

Original Articles

Short-time Asymptotics of the Heat Kernel on Bounded Domain

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摘要 The asymptotic expansion of the heat kernel $\Theta(t)$

$$\Theta(t) = \sum_{j=1}^{\infty} \exp(-t\lambda_j) \text{ where } \{\lambda_j\}$$

where $\{\lambda_j\}$ λ_j are the eigenvalues of the negative Laplacian $-\Delta$

$$-\Delta \text{ in } \mathbb{R}^n \text{ is studied for short-time}$$

for a general bounded domain Ω with a smooth boundary $\partial\Omega$. In this paper, we consider the case of afinite number of the Dirichlet conditions $\phi = 0$ on $\Gamma_i, (i=1, \dots, J)$ and the Neumann conditions

$$\frac{\partial \phi}{\partial \nu} = 0 \text{ on } \Gamma_i, (i=1, \dots, J)$$

$$\text{on } \Gamma_i, (i=J+1, \dots, k) \text{ and the Robin conditions } \left(\frac{\partial \phi}{\partial \nu} + \gamma_i \phi \right) = 0$$

 $\text{on } \Gamma_i, (i=1, \dots, m)$

$$\text{where } \gamma_i \text{ are piecewise smooth positive impedance functions, such that } \partial\Omega \text{ consists of a}$$

$$\text{finite number of piecewise smooth components } \Gamma_i, (i=1, \dots, m) \text{ where } \partial\Omega = \bigcup_{i=1}^m \Gamma_i.$$

We construct

the required asymptotics in the form of a power series over t .

The senior coefficients in this series are specified as

functionals of the geometric shape of the domain Ω . This

result is applied to calculate the one-particle partition

function of a "special ideal gas", i.e., the set of

non-interacting particles set up in a box with Dirichlet, Neumann

扩展功能

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and Robin boundary conditions for the appropriate wave function.

Calculation of the thermodynamic quantities for the ideal gas such

as the internal energy, pressure and specific heat reveals that

these quantities alone are incapable of distinguishing between two

different shapes of the domain. This conclusion seems to be

intuitively clear because it is based on a limited information

given by a one-particle partition function; nevertheless, its

formal theoretical motivation is of some interest.

关键词 [Inverse problem, heat kernel, Eigenvalues, short-time asymptotics, special ideal gas, one-particle partition function](#)

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