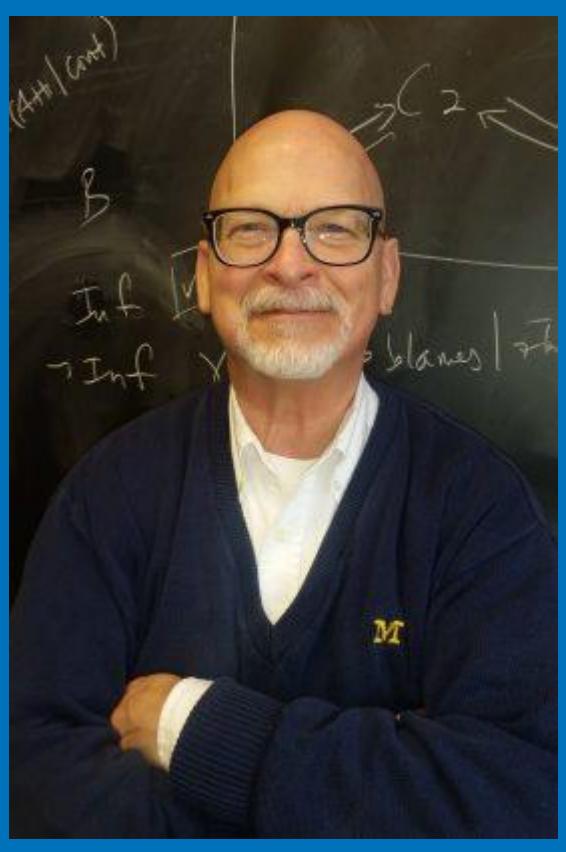
Pacific Institute *for the* Mathematical Sciences

# PIMS - UVic Distinguished Lecture

Friday, September 20, 2019
3:00 pm meet & greet and 3:30 pm talk

David Strong Building
room C108
University of Victoria



Charles R. Doering, CSCS Director,
Nicholas D. Kazarinoff Collegiate Professor of Complex Systems, Mathematics and Physics
University Of Michigan

**Applications of optimization and optimal control to some fundamental problems in mathematical hydrodynamics**

Optimization and optimal dynamical control are used to investigate the accuracy of analytical estimates for solutions of some basic nonlinear partial differential equations of mathematical hydrodynamics. Even though many mathematical estimates are demonstrably sharp, the result of a sequence of applications of such estimates need not be, leaving uncertainty in the precision of the ultimate result of the analysis. We examine the classical analysis bounding enstrophy and palinstrophy amplification in Burgers' and the Navier-Stokes equations and discover that the best known instantaneous growth rates estimates for these quantities are indeed sharp. Integrating the estimates in time may (as in the 2D Navier-Stokes case) but does not always (as in the Burgers case) produce sharp estimates in which case optimal control techniques must be brought to bear to determine the actual extreme behavior of the nonlinear dynamics. The question for the 3D Navier-Stokes equations remains unresolved although work is in progress to apply these tools to address it. The most recent work reported here is joint with Diego Ayala and Thilo Simon, *Journal of Fluid Mechanics* **837**, 839–857 (2018).