Foreword

Selected papers from the 2021 International Conference on Mathematics and Computational Methods Applied to Nuclear Science and Engineering (M&C 2021)

Guest Editors

Patrick S. Brantley,[a] Dmitriy Y. Anistratov,[b] and Todd J. Urbatsch[c]

[a]*Lawrence Livermore National Laboratory*
[b]*North Carolina State University*
[c]*Los Alamos National Laboratory*

Mathematics and computational methods are of fundamental importance in the design and analysis of nuclear systems. The "Math & Comp" research community is actively engaged in advancing numerical algorithms and computational methods to simulate nuclear systems with increasingly higher fidelity. The American Nuclear Society (ANS) 2021 International Conference on Mathematics and Computational Methods Applied to Nuclear Science and Engineering (M&C 2021) continued the rich tradition of this biennial conference series, showcasing preeminent computational science research for nuclear applications. M&C 2021 was an M&C conference like none before. Much of the planning for the conference was conducted amid the uncertainty of the COVID-19 pandemic via e-mail and Zoom sessions in 2020 and 2021. The conference was originally scheduled for April 11–15, 2021, in Raleigh, North Carolina. The pandemic resulted in the delay of the conference to October 3–7, 2021, and the COVID-19 Delta surge led to the last-minute decision to go fully virtual for the first time in the history of the conference. A constant focus in planning the conference was a strong commitment to excellence in the technical program, a hallmark of this series of conferences. The papers in this special issue of *Nuclear Science and Engineering* represent selected highlights of the research presented at M&C 2021.

The themes of M&C 2021 were mathematical and computational methods, numerical analysis, computer codes, and high-performance computer architectures for solving problems in nuclear science and engineering. The M&C 2021 technical program was based on 14 technical tracks:

- deterministic methods for particle transport;
- Monte Carlo and hybrid methods for particle transport;
- mathematical methods in particle transport theory;
- massively parallel algorithms and exascale computing;
- computational fluid dynamics and thermal hydraulics;
- multiscale and multiphysics methods;
- computational methods for reactor physics analysis;
- stochastic media models;
- reduced-order models in nuclear science and engineering;
- modeling and simulations in high-energy-density physics, plasma physics, and fusion;
- nuclear and atomic data, methods, and theory;
- uncertainty quantification and sensitivity analysis;
- data science and machine learning;
- analytical solution, verification, and numerical methods analysis.

The plenary talks at the conference presented reviews and new insights on various fundamental problems. Thomas Evans (Oak Ridge National Laboratory) opened the technical program with an overview of the application development focus area of the Exascale Computing Project and the challenges associated with multiphysics scientific applications in his talk, "Optimizing Multiphysics Simulation Codes for Heterogenous HPC Architectures: A Survey of Approaches in the Exascale Computing Project." The multifaceted role of radiation effects in modeling astrophysical phenomena was the topic of the talk by Christopher Fryer (Los Alamos National Laboratory) on "Radiative Transfer's Role in the

Life and Death of Stars." Edward Larsen (University of Michigan) presented "Some New Perspectives on an Old Problem: The Asymptotic Diffusion Limit in Neutron Transport," a novel analysis of the asymptotic limit of the multigroup transport equations. The challenges in thermal radiation transport simulation methods were reviewed by Nicholas Gentile (Lawrence Livermore National Laboratory) in "Thermal Radiative Transfer and its Discontents." In his talk "Diversity and Inclusion: My Journey," Warren "Pete" Miller Jr. (Texas A&M University) shared his powerfully moving stories of growing up in Chicago with Emmett Till as his friend, and he gave diversity, equity, and inclusion (DE&I) recommendations to attendees.

Memorial technical sessions were held at the conference for Russell Mosteller, Lénárd Pál, and Mark Williams.

International participation in the conference was strong despite the atypical circumstances. The conference had 327 registrants, including 102 students, hailing from 79 institutions in 21 countries, all of whom participated remotely on a schedule set in the U.S. eastern time zone. The technical program included 232 technical papers in 54 sessions, five plenary talks, and five workshops.

The general chairs for M&C 2021 were Yousry Azmy (North Carolina State University) and David Kropaczek (Oak Ridge National Laboratory). Given the unique challenges, we express our appreciation for their dedication to the successful planning and implementation of the conference. The technical program chairs for the conference were Dmitriy Anistratov (North Carolina State University) and Todd Urbatsch (Los Alamos National Laboratory). The publication chair was Patrick Brantley (Lawrence Livermore National Laboratory).

Honorary chairs for the conference were Warren "Pete" Miller Jr. (Texas A&M University), Thomas Sutton (Rensselaer Polytechnic Institute), and Paul Turinsky (North Carolina State University). The technical track leaders, who carried out the technical aspects of the review process, were Hany Abdel-Khalik (Purdue University), Dmitriy Anistratov (North Carolina State University), Teresa Bailey (Lawrence Livermore National Laboratory), Patrick Brantley (Lawrence Livermore National Laboratory), Jeffery Densmore (Naval Nuclear Laboratory), Thomas Evans (Oak Ridge National Laboratory), Benoit Forget (Massachusetts Institute of Technology), Frank Graziani (Lawrence Livermore National Laboratory), Terry Haut (Lawrence Livermore National Laboratory), Ryan McClarren (University of Notre Dame), Robert Nourgaliev (Lawrence Livermore National Laboratory), Todd Palmer (Oregon State University), Shawn Pautz (Sandia National Laboratory), Andrew Till (Los Alamos National Laboratory), and William Wieselquist (Oak Ridge National Laboratory).

M&C 2021 included a DE&I program chaired by Stefani Buster (North Carolina State University), Warren "Pete" Miller Jr. (Texas A&M University), and Madicken Munk (University of Illinois at Urbana-Champaign). The DE&I program sponsored daily events and Pete Miller's plenary talk.

Finally, we would like to thank Farzad Rahnema, editor of *Nuclear Science and Engineering*; David Strutz, production manager at ANS; and Mary Tong, peer review specialist at ANS, for their efforts to produce this special issue.