range of 0.4−7.5 nm while the voltage borders of the size fractions are determined considering the simultaneously measured air temperature and pressure. A high air flow rate of 32 dm^3/s and the isopotential principle suppress the disturbing effect of the external electric field and assure representative sampling of the finest charged particles. The loss of air ions in the inlet tract due to adsorption is 5% at the mobility of 1 $cm^2V^{-1}s^{-1}$. The sheath air is sucked into the instrument directly from the atmosphere together with the analyzed air and deionized by means of electrostatic filters. Natural humidity of the sheath air, the short residence time of 0.16 s and low heating of the air less than 0.5 K suppress the risk of changing of the ions during the measurement. The ions are collected by shielded and well-insulated electrostatic filters powered by the included miniature batteries. The analyzer is controlled via USB interface. The scanning technique assures that possible peculiarities in the recorded mobility distribution are not generated by technical troubles of individual mobility channels.

Two decades of mobility are logarithmically uniformly divided into 16 fractions and the fraction concentrations are recorded with 5-minute time resolution at the standard regime. The standard deviations of random errors in the mobility fraction concentrations of 1–4 nm particles are about 1 cm^{-3}. A time resolution of 20 s is available at random errors between 4 and 10 cm^{-3}.

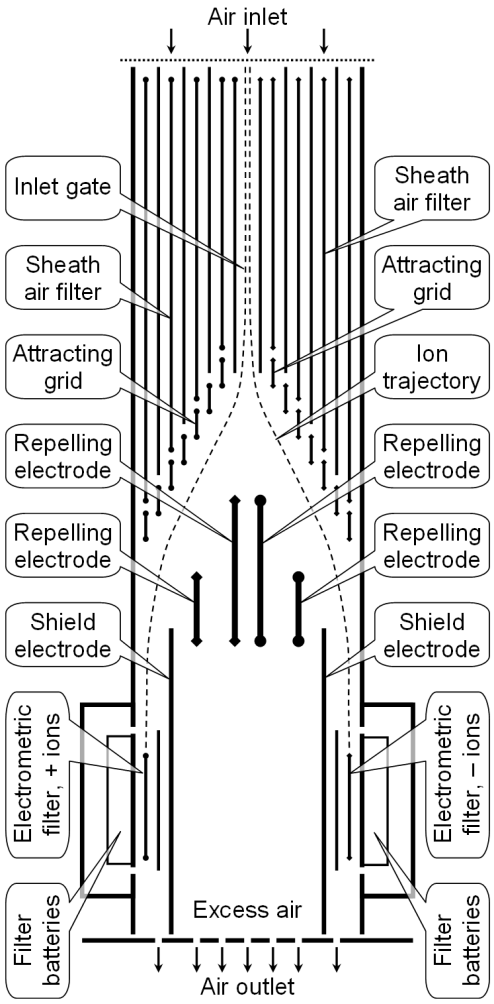

Figure 1. Simplified section of the planar aspiration condenser. The ends of lines indicate the polarity of plates: rhombs mark positive, round spots negative, and plain ends zero potential. The real geometric edges of all plates are still plain.

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