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Emergence of prescaling in far-from-equilibrium quark-gluon plasma

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Recently, in the context of the effective kinetic theory developed by Arnold, Moore and Yaffe [1], Berges and Mazeliauskas [2] have shown that the quark-gluon plasma after a sufficiently energetic heavy-ion collision exhibits prescaling, i.e., that the distribution function can be characterized by a scaling distribution plus three dynamical exponents that converge to the universal scaling exponents of the far-from-equilibrium scaling solution. However, the mechanism through which prescaling is realized has remained unclear thus far.

In this work we study an analytic description of the kinetic theory in terms of a Fokker-Planck collision integral, akin to the small-angle approximation of the full collision kernel, and show that prescaling emerges naturally when the solution approaches the scaling attractor. In the light of the recently proposed adiabatic hydrodynamization scenario by Brewer, Yan and Yin [3], we show that the scaling regime is driven by the slow modes of this system, whereas prescaling is realized when faster modes give competing but decaying contributions to the system's state. For some choices of initial conditions, the prescaling exponents can even be extended to arbitrarily early times, smoothly connecting the free-streaming regime and the scaling non-thermal fixed point. While (pre)scaling phenomena are only present at very early times, we discuss how the emergence of hydrodynamic-like features at this and later times are likely related to the dominance of a few slow modes driving the evolution of the whole plasma [4].

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[1] P. B. Arnold, G. D. Moore and L. G. Yaffe, "Effective kinetic theory for high temperature gauge theories," JHEP **01**, 030 (2003)
[2] A. Mazeliauskas and J. Berges, "Prescaling and far-from-equilibrium hydrodynamics in the quark-gluon plasma," Phys. Rev. Lett. **122**, no.12, 122301 (2019)
[3] J. Brewer, L. Yan and Y. Yin, "Adiabatic hydrodynamization in rapidly-expanding quark-gluon plasma," [arXiv:1910.00021 [nucl-th]]
[4] J. Brewer, B. Scheihing and Y. Yin (work in progress)

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