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Icy dust condensation in random channels: Application to Enceladus' Plume.

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We investigate scenarios for the condensation of ice grains in water gas vents at Enceladus' south pole. The gas emanating from the polar region escapes from hot subsurface regions to vacuum through a system of cracks. By expansion the gas becomes over-saturated and condensation sets in. We present a thermodynamically consistent model for condensation and particle growth in channels of variable cross section. It couples the hydrodynamic equations for the gas with thermodynamic equations for the phase transition. For the nucleation rates we use relations following from experimental data for water vapor at various temperatures and degrees of the over-saturation. We consider cracks or channel with random geometry which are characterized by the ratio of the most wide to the most narrow cross section and by the minimal characteristic length at which the channel width alters. This parameters are assumed to be uniformly distributed. Averaging over plausible ranges of parameters of the channel geometry, our model yields a distribution of particle sizes ranging from a fraction of a micron to a few microns. The observed particle size distribution qualitatively corresponds to a power law.