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Two dimensional roughness effects on hypersonic boundary layer instability KAHEI DANNY FONG, XIAOWEN WANG, XIAOLIN ZHONG, University of California at Los Angeles — Numerical simulations of 2-D roughness effects on modal growth are conducted for a hypersonic boundary layer. Perturbations correspond to pure mode S & mode F at 100 kHz and a wall normal velocity pulse with a frequency spectrum of 1MHz are considered. The evolution of perturbation at different frequency along the streamwise direction with the effect of surface roughness is studied by FFT. Our results show the importance of the relation between roughness location and the synchronization point, where the synchronization point is the point where mode S and mode F have the same phase velocity and synchronizes with each other. Its location can be obtained from the linear stability theory. The results show that if roughness is placed upstream of the synchronization point, perturbation is amplified. The amplification rate depends strongly on roughness height. On the other hand, if roughness is placed close to or downstream of the synchronization point, perturbation is damped. Similar to amplification, the strength of damping depends strongly on roughness height. A tentative explanation is that roughness alters the mean flow profile (ex: sonic line, inflection point). We believe this can be a candidate to explain the roughness-delayed transition as some experiments have shown.

Kahei Danny Fong
University of California at Los Angeles

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