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Continuum regime motion of a growing droplet in opposing thermo-diffusiophoretic and gravitational fields of a thermal diffusion cloud chamber

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Abstract

A model for the motion of aerosol particles by Stefan flow, thermo-diffusiophoresis and gravity in a continuum regime is described, which considers a phase change on the particle surface. It is tested in a thermal diffusion cloud chamber where a droplet formed by nucleation quickly grows and simultaneously moves upwards due to vertical temperature and concentration gradients. Kinetic coefficients are assumed to be constant. Model predictions of the height where the droplet reverses its motion are in satisfactory agreement with the experimental results of Ždímal et al. ((1996). *Colloids Surfaces A*, 106, 119). The droplet motion seems to be predicted well at higher gradients and vapor fluxes, but model underestimates droplet motion at lower ones. For those cases also the free-molecule and transition regimes need to be included.

Keywords: Thermal diffusion cloud chamber; Droplet growth; Continuum regime; Droplet motion

1. Introduction

In past three decades, thermal diffusion cloud chambers (TDCC) became an important tool for studying nucleation in supersaturated vapors (Katz & Ostermier, 1967; Heist & He, 1994). As far as kinetics of homogeneous nucleation are concerned, the method of TDCC has no substitute in the region of low rates. An approach developed by Smolík and Ždímal (1994) makes it possible to

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