UE Instabilities and Turbulences

Niveau d'étude
Bac +4

ECTS
3 crédits

Composante
UFR Informatique, mathématiques et mathématiques appliquées (IM2AG), UFR Physique, Ingénierie, Terre, Environnement, Mécanique (PhITEM)

Période de l'année
Automne (sept. à dec./janv.)

Diplômes intégrant cet élément

- Master Mathématiques et applications

Langue(s) d'enseignement: Anglais

Ouvert aux étudiants en échange: Non

Code d'export Apogée: PAX7MEAL

Présentation

Description

This course presents basic notions on instabilities and turbulence. We try to be as progressive as possible and to base our presentation on analyses of real experiments and real flows. We review few mathematical methods to analyze nonlinear systems in terms of instabilities. The students have to use their new knowledge to run and analyze numerical simulations of very simple systems. We then study some of the most important physical mechanisms for fluid instabilities and the corresponding criteria. We quickly present a zoology of common fluid instabilities and discuss the mechanisms and the possible technical implications. We

Informations non contractuelles.
Dernière mise à jour le 30 juin 2026

give a broad introduction on turbulence and describe few fundamental methods and results, in particular the Richardson cascade, the Reynolds decomposition and the Kolmogorov spectra.

Teaching program:

1. General introduction

- Instabilities and turbulence, interest?

- Reynolds experiment and Reynolds number

- Incompressible Navier-Stokes equations: diffusion and advection

- An example: the wake of a cylinder

2. Instabilities and transition to turbulence

- Systems with few degrees of freedom

- Fluid instability mechanisms and conditions

- Other flows examples

3. Effects of variable density

- Boussinesq approximation

- Unstable stratification, Rayleigh-Taylor instability

- Rayleigh-Benard instability (Ra, Nu)

- Stable stratification, Kelvin-Helmoltz instability and Richardson number

4. Turbulence

- Introduction, Richardson cascade

- Average and Reynolds decomposition

- Experimental and numerical methods to study turbulence

- Statistical descriptions

For this course, the students have to write in LaTeX a report on their practical work. Thus, we spent some time for a first gentle introduction of this tool widely used in scientific academia.

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Heures d'enseignement

CMTD	Cours magistral - Travaux dirigés	20h

Pré-requis recommandés

- Incompressible Navier-Stokes equation

- Vectorial operators

Période : Semestre 7

Infos pratiques

Contacts

Responsable d'UE

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Campus

Grenoble - Domaine universitaire

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