

# **Next-Generation CFD for Porous Media Flows: GPU Acceleration and Physics-Informed Neural Networks**

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## **Abstract**

Porous media flows are central to many energy and heat transfer applications, including thermal storage systems, geothermal technologies, fuel cells, and advanced cooling devices. However, accurate prediction of turbulent transport phenomena in complex porous structures remains computationally challenging due to multiscale interactions and high computational costs. This plenary talk presents recent advances in next-generation computational fluid dynamics (CFD) approaches that combine GPU-accelerated high-performance computing with physics-informed neural networks (PINNs) to enable faster and more accurate simulations of turbulent porous media flows. The integration of advanced numerical modelling, parallel computing architectures, and machine-learning-based physics constraints provides new opportunities for high-fidelity prediction of flow and heat transfer processes. The talk will highlight emerging computational strategies and their potential to accelerate innovation in energy-efficient systems and thermal engineering applications.