Violation of Onsager's theorem in approximate master equation approaches

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Onsager's theorem is an exact relation connecting the thermal and electrical transport within linear response. Its fulfillment is a strong test for the applicability of transport theories. Here we consider commonly used perturbative approaches, such as the Redfield and second-order von Neumann master equations, for thermoelectric transport through nanostructures. Studying a double quantum dot, which requires coherences between states for a correct description, we find that these perturbative approaches can provide results violating Onsager's theorem. We show that the deviations from the theorem scale with the lead-coupling strength in an order beyond the one considered systematically in the respective approach. Such comparisons provide a new way to study the reliability of perturbative approaches.[1]

[1] K. M. Seja et al, Phys. Rev. B 94 (2016) 165435.