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Similarity Solutions for Coagulation Equations

Similarity or group invariant solutions play a distinguished role in the analysis of qualitative properties of solutions of several nonlinear problems. In this talk I will present two generalized methods that determine similarity solutions for the coagulation equations that describe the evolution of the size distribution function of a system of particles. Analytical solutions to the coagulation equations and explicit formulas for the moments of solutions are only known for a restricted class of coagulation rates (coefficients). Similarity solutions are interesting particular solutions that describe the behavior of the general solutions of the coagulation equations. The first is an indirect method applied to a partial differential equation associated with a new modified form of the coagulation equation. This method determines a local Lie group of point transformations that leaves the PDE invariant. The second method is a new generalized version of the direct methods that determine the symmetry group of the point transformations to integro-differential equations. We apply this second method to the coagulation equation directly. These methods provide us with a new family of exact and asymptotic solutions to the coagulation equations which can be further used for numerical studies. The advantage of these methods over previous methods is that in some special cases the expression of the total mass of particles does not need to be known in advance.