STEVENS Institute of Technology

Arthur E. Imperatore School of Sciences & Arts

Department of Mathematical Sciences

Seminar in Nonlinear Systems

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Phase Transition and Uniqueness in the Coagulation-Fragmentation Kinetics

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Abstract: The celebrated Smoluchowski equation (1916) is a classical nonlinear kinetic model that describes the evolution of merging and splitting particles (macromolecules, smoke, droplets, planets, etc). This equation was derived as a balance equation that satisfies the mass conservation law. However, McLeod, Leyvraz, Tschudi, Ernst, and Ziff found that, for high intensities of coagulation, the Smoluchowski equation may generate a solution with phase transition. This phase change corresponds to breaking down the mass conservation law, which, in terms of colloid and polymer chemistry, is usually associated with gel transition and the formation of a huge ”superparticle”. The question of what rates of coagulation and fragmentation cause the infringement of the mass conservation law is still far from a solution. In this talk we state, and outline the proof of, existence and uniqueness theorems for sublinear coagulation rates and show via counterexamples that even a minor change in the theorems' statements causes non-uniqueness of the solutions. Moreover, the appearance of such a bifurcation breaks down the mass conservation. This fact and an additional relation between the phase transition and uniqueness explaines why the mass conservation law breaks down for sublinear coagulation rates. If time allows, we also mention estimates for the blow-up time for the multiplicative coagulation rates, which are especially important in polymer chemistry. By the construction of a new coagulation equation, we find an explanation for the blow-up in the coagulating system and demonstrate a great proximity of the results for both (Smoluchowski and new) coagulation models.

Refreshments provided

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