S09 Atelier calcul haute performance et simulations numériques

Simulating warped accretion discs with Shamrock

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A lot of accretion discs, around multiple star systems or supermassive black holes, are not flat. Understanding their complex geometries remains essential for interpreting observational phenomena such as type-C quasi-periodic oscillations (QPOs) and stellar-related signatures. However, limited resolution in numerical simulations previously hindered further characterization of such discs. While state-of-the-art simulations use 10 million SPH particles to reach an effective viscosity alpha of 0.01, a factor at least 10 in spatial resolution, meaning 1,000 in computational power, is required to allow local instabilities to grow.

Over the past decade, GPUs have revolutionized supercomputing capabilities, culminating in the exascale barrier (10^{18} FLOPS) being broken in 2022 with the Frontier cluster. Shamrock, a new astrophysical code released in March 2025, is among the codes capable of running on such machines. In this talk, I will present recent developments in the Shamrock code regarding the magnetohydrodynamics and general relativity solvers.