

DOCTORAL THESIS

Thermal rectification in one-dimensional nonlinear systems

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Thermal Rectification in One-Dimensional Nonlinear Systems

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Abstract

The problem of heat conduction in low-dimensional lattices is not only interesting for exploring the fundamentals of nonequilibrium statistical mechanics, but also sheds light on the possibility of designing thermal devices. In recent years, the designs of thermal rectifiers in such lattice systems have been proposed with better understanding of the mechanism of heat conduction.

In the present thesis, we extensively investigate thermal rectification in one-dimensional classical lattices. With the classification of possible factors leading to thermal rectification, we give a discussion of necessity for thermal rectification. Although a rigorous theoretical framework is still far from being tackled, we present an analytical approach to characterize asymmetric heat conduction through a weak link in a nonlinear chain. We also study the thermal rectification effect of heat conduction at macroscopic size. A design of a macroscopic thermal rectifier based on a phenomenological mechanism is introduced and discussed. Furthermore, we study the reversal of thermal rectification in some nonlinear models. The predominant direction of the thermal rectifiers can be affected by several parameters, such as the interfacial coupling, the system size, and the temperature. The effects of these parameters are studied separately and understood consistently.

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