Name : Chihiro MATSUI
Research Field: Applied Mathematics
Keywords: Mathematical Physics, Statistical Mechanics, Integrable Systems

Current Research Overview

I am currently researching physical phenomena arising from the mathematical structures inherent in physical models. In particular, I am interested in solvable models known as integrable systems and the physical phenomena they exhibit. Solvable models, including integrable systems, are often characterized by the existence of an increasing number of conserved quantities as the size of the physical system grows. In other words, the fact that a physical model is "solvable" implies the existence of a "mathematical structure" that generates a large number of conserved quantities compared to generic physical models. The aim of my research is to understand why some physical models are solvable from the perspective of mathematical structures.

Solvable models exhibit various atypical behaviors. As a characteristic example, the phenomenon of thermalization commonly observed in everyday life does not occur in solvable models. This is understood to be due to the presence of a large number of conserved quantities, which strictly restrict relaxation processes. This fact is closely related to the long-standing problem in statistical mechanics of "why does thermalization occur" and has attracted attention, but a clear answer has not yet been obtained. The goal of my research is to formulate the mathematical framework necessary for treating statistical mechanics, such as what the necessary and sufficient conditions for thermal equilibrium are, and how the macroscopic variables that characterize thermal equilibrium states are determined.

Moreover, in solvable models, physical quantities can be exactly calculated including their time evolution. Clarifying the behavior of solvable models can be expected to be a step towards extending the concepts of statistical mechanics, which is applicable only to equilibrium states, to non-equilibrium states.

Requests to Students

What I would like students to study before entering graduate school are the fundamental aspects of quantum mechanics and statistical mechanics. Especially in quantum mechanics, we use specific notations, so getting familiar with them beforehand will facilitate smooth discussions. If you have extra time, reading textbooks related to integrable systems will allow you to engage in cutting-edge research from an early stage.