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Data-driven-estimated pressure from snapshot PIV and fast probes

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ABSTRACT:

The hardware advancements in the Particle Image Velocimetry (PIV) technique has open the path in the last decade to the measurements of pressure fields [1] through the integration of the momentum equation. This approach, however, requires the direct measurement of the Lagrangian acceleration which, with actual technology, is available only for low-speed flows. A promising approach to enhance the velocity-field time-resolution combines standard low-repetition-rate PIV with fast point probes through data-driven method. In this work, we exploit Extended Proper Orthogonal Decomposition (EPOD, [2]) to leverage the correlation between the most relevant features observed on synchronized measurements of flow fields and probe data via modal analysis. The availability of time-resolved velocity fields allows the enforcing of physical constraints to obtain the corresponding pressure fields. The method is tested using synthetic and experimental data. Fig. 1 reports the comparison between pressure fields from the original DNS of the flow in the wake of a fluidic pinball [3] and from the data-driven estimation for a single snapshot, as well as the error produced by the data-driven pressure estimation.

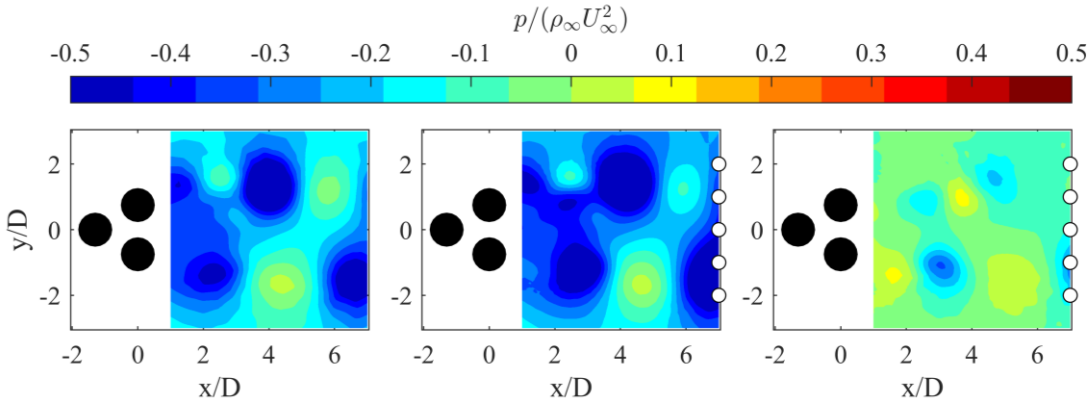

Figure 1 Instantaneous pressure from DNS (left); instantaneous pressure from data-driven estimation (center); error map of data-driven estimation vs. DNS pressure (right). The white circles indicate the position of the fast probes.

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