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Characterization of tandem aerosol classifiers for selecting particles: implication for eliminating the multiple charging effect

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1 Calculation of volume equivalent diameter

The fitted PNSD$_{ae}$ for each experiment was converted to number volume-equivalent size (d_{ve}) distribution (PNSD$_{ve}$). According to Eq. 26, d_{ve} is determined by,

$$m = \frac{\pi}{6}\frac{Cc(d_{ae})\rho_0 d_{ae}^2 d_m}{Cc(d_m)}, \tag{S1}$$

$$\frac{\pi}{6}\rho_m d_{ve,n}^3 = \frac{\pi}{6}\frac{Cc(d_{ae})\rho_0 d_{ae}^2 d_m}{Cc(d_{m,n})}, \tag{S2}$$

where $d_{ve,n}$ is volume equivalence diameter, ρ_m is particle density, and ρ_m =1.8 g cm^{-3} is used, $d_{m,n}$ is the corresponding electrical mobility diameter for particles with n charges. Assuming that all the particles have the same electrical mobility as it classified by DMA, according to Eq. 1, the $d_{m,n}$ of particles with single, double and triple charges can be calculated, respectively. It should be noted that in Fig. 5b, three peaks have the same d_{ae} range but different d_m. As a result, their d_{ve} ranges were different. The number concentration of dN/dlog(d_{ae}) were converted to dN/dlog(d_{ve}) using the calculated d_{ve} range.

2 Classification limitations of DMA-AAC

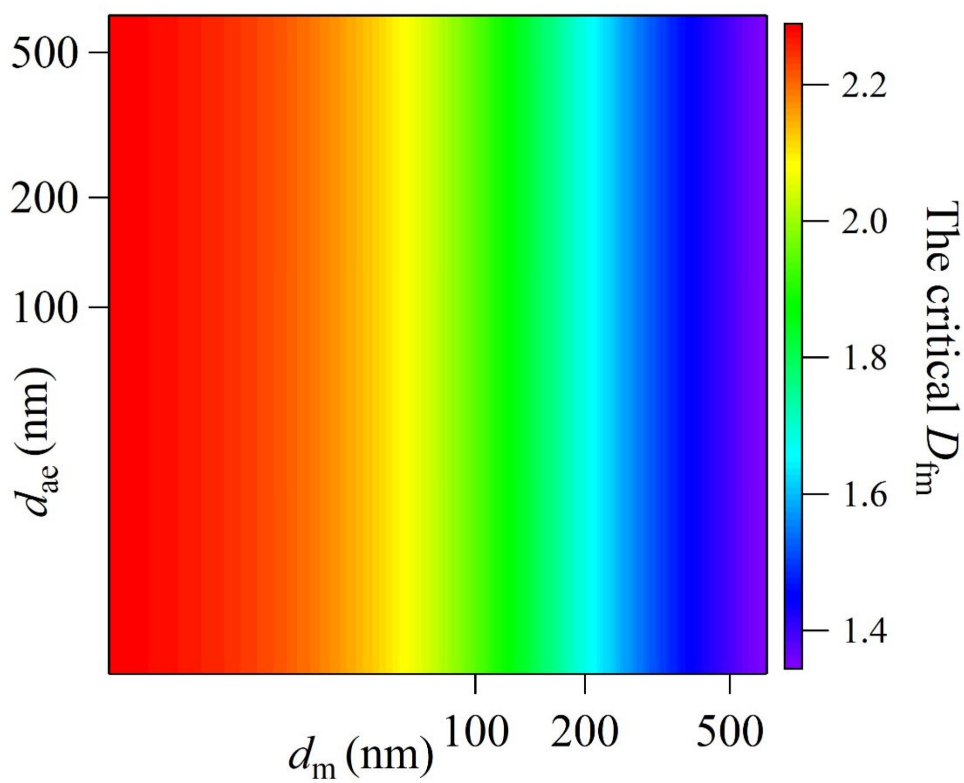

Figure S1: Variations of the critical D_{fm} as a function of classified d_m and d_{ae}. The following parameter set was employed for the calculations: β_{DMA} = 0.1, β_{AAC} = 0.1. The background color coding denotes the critical D_{fm}. The background color coding denotes the critical D_{fm} of particles that DMA-AAC can select monodispersed particles.

3 Determine the mode d_{ae} and m of mobility selected particles

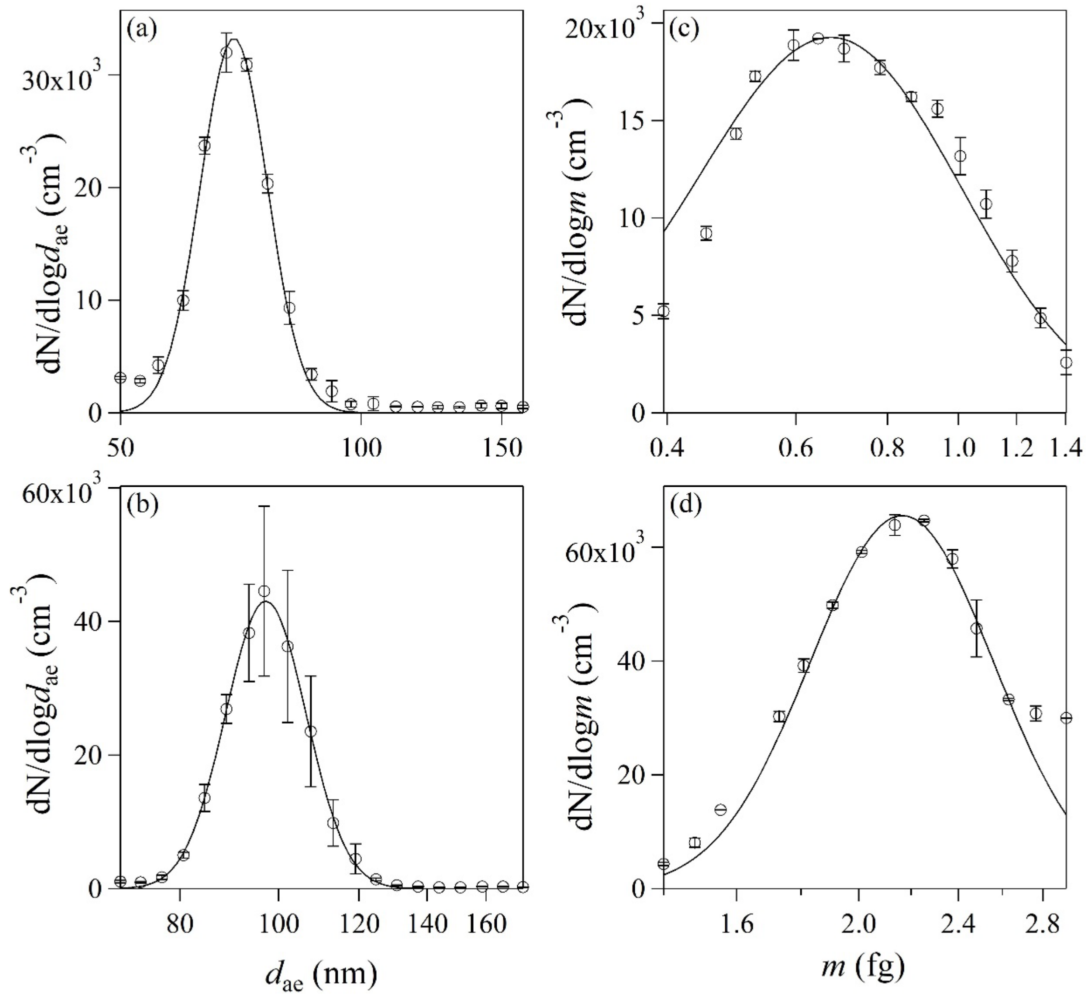

Figure S2: The number aerodynamic diameter distributions of particles selected by DMA at (a) d_m of 150nm and (b) 250 nm. The number mass distributions of particles selected by DMA at (c) d_m of 150nm and (d) 250 nm.

4 Classification results for two sizes soot particles

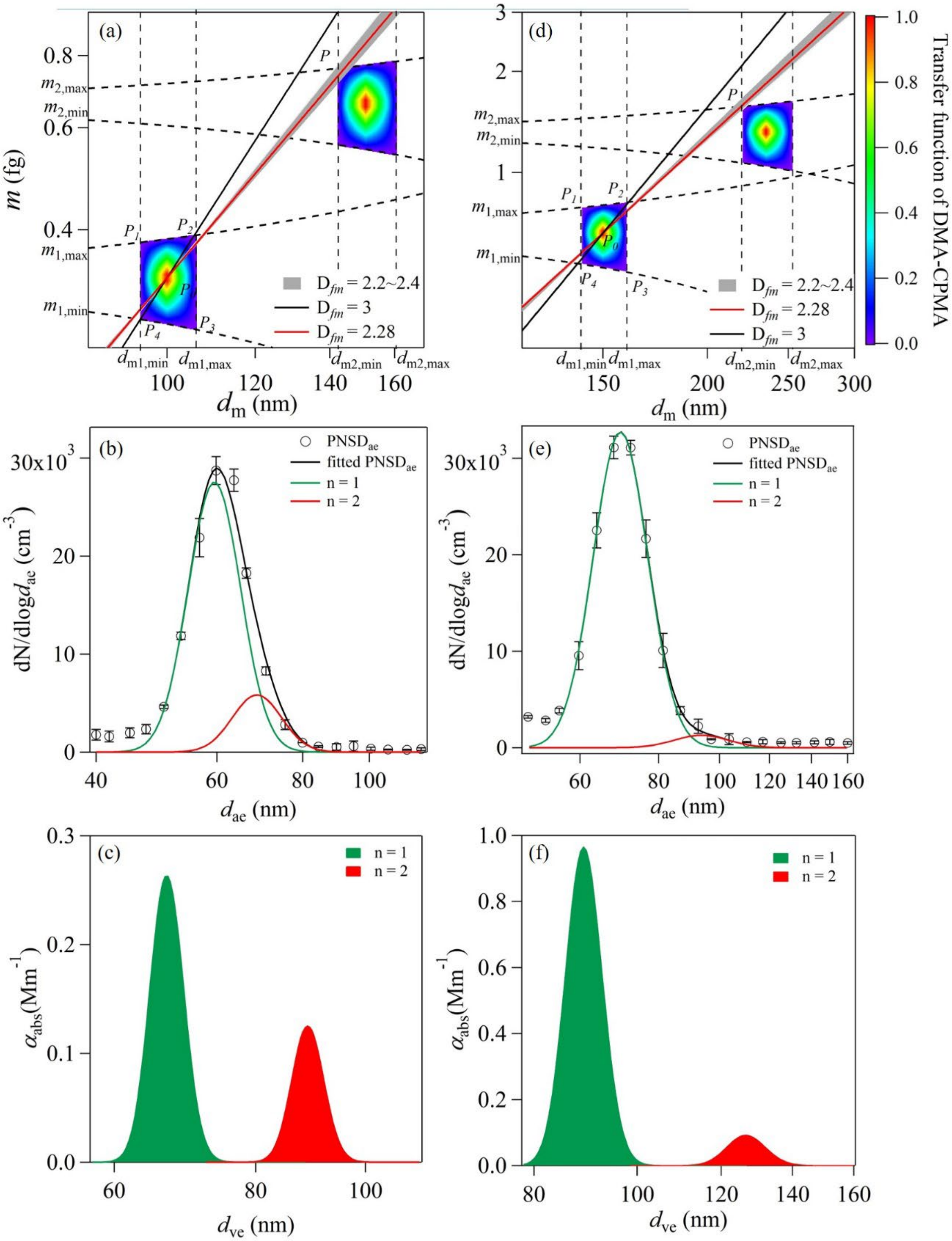

Figure S3: (a) The transfer functions of DMA-CPMA when selecting 100 nm particles. The following parameter set was employed for the calculations: d_{m1} = 100 nm, β_{DMA} = 0.1, m_1 = 0.27 fg, Q_{CPMA}=0.3 L min^{-1}, R_m = 8. (d) The transfer functions of DMA-CPMA when selecting 150 nm particles. The following parameter set was employed for the calculations: d_{m1} = 150 nm, β_{DMA} = 0.1, m_1 = 0.66 fg, Q_{CPMA}=0.3 L min^{-1}, R_m = 8. The red solid line is the generated soot particle population. (b) and (e) are the aerodynamic size distributions of particles classified by

DMA-CPMA for 100 and 150 nm particles, respectively. The circles are data measured by AAC-CPC and the black, green and red lines are log-normal fitted distributions of bulk, singly charged and doubly particle population. (c) and (f) are the contributions to light absorption of particles with single and double charges when selecting 100 and 150 nm particles.

5 Classification limitations of DMA-CPMA

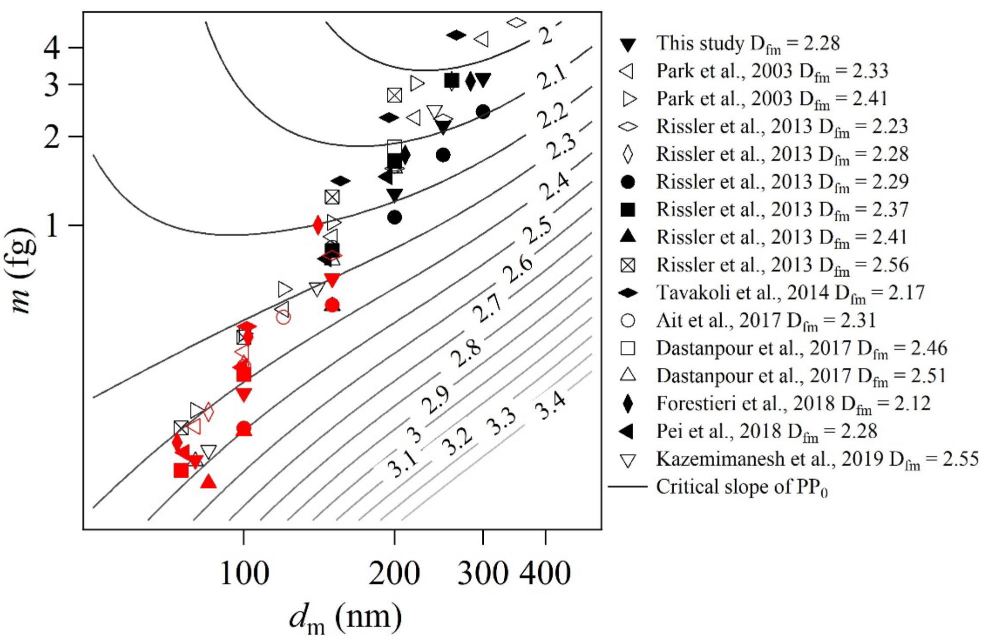

Figure S4: Variations of the slope of PP_0 as a function of classified d_m and m. The following parameter set was employed for the calculations: β_{DMA} = 0.1, Q_{CPMA}=0.3 L min^{-1}, R_m = 8. The contour lines denote the slope of PP_0, with values labeled on them. The data points are soot particles measured in the literature (Park et al., 2003; Rissler et al., 2013; Tavakoli et al., 2014; Ait Ali Yahia et al., 2017; Dastanpour et al., 2017; Forestieri et al., 2018; Pei et al., 2018; Kazemimanesh et al., 2019) and generated in this study (see details in Section 3.2). The D_{fm} values of these data points are listed in the legend. The data points become red when D_{fm} is smaller than the critical slope of PP0 in the background, i.e., the potential multiple charging effect may exist.