Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Improved Proper Orthogonal Decomposition for Noise Reduction in Particle Flow Simulations[1] MALGORZATA ZIMON, University of Strathclyde, LEOPOLD GRINBERG, IBM T.J. Watson Research Center, JASON REESE, University of Edinburgh, DAVID EMERSON, STFC Daresbury Laboratory
— Proper orthogonal decomposition (POD), widely utilised for turbulent flows, has recently been explored for processing particle data. An extension of the method based on time-windows offers a useful approach for noise reduction in particle simulations. However, to successfully remove statistical noise from the system, large amounts of data need to be provided. Moreover, POD can fail to improve the quality of an ensemble mean (statistical average) when applied to steady-state simulations. In order to achieve a better efficiency of POD in processing non-stationary fields, we have combined the method with wavelet-based filtering. In this new procedure, the wavelet thresholding is performed within POD's domain. In case of stationary problems, we will show how effectively POD can be applied to a matrix constructed from the mean, following the application of singular spectral analysis (SSA). The combination of POD and SSA is shown to successfully smooth time-dependent observables. Simulations were undertaken to illustrate the performance of the new tools applied to noisy velocity and density fields. Numerical examples include molecular dynamics, dissipative particle dynamics simulations of force-driven fluid flows and phase separation phenomena.

[1]The research has received funding from the UK's Engineering and Physical Sciences Research Council (EPSRC) under Grant EP/I011927/1. Results were obtained using the ARCHIE-WeSt High Performance Computer, under EPSRC grant EP/K000586/1.

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Date submitted: 01 Aug 2014 Electronic form version 1.4