Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

Effects of spanwise instabilities on the suppression of wake mode in flow over a long rectangular cavity[1] YIYANG SUN, KUNIHIKO TAIRA, LOUIS CATTAFESTA, Florida State University, LAWRENCE UKEILEY, University of Florida — Direct numerical simulation (DNS) and biglobal stability analysis are performed to examine the spanwise effects on the appearance of the so-called wake mode in the flow over long rectangular cavities. The wake mode has been reported to exhibit high-amplitude fluctuations and eject large spanwise vortices in numerical studies, despite its lack of observation in experiments, leaving its existence an open question. The present study focuses on a rectangular cavity flow with aspect ratio of $L/D = 6$, free stream Mach number of $M_\infty = 0.6$ and $Re_D = 502$. The properties of the wake mode are revealed via 2D DNS. From the biglobal stability analysis, the wake mode can be captured with a zero spanwise wavenumber. Furthermore, 3D eigenmodes are calculated with spanwise wavelength $\lambda/D \in [0.5, 2]$. With the knowledge of the features of the wake mode and the 3D eigenmodes, 3D DNS are performed with width-to-depth ratio of $W/D = 1$ and 2. We find the flow exhibits the wake mode with $W/D = 1$ but presents a moderate shear-layer mode with $W/D = 2$. Based on the findings, we argue that the spanwise instabilities in flows over wide cavities redistribute energy from spanwise vortices to streamwise vortical structures, which suppresses the emergence of the wake mode in the 3D cavity flows.

[1]This work was supported by the US Air Force Office of Scientific Research (Grant FA9550-13-1-0091).

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Date submitted: 01 Aug 2016 Electronic form version 1.4