Relativistic Random Walk and Causal Thermodynamics

Tadas Nakamura[1]

[1] FPU

http://mira.bio.fpu.ac.jp/tadas

The problem of relativistic random walk is studied in connection with relativistic causal thermodynamics.

It is well known that hyperbolic evolution equations have intrinsic problem of infinite propagation speed. Given a delta function as an initial condition at t = 0, for example, a hyperbolic evolution equation has a Gaussian type solution. This solution does not vanish at infinitely large distance, which means infinite propagation speed. This fact causes serious contradiction with relativity because propagation faster than the light speed means violation of causality.

This problem has been extensively studied in the context of relativistic thermodynamics for a dissipative continuum. A hyperbolic equation is inevitable if one assumes dissipation flux is a linear function of the deviation from the equilibrium state. Several theories have been proposed to avoid this difficulty, however, final solution is yet to come. These theories are called Causal Thermodynamics because they are intended to avoid the violation of causality due to the infinite propagation speed.

Relativistic random walk has the problem with the same root; a classical diffusion equations of particles has the same hyperbolic structure. However, it is not known whether the methods in causal thermodynamics is readily applicable or not. In the present study it has been shown some methods in causal thermodynamics are not applicable in its present form.

A theoretical approach towards the causal random walk theory will be discussed along with the brief review of causal thermodynamics in the presentation.