香港中文大學 The Chinese University of Hong Kong
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Analysis and PDE Seminar

Professor Diogo Arsénio
Division of Science, New York University Abu Dhabi

TITLE: Entropic Dispersion and the Heat Death of the Universe

Date : May 9th, 2025 (Friday)
Time : 10am-11am (Hong Kong time)
11am-12noon (Korea time)
Link to ZOOM : https://cuhk.zoom.us/j/99008163597
Meeting ID : 990 0816 3597
Password : 219834

Abstract. The phenomenon of dispersion in a physical system occurs whenever the elementary building blocks of the system, whether they are particles or waves, overall move away from each other, because each evolves according to a distinct momentum. This physical process limits the superposition of particles or waves, and leads to remarkable mathematical properties of the densities or amplitudes, including local and global decay, Strichartz estimates, and smoothing.

In kinetic theory, the effects of dispersion in the whole space were notably well captured by the estimates developed by Castella and Perthame in 1996, which, for instance, are particularly useful in the analysis of the Boltzmann equation to construct global solutions. However, these estimates are based on the transfer of integrability of particle densities in mixed Lebesgue spaces, which fails to apply to general settings of kinetic dynamics.

Therefore, we are now interested in characterizing the kinetic dispersive effects in the whole space in cases where only natural principles of conservation of mass, momentum and energy, and decay of entropy seem to hold. Such general settings correspond to degenerate endpoint cases of the Castella–Perthame estimates where no dispersion is effectively measured. However, by introducing a suitable kinetic uncertainty principle, we will see how it is possible to extract some amount of entropic dispersion and, in

essence, measure how particles tend to move away from each other, at least when they are not restricted by a spatial boundary.

A simple application of entropic dispersion will then show us how kinetic dynamics in the whole space inevitably leads, in infinite time, to an asymptotic thermodynamic equilibrium state with no particle interaction and no available heat to sustain thermodynamic processes, thereby providing a provocative interpretation of the heat death of the universe.

All are welcome

This is a joint activity organized by Department of Mathematics, The Chinese University of Hong Kong, Hong Kong; Department of Mathematics, Institute of Mathematical Research, Research Division of Mathematical and Statistical Science, The University of Hong Kong, Hong Kong; and Department of Mathematical Sciences, Ulsan National Institute of Science and Technology, Korea. More details can be found in https://hkumath.hku.hk/~imr/event/CUHK_HKU_UNIST_Analysis_and_PDE/index.php.