

論文 / 著書情報
Article / Book Information

題目(和文)	一列縦隊拡散の巨視的揺らぎの理論における厳密解
Title(English)	Exact solution in the macroscopic fluctuation theory for single-file diffusion
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学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	要約
Type(English)	Outline

論文要約

THESIS SUMMARY

系・コース： Department of, Graduate major in	物理学 物理学	系 コース	申請学位 (専攻分野)： Academic Degree Requested	博士 Doctor of	(理学)
学生氏名： Student's Name	守屋 宏紀		指導教員 (主)： Academic Supervisor(main)	笹本 智弘	
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要約 (自由形式)

Thesis Summary

This thesis examines the long time statistics of the fluctuations or large deviations for the time-integrated current passing through the origin in one-dimensional single-file systems, including the symmetric simple exclusion process (SEP), the reflecting Brownian motion (RBM), and the Kipnis-Marchioro-Presutti (KMP) model.

For this purpose, the macroscopic fluctuation theory (MFT) is applied to these models. The MFT postulates the action functional for diffusive models and its saddle point equations so-called the MFT equations give the optimal path of the density field and its conjugate response field. The MFT equations must be solved with the annealed or quenched initial conditions depending on whether we allow the initial state fluctuates or not. However, the MFT equations for the interacting models have prevented detailed analysis for a long time due to their non-linearity and mixed time boundary conditions.

In this thesis, we present the general scheme to solve the MFT equations. Through a non-linear transformation that can be regarded as the generalization of the canonical Cole-Hopf transformation, the MFT equations turn out to be mapped into classically integrable partial differential equations (PDEs) to which the inverse scattering method (ISM) can be applied. This approach opens a new way to study the large deviations, and thus enables us to derive the first exact solution of the time-dependent MFT equations for SEP under the annealed initial condition. Additionally, we obtain exact and compact formulas for the optimal density profile and the response field which produce a required fluctuation, both at initial and final times. Using these results, the large deviation function of the current can be computed and it coincides with the formula obtained previously by microscopic calculations. This provides the first analytic confirmation of the validity of the MFT for an interacting model in the time-dependent regime. Later, the analysis of the quenched initial condition is also conducted. The problem amounts to solving the boundary equations with respect to the final profile.

In the case of the SEP and the KMP model, we analyze the boundary equation through the perturbation method and we confirm the perfect agreement between the final profiles which are responsible for the second cumulant, obtained by the conventional perturbative method in MFT and the ISM. In the case of the SEP starting from the uniform mean density, we derive the conjectural new formula for the sixth cumulant, which has never been achieved within the framework of the previous approaches.

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

Note：Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

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