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Data-driven Modeling of Detonation Wave Interactions in Rotating Detonation Engines ARIANA MENDIBLE, University of Washington, JAMES KOCH, University of Texas, Austin, HENNING LANGE, STEVEN BRUNTON, NATHAN KUTZ, University of Washington — Direct observation of a Rotating Detonation Engine (RDE) combustion chamber has enabled the extraction of the kinematics of its detonation waves. The resulting combustion fronts are composed of co- and counter-rotating coherent traveling shock waves whose nonlinear dynamics are rife with mode-locking behavior, bifurcations, and instabilities which are not well understood. Computational fluid dynamics simulations are ubiquitous in the endeavor to characterize the dynamics of RDEs, however, they prove to be prohibitively expensive when considering multiple engine geometries or operating conditions. Reduced order models (ROMs) are preferred to direct calculations because they exploit low-rank structure in the data to minimize computational cost and allow for rapid parameterized studies. ROMs are inherently inhibited by translational invariances such as the traveling waves present in RDEs. In this work, we overcome these roadblocks by using machine learning to discover moving coordinate frames into which the data is shifted. This allows for the application of traditional dimensionality reduction techniques. We explore a suite of data-driven models, ranging from simple representations to neural networks, describing the complex dynamics of the shock waves in the RDE.

Ariana Mendible
University of Washington

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