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Nonequilibrium equalities in absolutely irreversible processes YUTO MURASHITA, KEN FUNO, MASAHITO UEDA, University of Tokyo — Nonequilibrium equalities have attracted considerable attention in the context of statistical mechanics and information thermodynamics. Integral nonequilibrium equalities reveal an ensemble property of the entropy production σ as $\langle e^{-\sigma} \rangle = 1$. Although nonequilibrium equalities apply to rather general nonequilibrium situations, they break down in absolutely irreversible processes, where the forward-path probability vanishes and the entropy production diverges. We identify the mathematical origins of this inapplicability as the singularity of probability measure. As a result, we generalize conventional integral nonequilibrium equalities to absolutely irreversible processes as $\langle e^{-\sigma} \rangle = 1 - \lambda_{\rm S}$, where $\lambda_{\rm S}$ is the probability of the singular part defined based on Lebesgue's decomposition theorem. The acquired equality contains two physical quantities related to irreversibility: σ characterizing ordinary irreversibility and $\lambda_{\rm S}$ describing absolute irreversibility. An inequality derived from the obtained equality demonstrates the absolute irreversibility leads to the fundamental lower bound on the entropy production. We demonstrate the validity of the obtained equality for a simple model.

Yuto Murashita
University of Tokyo

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