Queen's School of Computing

Distingushed Speaker

Thursday December 1, 2016
2:30 - 3:30 pm
Dupuis Hall 217

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Kinetic Plasma Turbulence Simulations on Top Supercomputers Worldwide

A major challenge for supercomputing today is to demonstrate how advances in HPC technology translate to accelerated progress in key application domains. This is the focus of an exciting new program in the US called the "National Strategic Computing Initiative (NSCI)" – announced by President Obama as an Executive Order on July 29, 2015 involving all research & development (R&D) programs in the country to "enhance strategic advantage in HPC for security, competitiveness, and discovery." A strong focus in key application domains is to accelerate progress in advanced codes that model complex physical systems -- especially with respect to reduction in "time-to-solution" as well as "energy to solution." It is understood that if properly validated against experimental measurements/observational data and verified with mathematical tests and computational benchmarks, these codes can greatly improve much-needed predictive capability in many strategically important areas of interest.

Computational advances in magnetic fusion energy research have produced particle-in-cell (PIC) simulations of turbulent kinetic dynamics for which computer run-time and problem size scale very well with the number of processors on massively parallel many-core supercomputers. For example, the GTC-Princeton (GTC-P) code, which has been developed with a "co-design" focus, has demonstrated the effective usage of the full power of current leadership class computational platforms worldwide at the petascale and beyond to produce efficient nonlinear PIC simulations that have advanced progress in understanding the complex nature of plasma turbulence and confinement in fusion systems for the largest problem sizes. Unlike fluid-like computational fluid dynamics (CFD) codes, PIC codes are characterized by having less than 10 key operations which can then be the focus of advanced computer science performance optimization methods. Results from these truly cross-disciplinary investigations have provided strong encouragement for being able to include increasingly realistic dynamics in extreme-scale computing campaigns with the goal of enabling predictive simulations characterized by unprecedented physics resolution/realism needed to help accelerate progress in delivering fusion energy.

William Tang of Princeton University is a Principal Research Physicist at the Princeton Plasma Physics Laboratory for which he served as Chief Scientist (1997-2009) and Head, Theory Department (1990-2002). He is a Lecturer with Rank & Title of Professor in Astrophysical Sciences, Plasma Physics Section, and member of the Executive Board for the "Princeton Institute for Computational Science and Engineering (PICSciE)," which he helped establish and served as Associate Director (2003-2009). He received his PhD in Physics with dissertation carried out at the University of California Lawrence Livermore National Laboratory and is a Fellow of the American Physical Society. He is internationally recognized for expertise in the mathematical formalism as well as associated computational applications dealing with electromagnetic kinetic plasma behavior in complex geometries, and has well over 200 publications with more than 150 peer-reviewed papers and an "h-index" or "impact factor" of 44 on the Web of Science, including well over 7000 total citations. He was U.S. PI for the G8 Research Council's "Exascale Computing for Global Scale Issues" Project in Fusion Energy – an NSF-funded international HPC collaboration (2011-2014). Prof. Tang has taught for over 30 years at Princeton U. and has supervised numerous Ph.D. students, including recipients of the Presidential Early Career Award for Scientists and Engineers in 2000 and 2005. He is currently Distinguished Visiting Professor, Center for High Performance Computing and NVIDIA Center of Excellence, Shanghai Jiao Tong University, Co-PI of the Early Science GTC Application Project (2015 - present) in Oak Ridge National Laboratory's CAAR Program leading to the 200 PF "Summit" Supercomputing System1, and the Principal Investigator (PI) and Head of the Intel Parallel Computing Center that was recently awarded to the Princeton Institute for Computational Science & Engineering (PICSciE) at Princeton University (May, 2016).

(1) http://oakridgetoday.com/2016/07/08/new-200-petaflop-supercomputer-to-succeed-titan-at-ornl/

Reference: "Scientific Discovery in Fusion Plasma Turbulence Simulations at Extreme Scale" William Tang, Bei Wang, and Stephane Ethier, Comput. Sci. Eng" http://dx.doi.org/10.1109/MCSE.2014.54