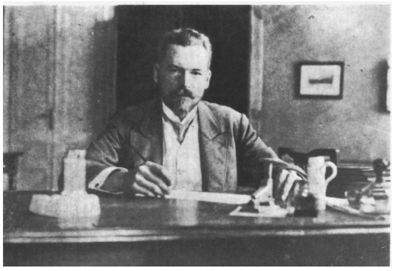

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Hopf bifurcation in addition-shattering kinetic equations

Tuesday, 28 September 2021 18:09 (3 minutes)

We explore dynamical properties of addition-shattering kinetic equations. For a long time researchers believed that only possible asymptotic regime in closed systems was a steady state. However, stable oscillatory solutions were recently discovered in a series of numerical experiments for a closed system of kinetic equations describing simultaneous aggregation
[i] $\oplus [j] \ \to K_{ij}\ [i+j] andshattering [i] \oplus [j] \ \to \lambda \cdot K_{ij}\ \underbrace{[1] + \cdots + [1]}_{i+j} processes, where$K$_{ij}$ are kinetic rates and weight $0 < \lambda \ll 1$ corresponds to the intensity of shattering.

We attempt to theoretically justify the observed effect and consider a simplified model of the addition-shattering processes. The addition can be represented as [1] $\oplus [s] \ \to A_s\ [1{+}s] andthespontaneousshatteringas [s] \ \to B_s\ \underbrace{[1] + \cdots + [1]}_{s} . Forthissystemwith$A$_s = s$ and $B_s = Bs^{\beta}$ we study the stability of the steady-state particle size distribution by studying the eigenvalues of the Jacobi matrix of the nonlinear addition-shattering operator. For a certain region of the parameter space we show the existence of stable persistent oscillatory solutions. They arise when the steady-state particle size distributions lose stability via Hopf bifurcation.

Until now, researchers demonstrated only stationary solutions for aggregation models with linear fragmentation terms but in our work we show that stable oscillations are possible for such class of systems. This work is supported by Russian Science Foundation project 19-11-00338.

[1] Budzinskiy S., Matveev S., Krapivsky P. (2021). Hopf bifurcation in addition-shattering kinetics. PRE, L040101.

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