European Einstein Toolkit Meeting 2024

Report of Contributions

https://indico.nikhef.nl/e/5531

Contribution ID: **56** Type: **not specified**

Introduction to Numerical Relativity

Monday, July 8, 2024 9:00 AM (1 hour)

Presenter: DIENER, Peter

Contribution ID: **57** Type: **not specified**

Introduction to Hydrodynamics

Monday, July 8, 2024 10:00 AM (1 hour)

Presenter: GIACOMAZZO, Bruno

Contribution ID: **58** Type: **not specified**

Numerical Methods in General Relativity

Monday, July 8, 2024 11:30 AM (1 hour)

Presenter: CORDERO-CARRIÓN, Isabel

Contribution ID: **59** Type: **not specified**

Introduction to the Einstein Toolkit 1

Monday, July 8, 2024 2:00 PM (1 hour)

Presenter: BRANDT, Steven

Contribution ID: **60** Type: **not specified**

Tutorial: Download, compile and run a TOV star

Monday, July 8, 2024 3:00 PM (1 hour)

Presenters: DIENER, Peter; BRANDT, Steve

Contribution ID: **61** Type: **not specified**

Tutorial: How to write a thorn for the Einstein Toolkit

Monday, July 8, 2024 4:30 PM (1 hour)

Presenter: MORRIS, Max

Contribution ID: **62** Type: **not specified**

Introduction to GRMHD

Tuesday, July 9, 2024 9:00 AM (1 hour)

Presenter: KIUCHI, Kenta

Contribution ID: **63** Type: **not specified**

Initial Data

Tuesday, July 9, 2024 10:00 AM (1 hour)

Presenter: GRANDCLÉMENT, Philippe

Contribution ID: **64** Type: **not specified**

Tutorial: Initial Data

Tuesday, July 9, 2024 11:30 AM (1 hour)

Presenter: GRANDCLÉMENT, Philippe

Contribution ID: **65** Type: **not specified**

Tutorial: CarpetX

Tuesday, July 9, 2024 2:00 PM (1 hour)

Presenter: SCHNETTER, Erik

Contribution ID: **66** Type: **not specified**

Tutorial: Generating a thorn with NRPy/Python

Tuesday, July 9, 2024 3:00 PM (1 hour)

Presenter: BRANDT, Steven

Contribution ID: **67** Type: **not specified**

Time to work on tutorial content

Presenters: MORRIS, Max; DIENER, Peter; GRANDCLÉMENT, Philippe; BRANDT, Steven

Contribution ID: **68** Type: **not specified**

Gravitational Waves

Thursday, July 11, 2024 11:30 AM (1 hour)

Presenter: HANEY, Maria

Contribution ID: **69** Type: **not specified**

Gravitational Waves - Detections/Techniques/Parameter Estimation

Thursday, July 11, 2024 2:30 PM (1 hour)

Presenter: SAMAJDAR, Anuradha

Contribution ID: **70** Type: **not specified**

Comoslogy/Beyond GR

Contribution ID: **71** Type: **not specified**

Multimessenger Astrophysics

Tuesday, July 9, 2024 4:30 PM (1 hour)

Presenter: NISSANKE, Samaya

Contribution ID: **72** Type: **not specified**

Turbulence in neutron-star merger simulations

Wednesday, July 10, 2024 11:30 AM (1 hour)

Presenter: HAWKE, Ian

Contribution ID: **73** Type: **not specified**

EM counterparts

Contribution ID: **74** Type: **not specified**

Discussion/Closeout

Friday, July 12, 2024 11:00 AM (30 minutes)

Contribution ID: **75** Type: **not specified**

Discussion: What's most crucial to include in Einstein Toolkit for future?

Wednesday, July 10, 2024 3:30 PM (1 hour)

Contribution ID: **76** Type: **not specified**

Discussion

Thursday, July 11, 2024 4:00 PM (30 minutes)

Contribution ID: **79** Type: **not specified**

Gravitational Wave Signals from 3D GRMHD simulations of Core-Collapse Supernovae

Thursday, July 11, 2024 10:00 AM (30 minutes)

With the increasing number of gravitational wave detections by the LIGO-Virgo-KAGRA (LVK) Collaboration, as well as the prospect of the upcoming 3rd generation detectors such as the Einstein Telescope and Cosmic Explorer, we will need to be able to identify the gravitational wave source and extract properties of the source from the detector data. In order to do this effectively, we must develop templates of possible gravitational waves signals emitted from the expected sources. One of the events for which gravitational wave signatures can be detected are Core-collapse supernovae (CCSNe), some of the most energetic explosions in the universe. Gravitational wave observations from CCSNe, would allow us to probe for information from the stellar interior during collapse and the subsequent explosion. Through numerical simulations we can investigate these signatures and among other things gain a better insight into the mechanism driving the explosion. We seek to present results from some of the first production-level GPU based simulations of stellar core-collapse supernovae for a variety of pre-supernova model set-ups using the GPU-accelerated dynamical-spacetime general relativistic magneto-hydrodynamics code GRaM-X, which extends the general relativistic magneto-hydrodynamics (GRMHD) capability of the Einstein Toolkit. We model four CCSNe in 3D, without any symmetry assumptions, varying the rotation rate of the progenitor. Each of the simulations extends for about 100ms post-bounce and the respective gravitational wave signatures are extracted and analyzed for potential detectability with future detectors.

Primary author: SCHNAUCK, Sophia (Anton Pannekoek Institute for Astronomy (API))

Presenter: SCHNAUCK, Sophia (Anton Pannekoek Institute for Astronomy (API))

Session Classification: Contributed Presentations

Contribution ID: **80** Type: **not specified**

Euclidean-Lorentzian Nexus

This study delves into the profound implications arising from the Euclidean-Lorentzian transition, with a primary focus on its influence on classical and quantum aspects. The investigation centers on the dynamic evolution of metrics, intricately constructed from a Lorentzian metric and a time-like vector field. By shedding light on the nuanced interplay between geometry and gravitational dynamics, our research significantly advances our comprehension of early universe dynamics. It paves the way for valuable insights into the behavior of classical and quantum gravity on cosmic scales, offering a promising avenue for further exploration in these fundamental realms.

Primary author: SINGH, RAGHVENDRA (Ariel University Israel)

Presenter: SINGH, RAGHVENDRA (Ariel University Israel)

Session Classification: Contributed Presentations

Contribution ID: **81** Type: **not specified**

Bag model revisited

Motivated by a recent opinion expressed by M. C. Andersen that there are striking similarities between a quantum particle and a mini-black hole, we investigate the possibility that a nucleon (say, a proton) is akin to a black hole. From the MIT Bag model we know that the confinement of strongly interacting particles inside hadrons is accomplished in a Lorentz-invariant way, i.e., $T_{ab} \propto g_{ab}$ (T_{ab} is the stress tensor inside hadrons), leading to $\epsilon = -p = B \approx 160 MeV/fm^3$, where B is the bag constant. From General Relativity we know that the equation of state $p = -\epsilon$ leads to a de Sitter spacetime. To satisfy the junction conditions at the interface, we choose as geometry outside a proton a regular Schwarzschild spacetime. Moreover, we found that the outer and inner radial pressures are equal at the junction surface, as it should be.

Primary author: CULETU, Hristu

Presenter: CULETU, Hristu

Session Classification: Contributed Presentations

Contribution ID: **82** Type: **not specified**

Dynamics of fast rotating neutron stars: Time evolution of linear perturbations in full general relativity

Wednesday, July 10, 2024 2:00 PM (30 minutes)

We present a code that evolves perturbations of a rapidly rotating compact object in equilibrium in linearised full general relativity in time. We derive the perturbation equations for the spacetime in the Hilbert gauge leading to wave equations, while the hydrodynamical evolution is based on perturbations of the energy-momentum tensor. We use Kreiss-Oliger dissipation in order to achieve a stable time evolution. The code is parallelised using MPI and features favourable scaling with the number of threads. A modified version of the code employs individual grids for spacetime and perfect fluid in order to exploit the CFL criterion allowing for considerably larger time steps. The code features high accuracy at comparably low computational expense and we are able to extract the frequencies of nonaxisymmetric modes of compact objects with rotation rates up to the Kepler limit.

Primary author: KRUEGER, Christian (University of Tuebingen)

Presenter: KRUEGER, Christian (University of Tuebingen)

Session Classification: Contributed Presentations

Contribution ID: **83** Type: **not specified**

Simulating neutron stars under scalar tensor theories with the Einstein Toolkit

Wednesday, July 10, 2024 2:30 PM (30 minutes)

We present a numerical implementation of the Einstein equations under scalar tensor theories (STT) based on the Einstein Toolkit framework. We focus on the Jordan frame, where the influence of the scalar fields on the Einstein equations can be expressed through a modified BSSN (Baumgarte-Shapiro-Shibata-Nakamura) formalism while preserving the standard evolution of matter fields. This approach is particularly useful in the study of neutron stars, as it takes advantage of the modularity of the Einstein Toolkit to include more microphysics, allowing to analyze the structure and properties of neutron stars within these extended theories of gravity and identify deviations from general relativity.

Primary author: OLVERA MENESES, José Carlos (Tübingen University)

Co-authors: Dr DONEVA, Daniela (Tübingen University); Dr FONT, José A. (Valencia University); Dr CERDÁ-DURÁN, Pablo (Valencia University); Dr YAZADJIEV, Stoytcho (Sofia University)

Presenter: OLVERA MENESES, José Carlos (Tübingen University)

Session Classification: Contributed Presentations

Contribution ID: **84** Type: **not specified**

Registration and arrival

Monday, July 8, 2024 8:00 AM (50 minutes)

Contribution ID: **85** Type: **not specified**

Welcome

Monday, July 8, 2024 8:50 AM (10 minutes)

Presenter: MOESTA, Philipp (University of Amsterdam)

Contribution ID: **86** Type: **not specified**

Overlapping gravitational-wave signals

Thursday, July 11, 2024 10:30 AM (30 minutes)

Presenter: BHARDWAJ, Uddipta

Session Classification: Contributed Presentations

Contribution ID: **87** Type: **not specified**

NSNS/NSBH simulations

Wednesday, July 10, 2024 10:00 AM (1 hour)

Presenter: BERNUZZI, Sebastiano

Contribution ID: **88** Type: **not specified**

SpincsBSSN

Friday, July 12, 2024 9:30 AM (1 hour)

Presenter: DIENER, Peter

Session Classification: Contributed Presentations