Breakdown of Scaling in Aggregation-Fragmentation-Annihilation Process of n-Species Systems

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Abstract: The kinetic behaviors of aggregation-fragmentation-annihilation processes of three n-species systems are studied in this paper. Aggregation reaction occurs only between the same species but irreversible annihilation reaction occurs between two different species, and meanwhile the fragmentation reaction coexists. Based on the mean-field theory, we investigate the rate equations of the processes and obtain the asymptotic descriptions of the cluster-mass distributions for the symmetrical cases. We find that the fragmentation reaction may lead to the complete breakdown of the standard scaling description for the cluster-mass distribution of each species contrast to the scaling behavior of aggregation-annihilation processes without fragmentation. In our joint annihilation model, we also observe that the kinetic behaviors of distinct species are quite complicated for the case with different initial concentrations. The cluster-mass distribution of heavy species with the largest initial concentration possesses peculiar scaling properties, while that of light species has not scaling behavior.

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