Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Compliant wall excitation in turbulent channel flow: A data-driven analysis of the fluid-solid coupling and wall-pressure sources using SPOD[1] SREEVATSA ANANTHARAMU, KRISHNAN MAHESH, University of Minnesota — We numerically simulate the response of a compliant-wall in a turbulent channel flow using direct numerical simulation (DNS) at $Re_\tau = 180$ and 400. To understand the fluid-solid coupling as a function of frequency, we combine the modal decomposition of the solid and the Poisson equation for the fluid wall-pressure fluctuation to derive an expression for the plate averaged displacement spectrum of the form $\phi^a_{dd}(\omega) = \int_{-\delta}^{+\delta}\int_{-\delta}^{+\delta} \Gamma_{dd}(r,s,\omega)\,\mathrm{d}r\mathrm{d}s$. Here, δ is the half-channel height and $\Gamma^a(r,s,\omega)$ is called the net - displacement source cross-spectral density (CSD). Using the same framework, we derive a similar expression for the net - wall-pressure source CSD ($\Gamma_{pp}(r,s,\omega)$) that integrates to give the wall-pressure spectrum. We compute the CSDs using the DNS data. Spectral Proper Orthogonal Decomposition (SPOD) of the CSD supports the case that for both the structural response and the wall pressure, we can decompose the sources into an active part that contributes to the entire PSD and an inactive part that undergoes destructive interference. Analysis of the SPOD modes reveals the dominance of the buffer layer sources at these Reynolds numbers.

[1]Supported by Office of Naval Research

Sreevatsa Anantharamu
University of Minnesota

Date submitted: 31 Jul 2020 Electronic form version 1.4