Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Input-output analysis of a turbulent separation bubble with a time-periodic base flow[1] ALBERTO PADOVAN, CLARENCE ROWLEY , Princeton University, WEN WU, CHARLES MENEVEAU, RAJAT MITTAL, Johns Hopkins University — Direct numerical simulations are performed for three-dimensional turbulent boundary layer flow at $Re_{\theta_0} = 490$, in which a suction velocity profile is imposed at the top of the computational domain to induce separation at the bottom wall. We study the input-output characteristics of perturbations about two different base flows: a spanwise-averaged, time-averaged base flow and a spanwise-averaged, time-periodic base flow. The first approach leads to the well-known resolvent analsysis, through which we compute the optimal forcing and response modes at a given frequency and spanwise wavenumber. The latter approach leads to the formulation of the harmonic transfer function, a linear operator that governs the dynamics of fluctuations about time-periodic base flows. Within this framework, perturbations at different temporal frequencies are coupled to one another through the base flow, and we can therefore study the cross-frequency and energy transfer mechanisms. For the harmonic transfer function, we compute the optimal global forcing and response modes, which are full spatio-temporal flow fields. The cross-frequency modes provide insight into the spatial patterns that arise from the scattering of perturbations from the base flow.

[1]This material is based upon work supported by the Air Force Office of Scientific Research under award number FA9550-17-1-0084.

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Date submitted: 31 Jul 2019 Electronic form version 1.4