TIME TABLE

TIME	Monday	Tuesday	Wednesday	Thursday	Friday
	June 14	June 15	June 16	June 17	June 18
09.00 - 09.45	Registration	Le Bars	Le Bars	Llewellyn Smith	Noir
09.45 - 10.30	Le Bars	Le Bars	Le Bars	Llewellyn Smith	Noir
11.00 - 11.45	Llewellyn Smith	Shaw	Llewellyn Smith	Shaw	Shaw
11.45 - 12.30	Lecoanet	Young	Llewellyn Smith	Shaw	Young
14.00 - 14.45	Lecoanet	Noir	Shaw	Young	
14.45 - 15.30	Participants flash talk #1	Lecoanet	Young	Young	
16.00 - 16.45	Participants flash talk #2	Participants flash talk #3	Noir	Noir	
16.45 - 17.30	Poster session #1	Poster session #2	Lecoanet	Lecoanet	
18.00	Welcome aperitif				

ADMISSION AND ACCOMMODATION

The course is offered in a hybrid format, allowing participants the flexibility to attend either in person or remotely via the Microsoft Teams platform. Admission to on-site attendance is granted on a first-come, first-served basis to comply with the capacity of the lecture room.

Registration fees:

- Early Bird On-Site Participation: € 650.00 + VAT*
Deadline: April 14, 2027

- Late On-Site Participation: € 800.00 + VAT*
Deadline: June 2, 2027

- Live Streaming Online Participation: € 250.00 + VAT*
Deadline: June 2, 2027

On-site participation includes a complimentary bag, five fixed menu buffet lunches, hot beverages, downloadable lecture notes.
Online participation includes downloadable lecture notes.

Application forms should be submitted online through the website: http://www.cism.it. A confirmation message will be sent to participants whose applications are accepted.
Upon request, and subject to availability, a limited number of on-site participants can be accommodated at the CISM Guest House for € 35 per person per night. To request accommodation, please contact: foresteria@cism.it

** where applicable; bank charges are not included - Italian VAT is 22%.*

CANCELLATION POLICY

Applicants may cancel their registration and receive a full refund by notifying the CISM Secretariat in writing (via email) no later than:
- April 14, 2027, for early bird on-site participation;
- May 14, 2027, for late on-site participation;
- June 2, 2027, for online participation.

No refunds after the deadlines. Cancellation requests received before these deadlines and incorrect payments will be subject to a € 50.00 handling fee.

GRANTS

A limited number of participants without institutional support may apply for a registration fee waiver and/or free lodging. Additional grants, supported by the Simons Foundation, are also available.
Applications must be submitted through the CISM website by **April 14, 2027**, by selecting the relevant option in the online application form. Applicants will be asked to provide a short CV and a letter from their supervisor confirming the lack of institutional financial support.

For further information please contact:

CISM (Seat of the course)
Palazzo del Torso - Piazza Garibaldi 18 - 33100 Udine (Italy)
tel. +39 0432 248511 (6 lines)
e-mail: info@cism.it | www.cism.it

Centre International des Sciences Mécaniques
International Centre for Mechanical Sciences

ACADEMIC YEAR 2027
Andreas Acrivos Session

FLUID MECHANICS OF PLANETS AND STARS

CISM Advanced School
coordinated by

Michael Le Bars
IRPHE, CNRS, Aix-Marseille University
Marseille, France

Daniel Lecoanet
Center for Computational Astrophysics
Flatiron Institute, New York, NY, USA

SIMONS FOUNDATION

Udine *June 14 - 18* 2027

FLUID MECHANICS OF PLANETS AND STARS

Understanding the dynamics of planetary and stellar fluid layers, including the atmosphere and oceans of the Earth and other planets, iron cores, and stellar convective and radiative zones, remains a tremendous interdisciplinary challenge, relying on common knowledge in fundamental fluid mechanics. A few of the numerous open questions include:

- What are the basic physical mechanisms responsible for climate circulation, and how can they be parameterised to reliably predict global climate change?

- What are the prevalent force balances and physical mechanisms behind natural large-scale features such as Jupiter's Great Red Spot, polar clusters, and bands?

- What are the relevant driving forces and flow regimes in conducting planetary cores for explaining the generation of large-scale magnetic fields by dynamo action?

- How are the various types of waves propagating in the oceans, atmospheres, cores and stellar interiors generated, and what influence do they have on the dynamics?

Interdisciplinary research in geo- and astrophysical fluid dynamics is also intrinsically multi-method. Indeed, the main obstacle to quantitative modeling and understanding of planetary and stellar flows stands in the extreme character of the involved dimensionless parameters. Relevant studies thus rely on the principle of dynamical similitude and scaling laws, sustained by theory, experiments and numerical simulations.

Much research effort has been devoted to understanding planetary and stellar flows within the various communities of Mechanics, Applied Mathematics, Engineering, Physics, Planetary, Atmospheric and Earth Sciences, Oceanography, and Astrophysics. But progress has mostly been confined to each separate domain, with only marginal cross-fertilisation. The objective of this school is to go beyond this state, by providing participants with a global introduction and an up-to-date overview of all relevant studies, fully addressing the wide range of involved disciplines and methods.

The course will be organized in three parts. The first will focus on fundamental aspects of fluid mechanics in geo- and astrophysical flows, including introductory material as well as current cutting-edge research, with a focus on instabilities, turbulence, and waves. The second part will focus on concrete applications to topical problems, with lectures focusing on planetary interiors, atmospheres, and oceans. Finally, the third part will involve practical numerical sessions using the open-source solver Dedalus (http://dedalus-project.org). Participants will learn to set up and run numerical simulations on their laptops related to problems discussed in the lectures.

The targeted audience for this school is PhD students, postdocs, and young researchers, working in departments of Mechanics, Applied Mathematics, Engineering, Physics, Planetary, Atmospheric and Earth Sciences, Oceanography, and Astrophysics. A background in fluid dynamics will be assumed for each participant, but no specific knowledge in application domains or computational methods will be requested. Each participant will present her/his work during a flash talk, followed by a poster session.

PRELIMINARY SUGGESTED READINGS

Vallis, G. K. (2006). Atmospheric and Oceanic Fluid Dynamics: Fundamentals and Large-Scale Circulation. Cambridge University Press.

Sutherland, B. R. (2010). Internal Gravity Waves. Cambridge University Press.

Tilgner, A. (2007). “Rotational Dynamics of the Core.” In Treatise on Geophysics, Vol. 8: Core Dynamics, pp. 207–243. Elsevier.

Le Bars, M., & Lecoanet, D. (Eds.). (2020). Fluid Mechanics of Planets and Stars. CISM International Centre for Mechanical Sciences, Vol. 595. Springer, Cham.

Davidson, P. A. (2013). Turbulence in Rotating, Stratified and Electrically Conducting Fluids. Cambridge University Press.

LECTURES

All lectures will be given in English. Lecture notes can be downloaded from the CISM web site. Instructions will be sent to accepted participants.

INVITED LECTURERS

Michael Le Bars - IRPHE, CNRS, Aix-Marseille University, France
5 lectures on:
Fundamental fluid mechanics in rotating and stratified flows, including the most common instabilities (barotropic, baroclinic, inertial) and basic properties of turbulence (3D, 2D, rapidly rotating, strongly stratified).

Daniel Lecoanet - Center for Computational Astrophysics, Flatiron Institute, New York, USA
5 practical sessions using the open-source solver Dedalus. Each day, an illustrative problem is presented and simulated by students on their laptops, e.g. Rayleigh-Bénard convection, 2D turbulence, wave generation and propagation, and moist convection.

Jerome Noir - ETH Zurich, Switzerland
5 lectures on:
Planetary cores and subsurface-ocean dynamics, including fundamental questions on planetary fluid layers, what rotation reveals about internal structure, precession, libration and tides, application to the lunar core, and laboratory dynamo.

Tiffany Shaw - University of Chicago, Illinois, USA
5 lectures on:
Atmospheric fluid dynamics, including the basic structure of the Earth's atmosphere, general circulation, energetic regimes and instabilities, and atmospheric wave-driven periodic flows (QBO, MJO).

Stefan Llewellyn Smith - University of California San Diego, La Jolla, USA
5 lectures on:
Fundamental fluid mechanics in rotating and stratified flows, including convection regimes (Rayleigh-Bénard, horizontal, vertical) and generic wave properties (internal gravity, inertial, nonlinear and wave-mean-flow interactions).

William R. Young - Scripps Institution of Oceanography, University of California San Diego, La Jolla, USA
5 lectures on:
Ocean fluid dynamics, including fundamental force balances and energy budget, oceanic waves across scales, boundary processes at the ocean bottom and poles, turbulence and mixing parameterization, and subsurface oceans of icy moons.