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# Some Applications of Evolution Modelling for Multi-Particle Systems in the Kinetic Model Framework[1]

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In this paper, we will describe our experience in application of kinetic models in the rarefied gas dynamics, as well as in some other areas: coagulation of particles, vehicular traffic flows, and prices formation in the market. In all these cases, the use of the integral equations and the corresponding Markov chains allows to extend the well-developed theory of weighted Monte Carlo methods to the problems under consideration. Moreover, this makes it possible to estimate the parametric derivatives of the solution. This is especially important when one studies the influence of various parameters on the solution of the nonlinear kinetic equations.

## 1 Introduction

A number of mathematical physics problems could be reduced to the estimation of some linear functionals of solutions to integral equations. This is mainly because a mathematical model of such problems is constructed based on the corresponding stepwise Markov process, which terminates with probability one. The transition density of the latter process is the substochastic kernel of the integral operator, which describs the evolution of the system during single a step. The first example of such equation is the nonlinear kinetic Boltzmann equation, which remains the basis of the kinetic theory of gases. This integro-differential equation describes the dynamics of a rarefied gas and was derived by Ludwig Boltzmann in 1872. The nonlinearity of this equation lies in the collision integral, which describes the pair interactions of particles.

Though the kinetic equation was first obtained for the homogeneous relaxation of a single component ideal gas, the range of its applications turned out to be much wider. Boltzmann type equations are used to study the radiation transfer in matter, neutrons transfer in a nuclear reactor, electrons transfer in solids and plasmas, and also to study the growth of droplets in clouds, defects in materials, gas pores in metals, etc.

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# 2 Applications

In this paper, we summarize our approaches earlier developed in the field of multi-particle systems modelling for various problems such as: rarefied gas relaxation (see, for example, [1]), particle coagulation [1, 3, 5], vehicular traffic flow [2, 4] and price formation [6]. All these problems are described by the Boltzmann type equations. To solve them numerically, we propose to use the integral equation of the second kind and the weighted modelling using the Markov chain, which is uniquely determined by the coefficients of this integral equation.

For some problems we construct "value" modifications of the weighted statistical modelling to solve numerically the kinetic equation (for details see [1, 3, 5]), which leads to a considerable reduction of computational costs.

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