中国高能核物理网络论坛
HIGH ENERGY NUCLEAR PHYSICS IN CHINA

HENPIC

The 225th HENPIC Seminar

Bridging Physical Simulations of Heavy Ion Collisions with AI for Scientific Discovery

Speaker: Longgang Pang (CCNU)

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Abstract:

Relativistic heavy-ion collisions recreate an exotic state of nuclear matter—QGP—mirroring the primordial matter that permeated the universe within its first microseconds after the Big Bang. The QGP is the hottest substance ever created on Earth, hosts record-breaking vorticity and magnetic fields, and approaches the theoretical limit of minimal viscosity ($\eta/s \sim 1/4\pi$). Despite its fleeting lifetime ($\sim 10^{-23}$ seconds), the QGP encodes profound insights into fundamental physics, accessible through the momentum distribution of final-state hadrons. These observables unveil critical features of QCD, including the phase structure, equation of state, transport coefficients, and the initial-state nuclear configurations. In this talk, I will present our recent work at the intersection of high-energy nuclear physics and artificial intelligence (AI). We leverage AI to revolutionize scientific inquiry across multiple frontiers:

- Solving inverse problems to reconstruct the QGP properties and the initial state of HICs
- Designing physics-informed neural networks for effective theory in QCD
- Simulating medium response dynamics with unprecedented precision
- Developing large language model (LLM) agents to automate and enhance scientific workflows

This interdisciplinary study bridges computational physics and machine learning, opening new paradigms for understanding strongly coupled quantum systems.

About the speaker:

Longgang Pang is a professor at CCNU, specializing in high-energy nuclear physics and AI-driven scientific computing. He earned his B.Sc. (2006) and Ph.D. (2012) from USTC, with a joint program at LBNL. After postdocs at Institute of Particle Physics (China), FIAS (Germany) and UC Berkeley (US), he joined CCNU in 2019. He developed CLVisc (GPU-accelerated QGP hydrodynamics) and contributed to SMASH, pioneered AI for QGP tomography and LLM-driven research automation. His current focus are: CLVisc 3.0, AI for QGP inverse/generative problems and LLM-powered scientific tools.

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