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Thermal coherent sets and heat transfer in chaotic laminar flows
SHIBABRAT NAIK, Mitsubishi Electric Research Labs and Virginia Tech, PIYUSH GROVER, Mitsubishi Electric Research Labs — The relation between the chaotic nature of the advection flow field and heat transfer in laminar flow heat exchangers is known to be subtle. We use the Perron-Frobenius transfer operator approach to analyze thermal transport in a coiled tube with 3D laminar flow and Dirichlet thermal boundary condition. The usual advection-only transfer operator is combined with a finite-difference diffusion operator via an operator-splitting technique. We compute various coherent sets of this approximate advection-diffusion operator. These coherent sets correspond to the important "thermal structures" which govern the heat transfer in this problem. This analysis gives an insight into the effect of chaotic advection field on the heat transfer performance of such devices. We study the dependence of heat transfer enhancement factor on Peclet number.This transfer operator based analysis could lead to systematic geometric optimization of micrometer sized heat exchangers.

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