"Improved Equation-Free Method that Maximizes the Preservation of Microscale Properties" – C.S. Chang, SciDAC Fusion HBPS

SciDAC ASCR - Applied Mathematics Highlight **(In collaboration with ECP-WDMApp)**

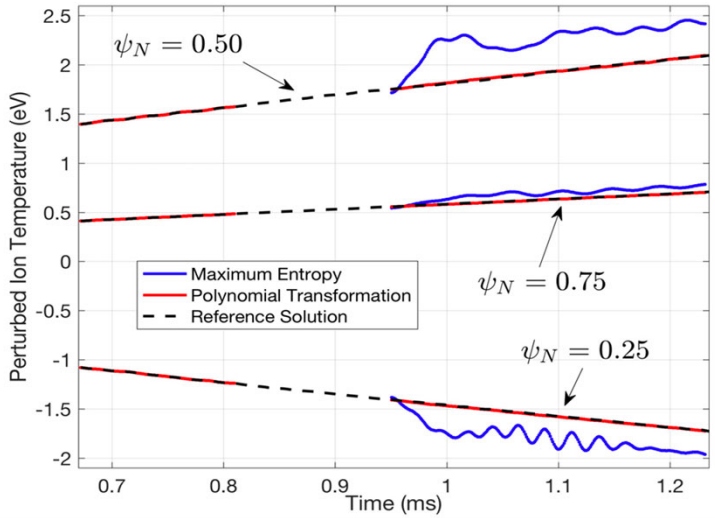
Objectives

- **Improve Equation-Free method to address its weakness: arbitrariness in the lifting operation**
- **Develop a new lifting algorithm that maximizes preservation of microscale properties**

Impact

- **Provide multiscale research community with a more reliable Equation-Free method**
- **Highly scalable and simple algorithm**
- **Enable application of the equation-free method to first-principles-based, extreme-scale magnetic-fusion simulation**

Deployment of the new method to the gyrokinetic code XGCa



Accomplishments

- **Established that a polynomial transformation scheme combined with PDF from previous microscale simulation improves accuracy of the Equation-Free method dramatically.**
- **Left figure shows the new method (red) compared with previous best method (blue).**
- **Results in > 4X acceleration of the XGCa gyrokinetic simulation of tokamak plasma.**
- **Published by Benjamin Sturdevant (PPPL), Scott Parker, C.S. Chang and Robert Hager in Physics of Plasmas, 27, 032505 (2020).**