

[Talk 11] The Gibbs paradox revisited from the fluctuation theorem with absolute irreversibility

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The Gibbs paradox, which originated from gas mixing, has three distinct aspects on the foundation of thermodynamics and classical statistical mechanics. In this talk, we address one of them, namely, the interrelation between thermodynamic and classical statistical-mechanical entropies. In the thermodynamic limit, this issue was resolved by Pauli and Jaynes by requiring extensivity for the thermodynamic entropy. However, this method cannot apply to small thermodynamic systems because extensivity breaks down. In this talk, we demonstrate that in small thermodynamic systems the validity of the fluctuation theorem with absolute irreversibility is equivalent to the inclusion of the factor $-\ln N!$ in the thermodynamic entropy. In particular, we can utilize the fluctuation theorem with absolute irreversibility as an operational definition of the thermodynamic quantities.