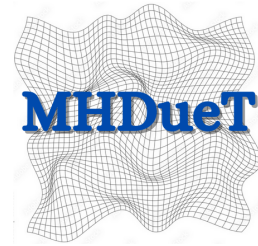
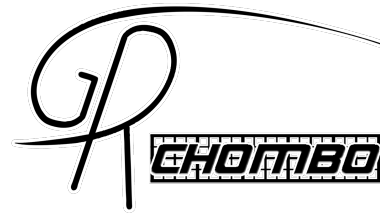




CCP-UKNR : UK Numerical Relativity



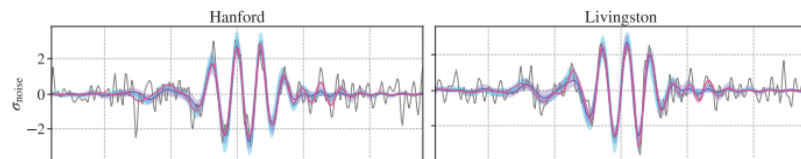
METHOD

BAM
code

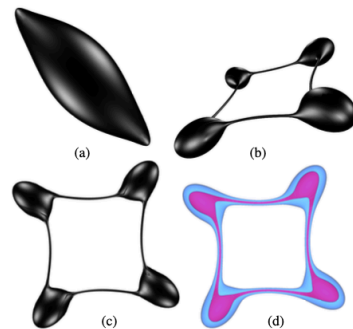


Who are we and what do we do?

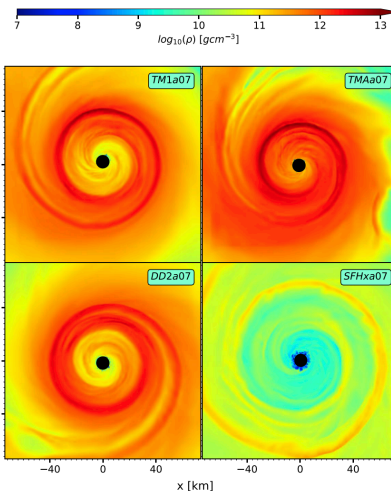
We are members of the UK scientific community who develop and use numerical relativity codes to investigate the physics of extreme gravitational phenomena in the Universe. Our science encompasses observed astrophysical phenomena such as black hole and neutron star mergers, the physics of the Big Bang, and investigations of the theoretical foundations of physics such as string theory. Many members of the CCP-UKNR community are leading scientists in the international LIGO-Virgo-KAGRA collaboration.



Gravitational waves results from black hole merger event GW231123, the most massive black hole merger ever recorded at 265 solar masses, as detected by LIGO superimposed on theoretical predictions generated using numerical relativity. (From LIGO paper *ApJ. Lett.* 993 L25, led by CCP-UKNR member Mark Hannam of Cardiff University with Patricia Schmidt and Geraint Pratten of Birmingham University.)



Simulations of collapsing black hole in 6 dimensions, demonstrating a novel instability that violates Penrose' Cosmic Censorship conjecture. Work led by Pau Figueras (QMUL) using GRCHOMBO. (From *Phys Rev Lett.* 116 071102).



Spinning remnant black hole surrounded by ejecta of a neutron star-black hole merger simulated using ETK/ WhiskyTHC code. (From Rahime Matur, Ian Hawke, and Nils Andersson, Southampton University.)

Gregynog 2025 International Workshop on NR : *Towards the Next Generation*

This very successful workshop was held from 17-19th June, 2025 at the historical Gregynog Hall venue (which was the site of the first ever NR workshop held in 1986). This workshop brought together the members of the CCP-UKNR community, CoSEC and international stake holders. In particular, the latter included Katherine Riley, who is the Director of Science for the US Argonne National Lab (which operates the first exascale machines Aurora and Frontier), and Mark Wilkinson who is the Director of DiRAC. The goals of the workshop were threefold. (a) Discuss the state of the art of NR and the science drivers for it. (b) Understand the present and future digital infrastructure landscape for the next 5-10 years, and the challenges it will bring to NR. (c) Formulate actions that will strengthen the foundations of a good community. The full meeting report is available at the CCP-UKNR website.



Group photo of the members of the CCP-UKNR community at the workshop.



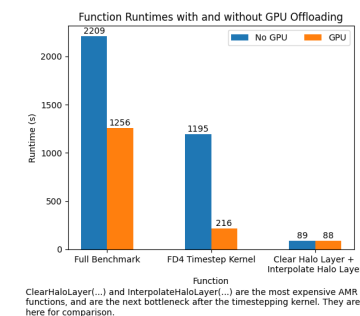
Katherine Riley, the Director of Science for the US Argonne National Labs, discussing the many challenges of the US HPC landscape for the next 10 years.



Find us at

<https://www.uknumericalrelativity.org/>

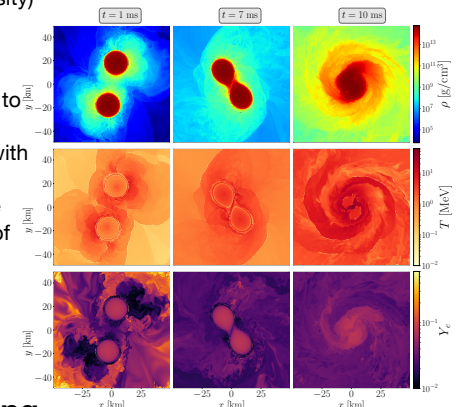
Leading the NR community in transitioning to GPU



ClearHaloLayer(...) and InterpolateHaloLayer(...) are the most expensive AMR functions, and are the next bottleneck after the timestepping kernel. They are added here for comparison.

ExaGRyPE is a multipurpose NR code developed at Durham University. Combining novel domain decomposition methods with task parallelism, the dev team have created a new domain specific language to study NR numerics which is directly tied to the LLVM compiler stack, allowing ExaGRyPE to run natively on all GPU platforms, achieving up to 2-3 times speed-up per GPU compared to all-CPU codes. Development of this code has led to crosscutting contributions, such as the incorporation of new tasking features to the Intel TBB. (Credit : Han Zhang, ExaGRype lead, Durham University)

MHDuet, an open source evolution code for GRMHD code with neutrino transport, has been released with a full AMReX backend, enabling it to run on CUDA-based CPU and GPU platforms. Developed within the *Simflowny* collaboration, with UK contributions led by Miguel Bezares (Nottingham) and support from DiRAC RSE. The figure on the right shows the simulated merger of two neutron stars with (top to bottom) their temperature, rest-mass density and electron fraction (From arXiv: 2510.13965).



Community codes benchmarking

We are undertaking a community wide effort to benchmark our present and future codes, in order to take a "screenshot" of our community readiness for the next generation compute landscape. This is led by Dr Miren Radia, with a generous allocation of compute resources from DiRAC. We expect the work to be completed by March 2026 for this round, and intend to continue a vigorous program of benchmarking beyond that time.



A vibrant and supportive community

We strive to be an inclusive and supportive community. Even though we are sometimes competitors in science, our core belief is that we are stronger when we have a shared vision and can speak with one voice. Our community often share knowledge and openly exchange ideas -- for example the developers of the MHDuet and GRTEclyn jointly apply for and share the same RSE resources in their respective code development campaigns. We will hold our CCP-UKNR Annual Meeting in Birmingham from 15-16 December, where we will unveil our 5 year Roadmap.

Finally, led by new **CoSeC Fellow** Miquel Miravet-Tenés (Southampton), we are rolling out a mentorship program, and other initiatives aimed especially at Early Career Researchers which will include a community wide journal club to help foster a strong community spirit.

