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カノニカルアンサンブルに対応する熱的な量子純粋状態
Thermal Pure Quantum State Corresponding To Canonical Ensemble

Sho Sugiura, Akira Shimizu
Department of Basic Science, University of Tokyo

In usual statistical mechanics using ensemble formulation, its basic principles such as equal a priori probability postulate are introduced in microcanonical ensemble. Then, various types of canonical ensemble are derived from it and all the ensembles are guaranteed to give a same result for any macroscopic variables in usual condition. These two facts allow the statistical mechanics to be applied to a wide range of physics.

On the other hand, we have introduced *generally* a pure quantum state that represents an equilibrium state a *thermal pure quantum state* (TPQ state) [1]. As a consequence, we have established a new formulation of statistical mechanics using a single realization of TPQ state. Moreover, we have shown that the new formulation is useful for practical purposes. TPQ state which was presented and constructed there corresponds to microcanonical ensemble. Thus, we call it microcanonical TPQ state.

Then, naive questions arise: Are there TPQ states which corresponds to various kinds of canonical ensembles? Do any TPQ states give same result?

In this talk, we propose a new class of TPQ state, canonical TPQ state. Then, we verify the equivalence among TPQ states corresponding different ensembles. Furthermore, we also show that canonical TPQ state and microcanonical TPQ state are connected by analytically simple transformations. Although the equilibrium state is specified by intensive quantities, this relation makes the practical calculation easy. Due to our novel canonical TPQ state and the related results, the formulation of statistical mechanics using TPQ state becomes more solid and robust theory. In application, we calculate the specific heat of spin-1/2 antiferromagnetic Heisenberg Kagome lattice at low temperature.

[1] S. Sugiura and A. Shimizu, Phys. Rev. Lett. **108**, 240401, (2012).