

博士論文公聴会の公示(物理学専攻)

学位申請者 : Nathan Yves Jean-Jacques Touroux

論文題目 : **Efficient Implicit Solver for Relativistic Hydrodynamics in the
Dynamical Modeling of Heavy-Ion Collisions**

(重イオン衝突の動的模型における相対論的流体方程式の効率的な陰
的数値解法)

日時 : 2025 年 10 月 23 日 (木) 15:00–16:30

場所 : 理学研究科H棟 7 階物理大セミナー室 (H701 号室)

主査 : 浅川正之

副査 : 長峯健太郎、Luca Baiotti、Marlene Nahrgang、赤松幸尚、François Gelis、
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論文要旨:

The rich phase structure of Quantum Chromodynamics (QCD) has been extensively studied for decades, both theoretically and experimentally. In particular, properties of the quark-gluon plasma (QGP), which is realized in the high-temperature medium, have been actively investigated in relativistic heavy-ion collisions at large experimental facilities such as the Relativistic Heavy Ion Collider (RHIC) and the Large Hadron Collider (LHC). One of the remarkable findings of these experiments is that the time evolution of the QGP in the hot medium created by the collisions is well described by relativistic hydrodynamics with small viscosity. In the dynamical modeling of heavy-ion collisions, therefore, computational hydrodynamics plays a central role.

In this thesis, we propose a new method to solve the relativistic hydrodynamic equations in the dynamical modeling of heavy-ion collisions. This method uses an implicit Runge-Kutta method for time integration with a locally optimized fixed-point iterative solver. We demonstrate that the accuracy and computational cost of the new method are better than those of conventionally used explicit ones. The advantage is more pronounced when the method is applied to viscous hydrodynamic equations. We implement the solver into a dynamical model of heavy-ion collisions and perform simulations to reproduce experimental data.