

## Title of BIP: Relativistic fluid dynamics

<u>General information</u>
<b>Objectives and Description:</b> The objective is to introduce the audience to the field of relativistic fluid dynamics and to its applications in high-energy and gravitational physics.
<b>Methods and outcomes:</b> The BIP consists of one week of lectures (2h/session * 2 sessions/day * 5 days = 20h) and tutorials (3h/day * 5 days = 15h), followed by team projects pursued by the students at their home institutions. Follow-up sessions (5 sessions * 2h/session = 10h) will be organized to guide the students through their projects.
<b>Field of Education:</b> Physics
<b>Target audience / Participants profile:</b> Master students; PhD students.
<b>No of ECTS issued:</b> 6
<b>Language of instruction and requirements:</b> English
<b>Dates for physical activity:</b> 25-29 May 2026
<b>Location of physical activity:</b> West University of Timișoara (main building)
<b>Dates for virtual component:</b> May – July 2026
<b>Virtual Component Description:</b> Students will work in teams of 2-4 on the projects chosen at the end of the physical component.
<u>Organizing Board:</u>
<b>Receiving/Host university:</b> <i>Universitatea de Vest din Timișoara</i> , Romania (Lect. Univ. Dr. Victor E. Ambruș, victor.ambrus@e-uvt.ro)
<b>Sending/Partner universities:</b> <i>P1. Goethe Univerity, Frankfurt am Main, Germany</i> (PD Dr. Hendrik van Hees, <a href="mailto:hees@itp.uni-frankfurt.de">hees@itp.uni-frankfurt.de</a> ); <i>P2. University of Florence, Italy</i> (Prof. Dr. Francesco Becattini, <a href="mailto:becattini@fi.infn.it">becattini@fi.infn.it</a> ); <i>P3. Bielefeld University, Germany</i> (Prof. Dr. Sören Schlichting, <a href="mailto:schlichting@physik.uni-bielefeld.de">schlichting@physik.uni-bielefeld.de</a> ); <i>P4. University of Catania, Italy</i> (Prof. Dr. Vincenzo Greco, <a href="mailto:vincenzo.greco@dfa.unict.it">vincenzo.greco@dfa.unict.it</a> )
<u>Detailed programme</u>

**1. Planned activities during virtual component:**

**In the last day of the physical component, the students form teams and each team selects a project from a list of proposals. During the virtual component, the students meet with the tutors assigned for the specific project to receive guidance (5 times in total). During the last session, the students defend their project in front of a panel formed by the tutor and the lecturer for the corresponding component.**

**2. Planned activities during physical component:**

1<sup>st</sup> day: 2x2h lectures + 3h tutorial on *Basics of Relativistic hydrodynamics*

This activity introduces the key concepts and the main equations of relativistic hydrodynamics, starting from a brief introduction to special relativity, tensors and covariant conservation equations; and leading to the modern formulation of relativistic hydrodynamics of perfect (ideal) and real (dissipative) fluids.

2<sup>nd</sup> day: 2x2h lectures + 3h laboratory session on *Numerical methods for Relativistic fluid dynamics*

This activity discusses the technical aspects behind solving the hydrodynamics equations on a computer, such as finite-volume methods, approximate Riemann solvers, propagation characteristics, with illustrations by state of the art hydrodynamics codes.

3<sup>rd</sup> day: 2x2h lectures + 3h tutorial on *Hydrodynamics as an effective field theory*

This activity demonstrates the tight connection between the fundamental framework of quantum field theory and the hydrodynamic description of relativistic fluids and plasmas.

4<sup>th</sup> day: 2x2h lectures + 3h tutorial on *Mesoscopic formulation of fluid dynamics*

This activity describes fluids at a mesoscopic level (i.e., using momentum space distributions), connecting the kinetic theory to the hydrodynamic equations.

5<sup>th</sup> day: 2x2h lectures + 3h tutorial on *Hydrodynamics in heavy ion collisions*

This activity summarizes the main achievements of hydrodynamics in identifying the quark-gluon plasma as a new state of matter formed in ultra high-energy nuclear collisions, addressing the current limitations of hydrodynamics and perspectives to overcome them in the case of small systems.

**Application procedure**

fill in application form available here:

<https://docs.google.com/forms/d/1JQWbUWj9jfp12ASTQWkM5vZRvmZsvyFPNKcKDIjmdT8/edit>