**Patrick Diehl**

Title: Asynchronous-Many-Task Systems: Challenges and Opportunities -- Scaling an AMR Astrophysics Code on Exascale machines using Kokkos and HPX

Abstract:

Dynamic and adaptive mesh refinement is pivotal in high-resolution, multi-physics, multi-model simulations, necessitating precise physics resolution in localized areas across expansive domains. Today's supercomputers' extreme heterogeneity presents a significant challenge for dynamically adaptive codes, highlighting the importance of achieving performance portability at scale. Our research focuses on astrophysical simulations, particularly stellar mergers, to elucidate early universe dynamics. We present Octo-Tiger, leveraging Kokkos, HPX, and SIMD for portable performance at scale in complex, massively parallel adaptive multi-physics simulations. Octo-Tiger supports diverse processors, accelerators, and network backends. Experiments demonstrate exceptional scalability across several heterogeneous supercomputers including Perlmutter, Frontier, and Fugaku, encompassing major GPU architectures and x86, ARM, and RISC-V CPUs. Parallel efficiency of 47.59% (110,080 cores and 6880 hybrid A100 GPUs) on a full-system run on Perlmutter (26% HPCG peak performance) and 51.37% (using 32,768 cores and 2,048 MI250X) on Frontier are achieved.

Bio:

Patrick Diehl is a research scientist specializing in Applied Computer Science at Los Alamos National Laboratory and serves as adjunct faculty in the Department of Physics & Astronomy at Louisiana State University. Prior to his current role, he was a research scientist at the Center for Computation and Technology at LSU. Patrick’s research focuses on scientific high-performance computing, quantum computing, and code portability. He is passionate about advancing openness in science and currently serves as a topic editor for the *Journal of Open Source Software* (JOSS). Additionally, Patrick is the co-author of the book *Parallel C++: Efficient and Scalable High-Performance Parallel Programming Using HPX*.