Foreword

Selected papers from the 2019 International Conference on Mathematics and Computational Methods Applied to Nuclear Science and Engineering (M&C 2019)

Guest Editor

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Mathematics and computation has been the vanguard of nuclear engineering research and has repeatedly led the world of computational engineering and applied mathematics in innovation. Some examples of this innovation that readily come to mind are discontinuous finite element methods,[1] nonlinear convergence acceleration techniques,[2] and, *avant la lettre*, asymptotic-preserving discretizations.[3] It was in this spirit of research dynamism that the American Nuclear Society (ANS) 2019 International Conference on Mathematics and Computation (M&C) was convened in Portland, Oregon, August 25–29, 2019.

As in previous iterations, this biennial meeting brought together researchers with a diverse array of interests, from materials science, uncertainty quantification, high-performance computing, reactor analysis, and transport methods. The Gerald C. Pomraning Memorial Award for contributions to the field of mathematics and computation was presented to Farzad Rahnema of Georgia Institute of Technology, who also delivered a plenary talk on his research for reactor, detector, and radiotherapy calculations. A plenary talk on the latest advances in deterministic discrete ordinates transport was given by Marvin Adams of Texas A&M University, highlighting the challenges of massively parallel calculations. Attendees got a peek at the latest developments in scientific computing and machine learning on graphics processing units (GPUs) from a hardware vendor's perspective in the plenary given by Tom Gibbs of NVIDIA. The final plenary was delivered by a humble researcher from the University of Notre Dame who talked about recent research in compressed sensing and nonlinear methods for nuclear science problems.

The number of papers presented at M&C 2019 was large, and participants were not lacking in compelling talks to attend. From the 284 papers given, the 12 in this special issue of *Nuclear Science and Engineering* have been selected to represent the scientific advances on offer at the conference. Readers interested in any of the topics discussed in this issue are encouraged to seek out the full conference proceedings,[4] available from ANS.

In terms of the papers contained in this issue, I will attempt to provide an *amuse-bouche* to the entree of the full papers, to whet the reader's appetite—though all of the authors herein will do a better job of promulgating their research than I can. The issue begins with a paper by Brunner et al. that demonstrates how the commingling of linear and nonlinear updates can accelerate radiation diffusion solves. This work, along with the coupling of high- and low-order methods of the second paper by Park, demonstrate a new dimension to iteration strategies for a variety of transport problems where linear and nonlinear operators are coupled in multiphysics systems.

The advancement of numerical methods for deterministic transport is an ineluctable feature of M&C meetings and for this special issue as well. A thrust in this direction is the artificial scattering discrete ordinates (as-S_N) method contributed by Frank et al., where the goal is to reduce the stubborn discretization errors known as ray effects. A novel approach to solving discrete ordinates problems in parallel using mulitgrid is provided in the paper by Hanophy et al. This paper presents a method that could be an important breakthrough for high-performance computing on future architectures in a similar vein to the paper regarding Monte Carlo calculations using threads in the work of Harper et al.

Given the importance of Monte Carlo particle transport simulations in nuclear science and engineering, it is unsurprising that important advances in this area were presented at M&C 2019. New tools for improving and speeding up analysis using the Serpent code are given by

Johnson et al. Additionally, as computational capabilities improve, applications beyond *k*-eigenvalue calculations become more common. To this end, Variansyah et al. advance the state of the art in utilizing Monte Carlo for time eigenvalue calculations.

This issue also contains three papers regarding the application of mathematical techniques to operating reactors. Advances in equivalence theory from Giudicelli et al. and the application of the nTRACER and PARCS codes to VVER reactors from Papadionysiou et al. are exemplary contributions in this field. There was also a vibrant discussion of vibrations in nuclear reactions (and the resulting effects on neutronics) at the conference. The paper by Vidal-Ferràndiz et al. exemplifies the application of mathematical techniques to the analysis of vibrations.

The final two papers in this issue are but two instances of the uncertainty quantification and data assimilation papers given at M&C 2019. A unique, and inspiring, combination of particle transport and material science is presented in the penultimate paper of this issue, by Keckler et al., in their work discussing the uncertainty of the neutron spectrum and the resulting radiation damage to materials in reactor cores. The combination of experimental data and simulation has been a hallmark of the nuclear community. Endo and Yamamoto build on these past successes in the final paper in this issue, where they present the results of data assimilation to estimate the prompt neutron decay constant using subcritical experiments.

As with any conference, the organization is the most important, and most thankless, work. For M&C 2019, these tasks were ably performed by the following people along with many supporters. The general chairs of the meeting were John Wagner of Idaho National Laboratory (INL) and Jim Rathkopf, recently retired from Lawrence Livermore National Laboratory. They received significant contributions from the assistant general chair, Marinelle Rowe of INL. The technical acumen of the meeting was assured via the stewardship of the technical program chairs: Todd Palmer of Oregon State University, Jean Ragusa of Texas A&M University, and Mark DeHart of INL. I would also like to thank Michael Corradini, the editor of *Nuclear Science and Engineering*, and David Strutz, production editor at ANS, for their efforts to produce this special issue. Finally, given that a significant portion of this issue was reviewed, revised, and edited during the COVID-19 pandemic, I wish to express my appreciation to the frontline workers throughout the global supply chain, food and beverage industries, and medical fields so that the research advances contained in this issue could be disseminated and that further research could be pursued.

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