

# 國立中央大學數學系

## 專題演講

主 講 人：鄭宇皓先生 (Department of Applied Mathematics,  
University of Washington)

演講題目：Dynamical Low-Rank Approximation for Plasma  
Kinetic Equations

演講茶會：2024年12月26日(星期四) 3:30 p.m. ~ 4:00 p.m.

茶會地點：中央大學鴻經館M306

演講時間：2024年12月26日(星期四) 4:00 p.m. ~ 4:50 p.m.

演講地點：中央大學鴻經館M107

### Abstract：

The Boltzmann equation, a fundamental type of kinetic equation, serves as a high-fidelity model for simulating fluid dynamic. By capturing dynamics in both space and velocity dimensions (also known as phase space), it offers valuable insights into plasma instabilities, one of the most critical challenges in fusion devices and other plasma applications. However, directly discretizing the six-dimensional phase space is computationally prohibitive. Low-rank approximation provides an efficient model reduction technique for handling large system matrices across various applications, such as image compression, linear dynamical systems, and regularization methods for ill-posed problems. Dynamical low-rank approximation specifically targets time-dependent data matrices and solutions to matrix differential equations. By projecting the time derivative onto the tangent space of the manifold of rank- $r$  matrices, this approach ensures that the solution matrix maintains a fixed rank throughout the simulation. This talk will first introduce the plasma kinetic equations and then focus on application of dynamical low-rank approximation to the Vlasov-Poisson equation, a simplified form of the plasma Boltzmann equation that excludes the collision operator and magnetic force. Numerical experiments demonstrate strong alignment with the theoretical predictions, showcasing the advantages of this method over direct phase-space discretization. Dynamical low-rank approximation thus emerges as a promising strategy to mitigate the computational cost of solving plasma kinetic equations.

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