



复旦大学数学科学学院 数学综合报告会

报告题目: Time-Reversal and Generative AI

报告人: AvH Professor Enrique Zuazua (Friedrich-Alexander-Universität Erlangen-Nürnberg)

时间: 2025-09-12 星期五 10:00-11:00

地点: 光华东主楼1801

报告摘要:

In this talk, we address the inverse design (time-reversal) challenges for parabolic and hyperbolic systems.

In the parabolic setting, although the classical backward uniqueness property holds, diffusivity imposes a severe obstacle to time-reversibility, making the reconstruction of initial sources and disturbances particularly delicate. We introduce a novel approach (joint work with Kang Liu) based on a long-time moment expansion of the heat equation combined with representer theorems, which enables the efficient recovery of atomic initial profiles. Furthermore, by leveraging the classical Li-Yau differential inequality, we provide a quantitative framework to analyze diffusion-based methods in generative AI.

In contrast, the hyperbolic setting exhibits completely different phenomena. The formation of singularities during forward evolution obstructs backward uniqueness, while unilateral constraints inherent to the forward dynamics restrict the set of admissible data. In collaboration with Thibault Liard and Carlos Esteve, we characterize the set of reachable states, study the multiplicity of initial configurations leading to a given target, and examine the roles of backward entropy and viscosity solutions in conservation laws and Hamilton-Jacobi equations.

The talk will be illustrated with numerical experiments, and we will conclude by outlining open problems and prospective research directions.

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