

# Kyle C. Nelli

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## SKILLS SUMMARY

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- **Languages:** C/C++11-20, Python, Bash, Perl, Mathematica
- **Software:** SpECTRE, VSCode, L<sup>A</sup>T<sub>E</sub>X, GNUPlot, VisIt, Paraview, Blender
- **Tools:** GIT/GitHub, Docker/DockerHub, Make, CMake, LLVM, GCC, GDB, HPCToolkit, SLURM
- **Parallelism:** Charm++, MPI, OpenMP
- **Platforms:** Linux (Ubuntu, Mint, CentOS, RedHat), Windows, MacOS
- **Clusters:** Wheeler (Caltech), Caltech HPC (Caltech), Frontera (TACC), Anvil (ACCESS, formerly XSEDE), Expanse (ACCESS), Bridges2 (ACCESS), Pleiades (NASA), Ocean (CSUF), Blue Waters (NCSA)

## EXPERIENCE

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- **Teukolsky Group, Caltech** November 2020 - Present  
Graduate Research Assistant
  - Member of Simulating eXtreme Spacetimes (SXS) collaboration (150+ people, 8+ institutions).
  - Updated and significantly reduced complexity of control loops in MPI-based Spectral Einstein Code (SpEC).Lead SpECTRE Developer/Engineer (500k+ lines of C++ 20)
  - Open-source software designed to run highly accurate simulations of binary black hole mergers and general relativistic magneto-hydro dynamics on HPC and exascale machines.
  - Utilized task-based (asynchronous) parallelism to achieve **3x speedup** when solving partial differential equations on exascale computing resources.
  - **Visualized ~1TB** of output from simulations using Paraview and its Python scripting framework.
  - Implemented detailed memory diagnostics. **Reduced memory usage by 5x** and found three bugs.
  - Designed and oversaw five student projects. Mentored undergraduate, masters, and other doctoral students.
- **Shapiro Group, University of Illinois Department of Physics, REU** May 2018 - July 2020  
Undergraduate Researcher
  - Created visualizations of numerical simulations of black hole and compact star mergers.
  - Wrote novel code in Python and C++ (27k+ lines) to automate visualization using VisIt software and Blue Waters supercomputer.
- **Dr. Christopher Powell, Argonne National Laboratory Internship** May 2017–July 2017  
Undergraduate Researcher
  - Utilized Advanced Photon Source (X-rays) to record fuel injector spray patterns.
  - Generated novel Python scripts to analyze experimental data for start of injection time; implemented visualizations with Blender software.

## EDUCATION

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- **California Institute of Technology (Caltech), CA** August 2020 - Present  
Doctorate of Philosophy: *Physics*
- **University of Illinois Urbana-Champaign, IL** August 2016 - May 2020  
Bachelor of Science: *Engineering Physics, Highest Honors*  
Bachelor of Science: *Astronomy, Summa Cum Laude and with High Distinction*

## PRESENTATIONS

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- “The SpECTRE CCE Module”, North American Einstein Toolkit Workshop, June 3 2024, Baton Rouge, LA
- “Horizon Tracking in SpECTRE with Task-Based Parallelism”, April APS Meeting, April 3 2024, Sacramento, CA
- “Horizon Tracking in SpECTRE with Task-Based Parallelism”, Pacific Coast Gravity Meeting, March 1 2024, Santa Barbara, CA
- “Cauchy-Characteristic Matching in SpECTRE”, April APS Meeting, April 16 2023, Minneapolis, MN
- “Cauchy-Characteristic Matching in SpECTRE”, Pacific Coast Gravity Meeting, April 1 2023, Caltech, CA
- “SpECTRE, Numerical Relativity Community Summer School 2022”, Numerical Relativity Community Summer School, Aug. 11 2022, ICERM at Brown University, MA

## PUBLICATIONS

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- [1] Yitian Chen, . . . , **Kyle C. Nelli**, et al. “Improved frequency spectra of gravitational waves with memory in a binary-black-hole simulation” (2024).
- [2] Guillermo Lara, . . . , **Kyle C. Nelli**, et al. “Scalarization of isolated black holes in scalar Gauss-Bonnet theory in the fixing-the-equations approach” (2024).
- [3] Teagan A. Clarke, . . . , **Kyle C. Nelli**, et al. “Toward a self-consistent framework for measuring black hole ringdowns”. *Phys. Rev. D* 109 (12 June 2024), p. 124030.
- [4] Sizheng Ma, Jordan Moxon, . . . , **Kyle C. Nelli**, et al. “Fully relativistic three-dimensional Cauchy-characteristic matching for physical degrees of freedom”. *Phys. Rev. D* 109 (12 June 2024), p. 124027.
- [5] Hengrui Zhu, Justin L. Ripley, . . . , **Kyle C. Nelli**, et al. “Nonlinear Effects In Black Hole Ringdown From Scattering Experiments I: spin and initial data dependence of quadratic mode coupling” (Jan. 2024).
- [6] Hengrui Zhu, . . . , **Kyle C. Nelli**, et al. “Black Hole Spectroscopy for Precessing Binary Black Hole Coalescences” (Dec. 2023).
- [7] Nils Deppe, . . . , **Kyle C. Nelli**, et al. “Simulating magnetized neutron stars with discontinuous Galerkin methods”. *Phys. Rev. D* 105.12 (June 2022).
- [8] Milton Ruiz, Antonios Tsokaros, Stuart L. Shapiro, **Kyle C. Nelli**, and Sam Qunell. “Magnetic ergostars, jet formation, and gamma-ray bursts: Ergoregions versus horizons”. *Phys. Rev. D* 102.10 (Nov. 2020).
- [9] Roberto Torelli, . . . , **Kyle C. Nelli**, et al. “Evaluation of Shot-to-Shot In-Nozzle Flow Variations in a Heavy-Duty Diesel Injector Using Real Nozzle Geometry” (Apr. 2018).