Accepted Manuscript

Determinism vs. statistics in classical many-body theory: Dynamical origin of irreversibility

A.Yu. Zakharov

PII: S0378-4371(17)30005-5
DOI: http://dx.doi.org/10.1016/j.physa.2017.01.005
Reference: PHYSA 17898

To appear in: *Physica A*

Received date : 30 September 2016

Please cite this article as: A.Y. Zakharov, Determinism vs. statistics in classical many-body theory: Dynamical origin of irreversibility, *Physica A* (2017), http://dx.doi.org/10.1016/j.physa.2017.01.005.

Determinism vs statistics in classical many-body theory: dynamical origin of irreversibility

A.Yu. Zakharov[1]

Yaroslav-the-Wise Novgorod State University, Veliky Novgorod, 173003, Russia

Abstract

The closed equation of motion for microscopic distribution function of classical many-body system with account of interactions retardation between particles is derived. It is shown that interactions retardation leads to irreversible behaviour of many-body systems without any probabilistic assumptions.

Keywords: Many-body systems dynamics; irreversibility; retarded interactions
PACS: 05.20.-y, 05.10.-a, 05.70.Ln

1. Introduction

Despite enormous advances of statistical mechanics in description of equilibrium properties and transport processes in condensed matter, the problem of *non-contradictory* microscopic foundation of both thermodynamics and kinetics remains unsolved. Currently, conventional microscopic foundation of thermodynamics and kinetics is based on the union of the probabilistic approach and classical mechanics. Combining deterministic classical mechanics with the concept of probability in the absence of a real source of randomization leads to self-contradictory theory.

For this reason, from time to time there are heated discussions on the use of probabilistic concepts in the classical theory of many-body systems (see., e.g., the discussion of this issue at the round table during 20th IUPAP International Conference on Statistical Physics [1]).

The first attempts to use the laws of classical mechanics, coupled with the "molecular chaos" (Stoßzahlansatz) probabilistic hypothesis by Boltzmann at the end of the XIX century, were immediately subjected to the very essential criticism from Loschmidt and Zermelo. They proved that Boltzmann's probabilistic assumptions contradict the exact theorems of classical mechanics [2, 3, 4].

Thus, the introduction of the probability concept into classical many-body dynamics allows to describe the irreversible phenomena, but this union of classical mechanics and probability theory is internally inconsistent.

In this connection it should be noted an exactly solvable discrete dynamical model (the ring model), proposed by Mark Kac [2, 3]. This model has the properties of reversibility and

[1]This work was partially supported by the Russian Ministry of Science and Education in the framework of the base part of state order (Project number 1755).