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Preface for the Sherwood Fusion Theory 2021–2022 special collection

Special Collection: Papers from the 2021-2022 Sherwood Fusion Theory Conferences

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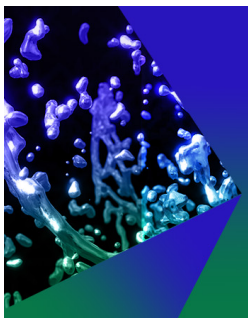

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Note: This paper is part of the Special Topic: Papers from the 2022 Sherwood Fusion Theory Conference.
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INTRODUCTION

The Sherwood Fusion Theory conference has a 60-year history and has been held nearly annually for at least five decades. With theoretical and computational research directed toward fusion energy as an organizing principle, the typical Sherwood program encompasses a wide range of plasma physics topics pertaining to a variety of confinement concepts along with advancements in algorithms and numerical methods for fusion plasma simulations. The typical annual meeting comprises roughly a dozen invited talks plus a small number of plenary speakers and several poster sessions. The program committee presents several awards each year to graduate (or undergraduate) students with outstanding poster presentations. Beginning in 2021, both invited speakers and student poster award winners were asked to submit manuscripts for this special collection, which combines contributions from the 2021 and 2022 Sherwood meetings.

Following the cancelation of the 2020 Sherwood meeting due to the COVID-19 pandemic, the 2021 meeting was the first annual meeting to be held in an entirely virtual format, with the usual poster sessions replaced by short contributed talks. In 2022, a mostly in-person meeting was organized at the originally planned 2020 meeting site of Santa Rosa, CA, with just a small fraction of talks presented virtually. Two papers from the 2021 conference and eight from the 2022 conference are included in the special collection.

SUMMARY OF AREAS COVERED

Turbulent transport in tokamaks, spanning the core, pedestal, and scrape-off layers, is the focus of a number of contributions. In accord with considerable recent interest in the beneficial features of negative triangularity shaped plasmas, Duff *et al.*[1] present linear and nonlinear simulations on the effect of triangularity on ion temperature gradient (ITG)-driven turbulence. Halfmoon *et al.*[2] study pedestal transport in a DIII-D H-mode and find that experimental energy fluxes and fluctuation data can be accounted for with contributions from micro-tearing modes and MHD in addition to electron temperature gradient (ETG) modes. Two papers[3,4] focus on electromagnetic gyrokinetic simulations of boundary plasmas. In XGC modeling presented by Hager *et al.*,[3] a new electromagnetic simulation algorithm is implemented for the boundary plasma, and comparison with electrostatic simulations confirms the importance of electromagnetic effects. Mandell *et al.*[4] use the Gkeyll code to predict a broadening of the electron heat-flux width (and reduction of peak heat flux) for high-beta regimes.

Several papers report results specific to other magnetic confinement concepts or of general applicability across configurations. Landreman *et al.*[5] present improved stellarator optimization with self-consistent inclusion of the bootstrap current, producing configurations with much lower alpha energy losses. In nonlinear MHD simulations, Gupta and Sovinec[6] found that in finite-beta reversed-field-pinch (RFP) plasmas, the pressure-gradient drive for the tearing instabilities is comparable to the current-gradient drive. Tripathi *et al.*[7] demonstrate the role of stable modes in the nonlinear saturation of sheared flow turbulence, in which up-gradient transport by stable modes almost cancels down-gradient transport. Li *et al.*[8] present an improved evaluation of the Bohm speed for sheath boundary conditions away from the asymptotic limit.

The final pair of papers focuses primarily on computational methods. With application to the SOLPS-ITER modeling suite, De Pascuale *et al.*[9] demonstrate the use of projective integration by dynamic mode decomposition (DMD) for simulation speedup. Finally, Joseph *et al.*[10] present a very comprehensive overview of prospects for quantum computing for fusion applications, including a tutorial on quantum computing basics.

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CONCLUSIONS

For decades, the realization of fusion for energy has seemed to loom just beyond the visible horizon, but the concrete prospects for a fusion power plant have come into sharper focus in the 2020s, along with renewed optimism and investment from both the public and private sectors. Spanning a range of topics—from divertor/plasma-facing-component heat fluxes, to transients, to alpha-particle confinement—theory and computation continues to play a vital role in validating solutions and reducing uncertainties for magnetic confinement concepts, as well as in designing next-step fusion devices. At the same time, as new computational hardware and architectures emerge, fusion theorists are developing new algorithms and codes to fully exploit these capabilities for problems of interest to the community. These activities drive a virtuous cycle of steady advancement toward commercial fusion power and a deeper understanding of basic plasma physics, both evident in the collection presented here.

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AUTHOR DECLARATIONS

Conflict of Interest

The authors have no conflicts to disclose.

Author Contributions

Valerie A. Izzo: Writing – original draft (lead). **S. J. Diem:** Writing – review & editing (supporting). **Ben Zhu:** Writing – review & editing (supporting).

DATA AVAILABILITY

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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