

Oberseminar Mathematische Strömungsmechanik

Institut für Mathematik der Julius-Maximilians-Universität Würzburg

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From Einstein‘s Equations to Neutron Star Mergers: A Journey into Numerical Relativity

Abstract: Einstein‘s equations of general relativity form a large system of highly coupled, nonlinear partial differential equations. Numerical relativity is the field devoted to solving them numerically, a task complicated by the propagation of constraint violations, coordinate singularities, gauge freedom and, when matter is included, by the formation of shocks. In this talk I will give an accessible introduction to the field from an applied-mathematics perspective. I will explain how the equations are recast as an evolution problem through the 3+1 decomposition, why the choice of formulation is crucial for well-posedness and stability, and review the main formulations and numerical methods behind the breakthroughs of the last two decades. I will then introduce the approach developed in our research group, which combines the Generalized Harmonic formulation with high-order Central WENO Finite-Difference schemes. While many existing codes treat spacetime and matter with different numerical methods, we discretize the coupled Einstein-Euler system in a unified, monolithic way. After presenting standard benchmark tests, I will focus on binary neutron star mergers, among the most fascinating phenomena in the Universe and a key source of gravitational waves. I will review the current state of the art and show the first results obtained with our new infrastructure.

room 40.03.003 (Emil Fischer Str. 40)

Thursday, Nov. 19, 2026 at 12:30 pm

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Zu diesem Vortrag sind Sie herzlich eingeladen.

gez. Christian Klingenberg