Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

A Bayesian approach to flow in a channel with small but arbitrarily directional system rotation[1] XIANG YANG, XINYI HUANG, Pennsylvania State University, MAHDI ABKAR, Aarhus University — We show dimensional analysis that when a boundary-layer flow is subjected to small system rotation, the constant stress layer survives, and the mean flow U^+ is a function only of y^+, Ω_x^+, Ω_y^+, and Ω_z^+, where U is the mean flow, y is the distance from the wall, Ω_i is the system rotation speed in the ith direction. Determining the mean flow behavior $U^+(y^+, \Omega_x^+, \Omega_x^+, \Omega_z^+)$ is non-trivial, and taking an analytical approach incurs large errors. Here, we pursue a Bayesian approach, where we survey the three dimensional parameter space of Ω_x^+, Ω_y^+, Ω_z^+ via direct numerical simulation. Surveying a parameter space for knowledge of a flow quantity is conventionally considered to be a "brutal force" approach. However, because a Bayesian surrogate gives not only a prediction of the objective function but also an estimate of the prediction's uncertainty level, we are able to very efficiently sample the parameter space and quickly obtain an accurate surrogate of U^+. Four independent surveys are conducted with 146 DNSs in total. Validating a surrogate with the data in other surveys, we show that the the Bayesian approach yields accurate estimates of U^+.

[1]Office of Naval Research

Xiang Yang
Pennsylvania State University

Date submitted: 02 Aug 2020 Electronic form version 1.4