

# POD- and DMD-based model reduction for a flow over an aeroelastic AGARD wing

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The development in the aerospace industry is closely associated with the analysis of flow phenomena and their influence on the structure flown around.

Computational aeroelastic analysis, basing on coupled simulation of interactions between a fluid and a structure, plays more and more important role in the design process, reducing wind-tunnel tests to the most sensitive cases. The growth of computing power of the clusters and the development of numerical methods allows to analyze increasingly complex geometries, however even the use of simplified flow models, such as Euler's or URANS equations still requires several days or weeks of calculations.

These reasons have increased interest in methods of low-dimensional flow modelling, like Galerkin method<sup>1</sup>, based on the approximation of the flow field by a weighted sum of modes. The weights (mode coefficients) are calculated from Galerkin system, resulting from the projection of the residual of approximated governing equation onto the space spanned by the modes. The most popular mode bases are obtained from Proper Orthogonal Decomposition (POD)<sup>2</sup> of high-dimensional data. Known limitations of this method, like the optimal capturing of the dataset and not the dynamics due to neglect of low energy modes<sup>3</sup>, resulted in recent development of new tools like Balanced POD and Dynamic Mode Decomposition (DMD)<sup>4,5</sup>.

In the present paper, results from aeroelastic simulation of a flow around AGARD wing are used to construct the POD and DMD mode bases (fig. 1), required in the design of reduced order models of fluid flow.

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<sup>1</sup>Noack et al., *J. Fluid Mech.* **497**, 335 (2003)

<sup>2</sup>Lumley and Poje, *Phys. Fluids* **9**, 2023 (1997)

<sup>3</sup>Rowley et al., *J. Fluid Mech.* **641**, 115 (2009)

<sup>4</sup>Schmid and Sesterhenn, *J. Fluid Mech.* **665**, 5 (2010)

<sup>5</sup>Frederich and Luchtenburg, *7th International Symposium on Turbulence and Shear Flow Phenomena* (2011)

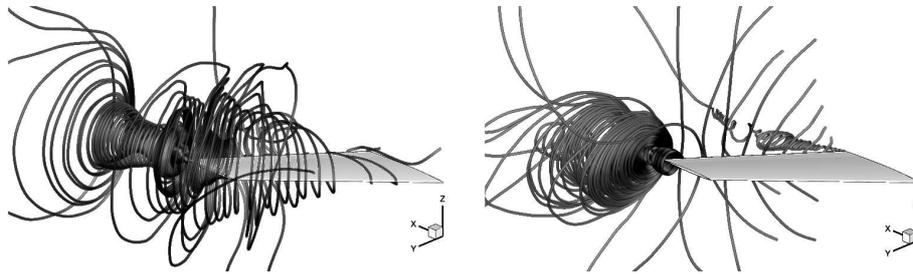


Figure 1: (a) Streamlines of selected POD (left) and DMD (right) modes for a flow around AGARD wing.