Model reduction for Fluid Mechanics and Heat Transfers

Course proposal – Master of Science in Aeronautics and Space

10 h

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Language: This course may be given in English depending on the audience.

With the technical advances in the experimental and numerical domains, researchers are faced with increasingly large amounts of data. It has thus become more necessary than ever, to have methods allowing to extract, if possible in an automatic way, the essential information from a physical point of view in order to understand, predict and if possible control the phenomena of interest. This problem is at the heart of dimensionality reduction. In this course, we will address this problem from a kinematic point of view (extraction of modes according to different criteria) and from a dynamical point of view (construction of reduced-order models allowing to reproduce the dynamics of the system).

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1/ Introduction.

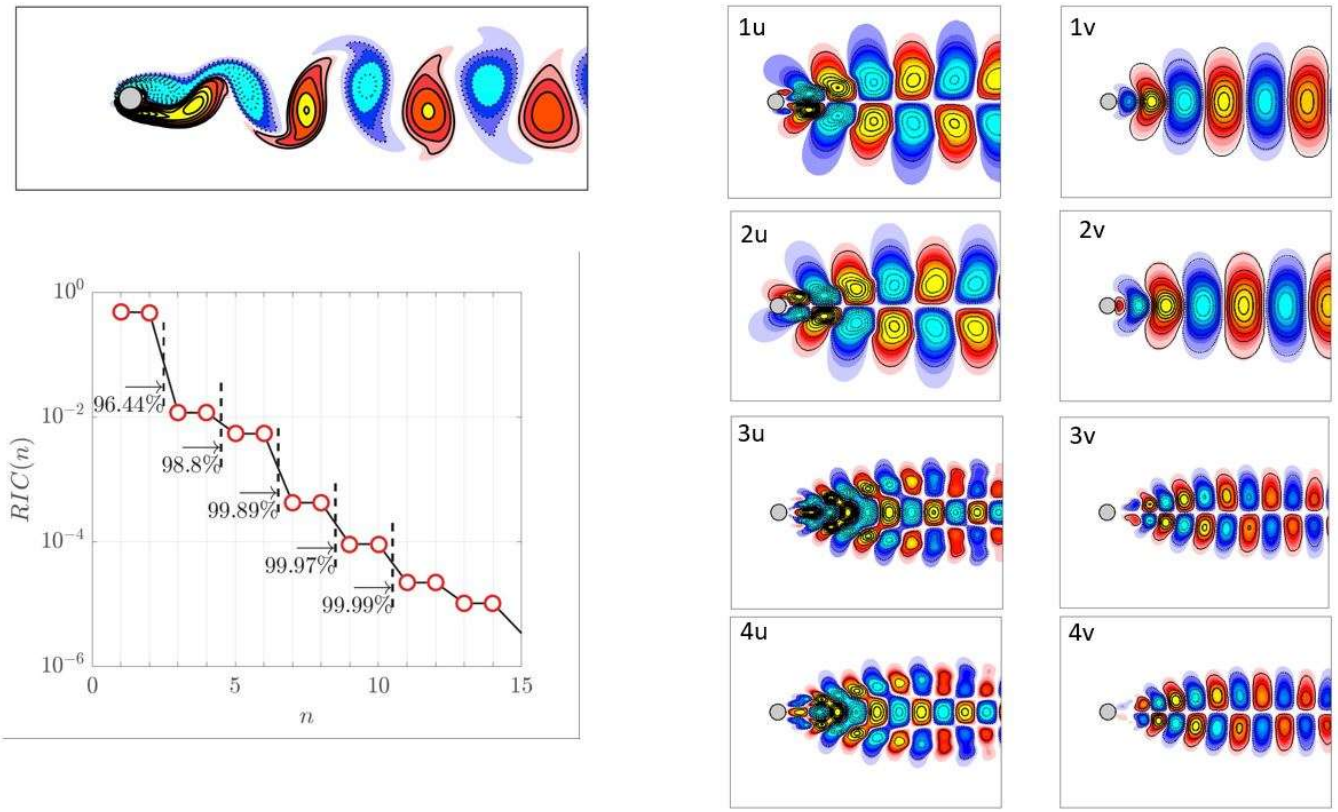
2/ Preliminaries
- 2.1/ Eigenvalue decomposition
- 2.2/ Singular Value Decomposition

3/ Data-driven reduction methods
- 3.1/ Proper Orthogonal Decomposition (POD).
- 3.2/ Dynamic Mode Decomposition (DMD).
- 3.3/ Balances modes (Balanced POD).
- 3.4/ Cluster-based Reduced Order Model (CROM).

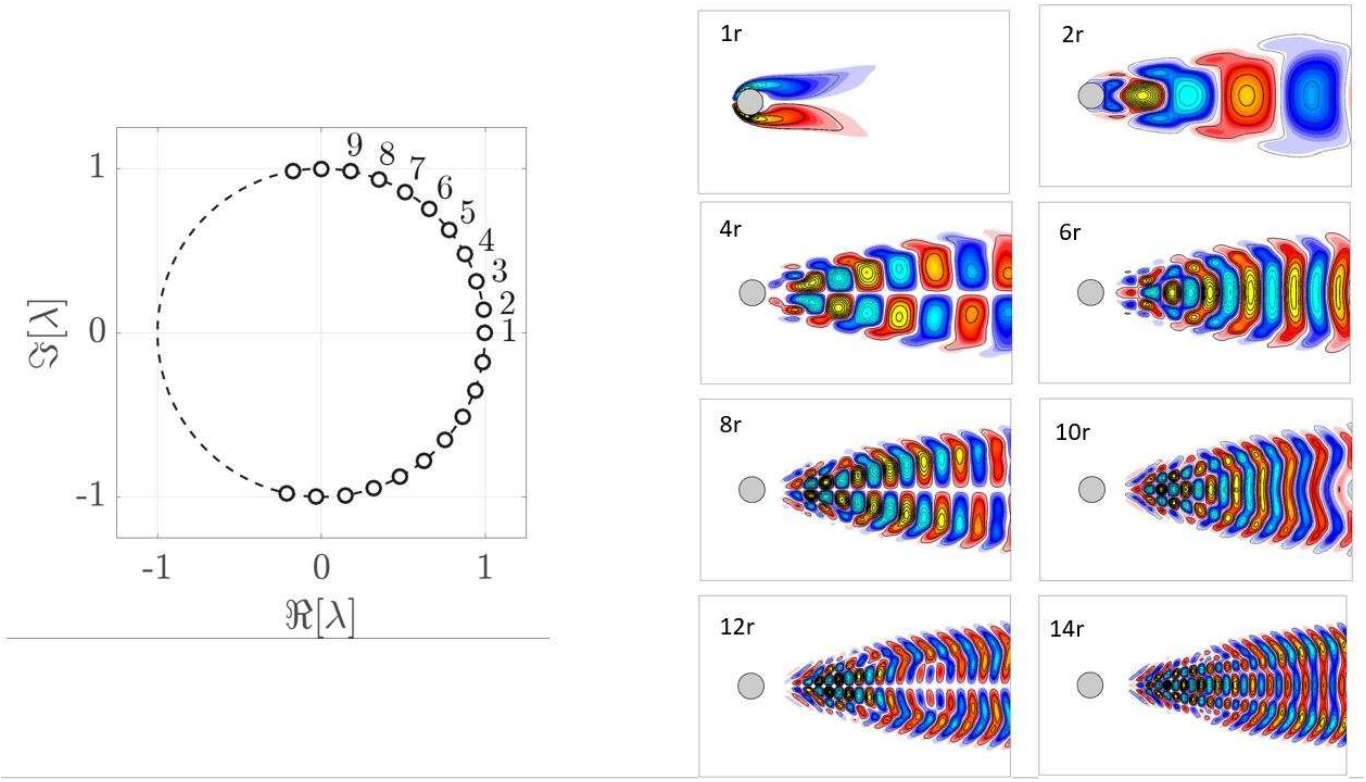
4/ Operator-based reduction methods
- 4.1/ Global stability analysis
- 4.2/ Resolvent modes
- 4.3/ Koopman analysis
- 4.4/ Galerkin Projection

5/ Model identification methods
- 5.1/ Linear regression model
- 5.2/ Sequential data assimilation
- 5.3/ Neural Network modeling with physical constraints

Notions of machine learning will be covered. These methods will be described in more detail in the course "Machine Learning for Physicists".



Model reduction by POD: illustration for a cylinder wake flow.



Model reduction by DMD: illustration for a cylinder wake flow.

Calendrier

Date, horaire	Salle
Vendredi 06 Novembre 17h30-19h30	B139 ENSMA
Mardi 10 Novembre 17h30-19h30	B134 ENSMA
Mercredi 18 Novembre 17h30-19h30	B139 ENSMA
Vendredi 20 Novembre 17h30-19h30	B134 ENSMA
Mardi 24 Novembre 17h30-19h30	B134 ENSMA