A new version of the Particle Size Magnifier for detection of airborne molecular clusters and nano-particles as small as 1 nm

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There is a growing demand on measuring airborne particles and clusters even down to the size of 1 nm. For instance, the new particle formation process is not yet completely understood on a molecular level, mainly due to the lack of suitable instrument to detect the recently formed particles. The new generation of condensation particle counters (*e.g.* Vanhanen *et al.,* 2011, Jiang *et al.,* 2011, Wimmer *et al.,* 2013) allow deriving parameters describing the new particle formation process, *e.g.* the formation and growth rates, directly from measurements also in the size range below 2 nm (Kirkby *et al.,* 2011; Kuang *et al.*, 2012; Kulmala *et al.,* 2013).

The Airmodus Particle Size Magnifier (PSM; Vanhanen *et al.,* 2011) can be used to resolve the size distribution of particles below about 3 nm. The cut-off size of the instruments was varied between 1-2.5 nm by altering the mixing ratio of saturator and aerosol flow and thus changing the supersaturation created. A schematics of the instrument is presented in Fig. 1.

The relation between the flow mixing ratio and activation diameter in the PSM has been determined in laboratory calibrations using size-selected ammonium sulphate ions. The PSM was found to activate ammonium sulphate clusters consisting of just a few molecules, and it was able to detect even single large molecules, for example tetra-alkyl ammonium halides. Clusters and particles of different composition activate at slightly different flow rate, indicating that there is a material dependency. This is further studied in Kangasluoma *et al.,* (2013).

The A09 PSM have been used to measure the size distribution of particles between 1 – 3 nm in field measurements *e.g.* at the Hyytiälä SMEAR II measurement station in southern Finland (Kulmala et al., 2013) and at the CLOUD experiments in CERN (Kirkby et al., 2011). The data was compared to neutral clusters measured with the CI-APi-TOF mass spectrometer (Jokinen *et al.,* 2012), and to ion clusters measured with the APi-TOF (Junninen *et al.,* 2011). By combining the PSM and the new mass spectrometric methods it is possible to cover the whole size range from molecules to aerosol particles.

A new version of the Particle Size Magnifier, A10, was developed during 2012-2013. It includes modifications especially in the air and liquid flow design. A special care has been taken in making the instrument stable in varying operating conditions. The A10 PSM has been tested in the laboratory, and it will be take part in atmospheric field measurement campaigns during spring 2013.

A special version of the A10 PSM will be used as a counter in the Gas Aerosol Nucleation Spectrometer built in the GANS project (http://www.gans-project.eu/, Dohányosová et al. 2013).

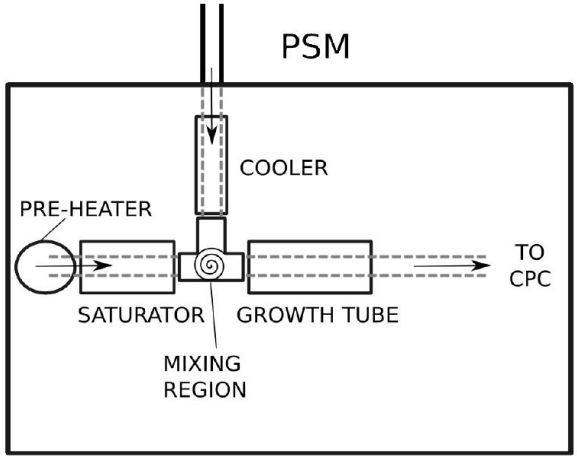

Figure 1. Schematics of the Particle Size Magnifier. Sample air is going from the inlet through a cooler before being mixed with saturated clean air in the mixing region. Particles grow to about 90 nm in the growth tube before they are directed to a counter CPC.

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