

Kinetic Behavior of Aggregation-Fragmentation Process with Annihilation

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(Received: 2001-5-30; Revised: 2001-8-16)

Abstract: The kinetic behavior of an aggregation-fragmentation-annihilation system with two distinct species is studied. We propose that the aggregation reaction occurs only between two clusters of the same species, and the irreversible annihilation reaction occurs only between two clusters of different species, meanwhile there exists the fragmentation reaction of a cluster into two smaller clusters for either species. Based on the mean-field theory, we investigate the rate equations of the process with constant reaction rates and obtain the asymptotic descriptions of the cluster-mass distribution. In the case of the same initial concentrations of two species, the scaling descriptions for the cluster-mass distributions of the two species are found to break down completely. It is also observed that the kinetic behaviors of distinct species are quite complicated for the case of different initial concentrations of the two species. The clusters of larger initial concentration species (heavy species) possess peculiar scaling properties, while the cluster-mass distribution of light species has not scaling behavior. The exponents describing the scaling behavior for heavy species strongly depend on its fragmentation rate and initial monomer concentrations of two kinds of reactants.

PACS: 05.45.-a

Key words: kinetic behavior, aggregation-fragmentation-annihilation process, scaling description, rate equation

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