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The Entropy Production Paradox and Fractional Master Equations

The entropy production paradox concerns the unexpected and robust increase of entropy production rates as one moves away from the (irreversible) diffusion equation to approach the (reversible) wave equation. This unexpected behaviour was discovered while studying fractional diffusion equations meant to capture anomalous super diffusion. It has shown up robustly on different domains for distinct evolution equations with rather different probability density functions, all of which exhibit what we called pseudo propagation. Broadening this investigation to fractional master equations, on a bounded domain, leads to the paradox again, but only as a transient, which ultimately relaxes to classical expectations, providing insight into the original paradox and the nature of irreversibility.