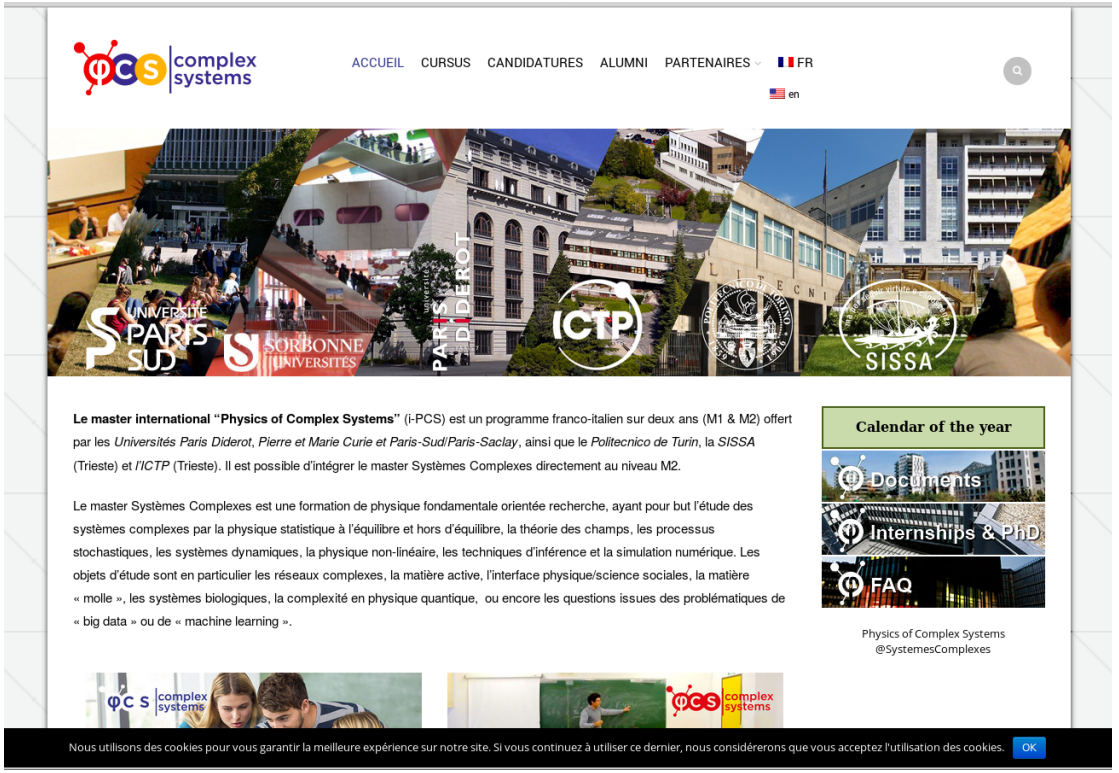
Physics of Complex Systems Master
Kickoff meeting

J.-B. Fournier, D. Mouhanna, E. Trizac

September 2nd 2019

Welcome



Jointly operated with
Polito, SISSA, ICTP

Distinguish
PCS (M2) / iPCS (M1 in Italy + M2)

Organization of the year (PCS+ PCS-like iPCS)

See below for 'true' iPCS

- **First semester** → Dec 6
- Special session on doctoral studies, mid October (Oct 21 ?)
- Autumn break and tour of labs : Oct 28 – Nov 1
- Second semester courses presentation mid November
- 1 week of revisions
- First round of exams before Xmas
- Second round early January
- **Second semester courses** : Mid Jan → Feb 28
- Exams mid March
- Internships → defense end of June (France)

More details available on the web

iPCS version

- First semester common
- Start of internship earlier : mid January
- Internship sandwiches
  Trieste "Spring" College : Feb 24 → March 20

2016

2017

2018

Program changes every year ; see web
Also open to some Master & PhD students + **some PCS as well**

- Internship defense : mid July in Italy
- Graduation ceremony in October in Italy

The 2020 Spring college

Lecturers and Courses:

Mahesh Bandi (OIST, Okinawa, Japan)
Fluctuations and Information in Physical Systems

Ramakrishna Ramaswamy (Indian Institute of Technology, Delhi, India)
Synchrony in nonlinear dynamical systems

Sidney Redner (Santa Fe Institute, New Mexico, USA)
A Kinetic View of Statistical Physics

Alessandro Silva (SISSA, Trieste, Italy)
Quantum systems out of equilibrium

Lenka Zdeborova (CNRS, Paris, France)
Statistical Mechanics toolbox for Machine Learning

First semester schedule

MONDAY (UP)		TUESDAY (SU, Jussieu)		WEDNESDAY (UP)		THURSDAY (SU, Jussieu)		FRIDAY (SU, Jussieu)	
		08:30 10:30	**Advanced nonlinear physics** *L. Foret & N. Pavloff* T23-24 room 201	08:30 10:30	**Statistical field theory** *J.-B. Fournier* HF 264E	08:30 10:30	**Mathematical tools** *G. Roux* T23-24 room 101	08:30 10:30	**Computational science** *F. Krzakala* T13-12 room 523
10:00 12:00	**Nonlinear physics and dynamical systems** *C. Nore* ODG 153	10:45 12:45	**Quantum field theory** *J. Serreau* T23-24 room 201	10:45 12:45	**Statistical physics of simple & complex fluids** *M. Durand & G. Foffi* C 356A	10:45 12:45	**Biophysics** *M. Lenz* T23-24 room 101	10:45 12:45	**Stochastic processes** *D. Mouhanna & C. Deroulers* T13-12 room 523
13:30 15:30	**Statistical field theory** *J.-B. Fournier* SG 0011	13:45 15:45	**Numerical simulations** *P. Viot* T24-34 room 101	13:45 15:45	**Stochastic processes** *D. Mouhanna & C. Deroulers* HF 227C			13:45 15:45	**Nonequilibrium and active systems** *J. Tailleur* T13-12 room 523
16:00 18:00	**Advanced statistical mechanics** *L. Cugliandolo* SG 0011								

C = Condorcet, ODG = Olympe de Gouge, HF = Halle aux farines, SG = Sophie Germain, T13/12 = Tower 13/12, entrance tower 13
UP = University of Paris (Paris Diderot), SU = Sorbonne University

Slight changes on weekly basis

The exams

- In December or March (Spring college apart)
- Usually written ; grade over 20
- If grade < 10, possibility of an oral exam.
  Course grade is *saturated to 10*.
-  Narrow time window for orals
  (1 week, before the jury in January)

- Very different from Italian system
- Exams are concentrated (written+oral)
- In practice : 1 session only
  The second session arrives after doct school competition
  → too late / irrelevant
- **First semester usually harder**

and some PhD applications (abroad)
are in March : second semester irrelevant

→ Work all courses simultaneously
And start now !

Relevant information on the web

https://physics-complex-systems.fr/

Le master international "Physics of Complex Systems" (i-PCS) est un programme franco-italien sur deux ans (M1 & M2) offert par les *Universités Paris Diderot*, *Pierre et Marie Curie et Paris-Sud/Paris-Saclay*, ainsi que le *Politecnico de Turin*, la *SISSA* (Trieste) et *l'ICTP* (Trieste). Il est possible d'intégrer le master Systèmes Complexes directement au niveau M2.

Le master Systèmes Complexes est une formation de physique fondamentale orientée recherche, ayant pour but l'étude des systèmes complexes par la physique statistique à l'équilibre et hors d'équilibre, la théorie des champs, les processus stochastiques, les systèmes dynamiques, la physique non-linéaire, les techniques d'inférence et la simulation numérique. Les objets d'étude sont en particulier les réseaux complexes, la matière active, l'interface physique/science sociales, la matière « molle », les systèmes biologiques, la complexité en physique quantique, ou encore les questions issues des

Calendar of the year

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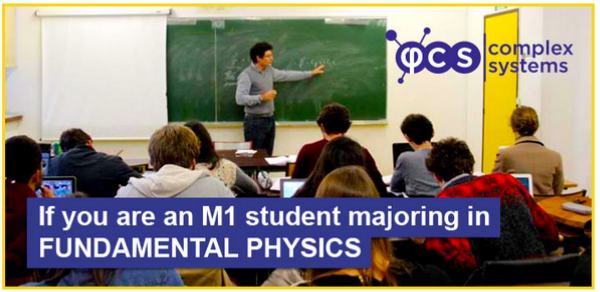
See in particular
Documents + Internships & PhD

matter, the interface between social sciences and physics, soft matter, biological systems, complexity in the quantum realm, or questions raised in the context of « big data » and « machine learning ».

You may attend the M1 & M2 international "Physics of Complex Systems" (i-PCS) program, in Italy for the M1 and in Paris for the M2. All courses are delivered in English. You obtain a double Italian-French degree. A small amount of additional integrative exam allow to obtain the engineer diploma of the Politecnico di Torino



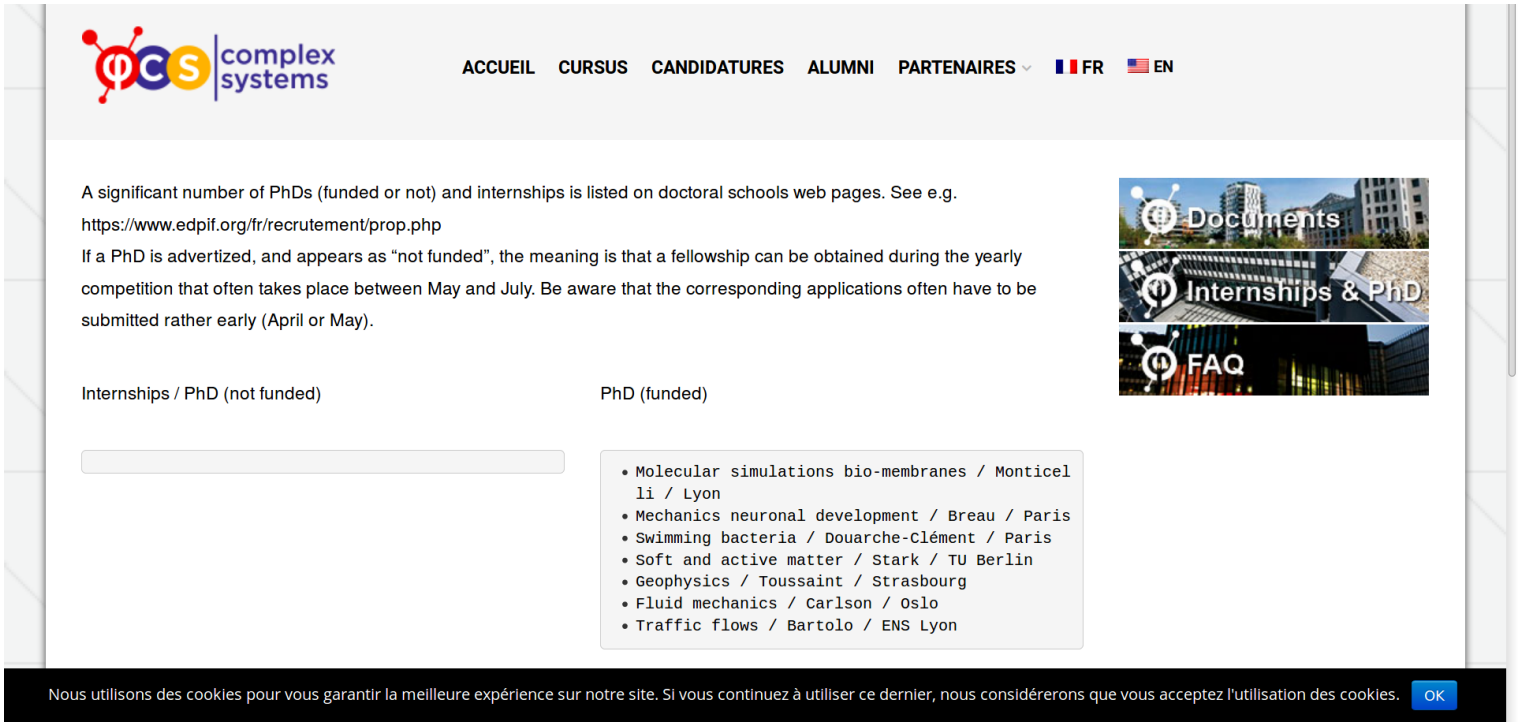
You can directly attend the M2 year "Physics of Complex Systems" (PCS) in Paris. The first semester is common with the international i-PCS Master. All courses are delivered in English.

11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

Follow @Phys_CS_Master

Internships & PhDs

- Doctoral schools websites
- Laboratory web sites
- PCS site



Internships & PhDs

- On you to search for internship/PhD
- Do not hesitate to contact researcher before visit
- Internships (in France) require “convention de stage”, to be completed *before* the beginning.

- Mid October : a session dedicated to doctoral studies

Misc

- Conditions for internship defense for iPCS
  → Defense in June in France if principal affiliation in France
  → If you are an “italian iPCS” (principal affiliation in Italy)
    - you graduate in July : defense in July in Italy. Only one defense. Grade needed before July 15.
    - you graduate later than July, too late for French grade, you then defend in June in France and later in Italy (autumn usually). Two defenses
- Prolongation of rooms @ cité U
  → you may need your room for the second semester

Presentation of courses : compulsory / 18 ECTS

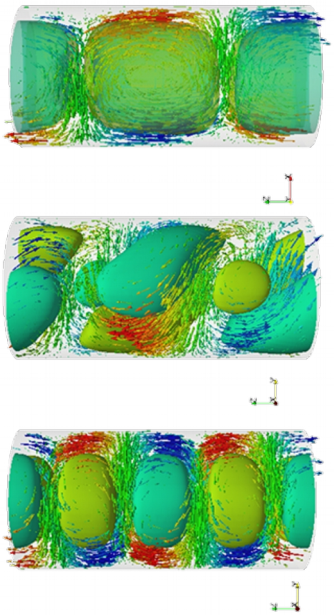
- Non linear physics & dynamical systems
- Stochastic processes
- Computational Science
- Statistical Field Theory

+ 4 elective courses, choose among 8 → 70 possibilities

C. Nore

Non-linear physics and dynamical systems

- Study systems with increasing complexity
- From 1d onwards
- PDE and beyond
- Bifurcation and chaos



See also the elective
"advanced non-linear physics"

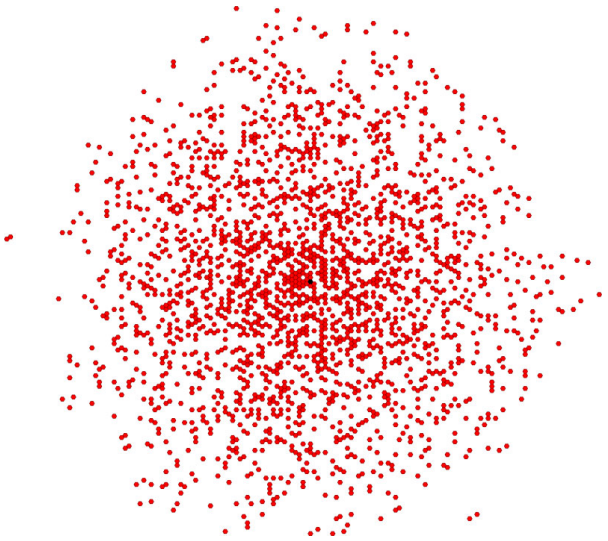
Using a term like nonlinear science is like referring to the bulk of zoology as the study of non-elephant animals (Stanislaw Ulam)

D. Mouhanna

Stochastic processes

C. Deroulers

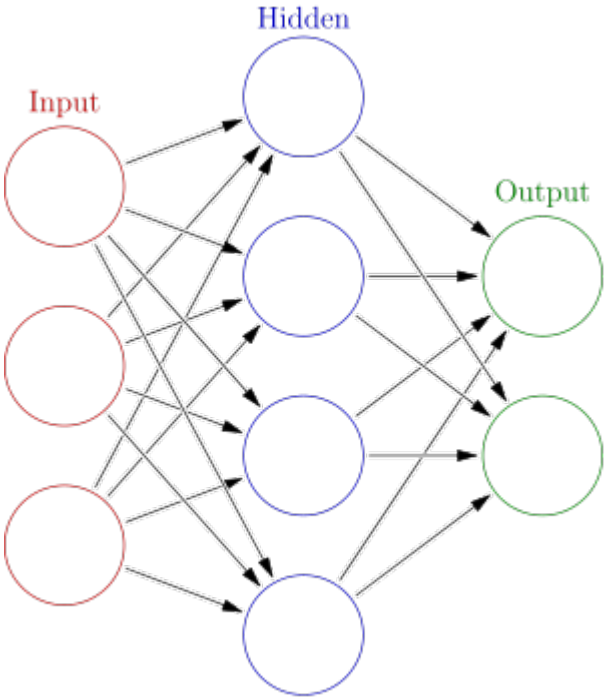
- How to model randomness ?
  Large number of applications
- How to account for random features ?
- Reminder in probability
- Brownian motion
- PDE description
- Example driven → formal notions
  and their universal character

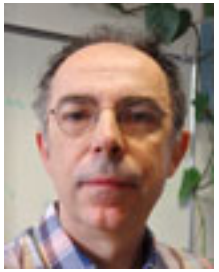


Computational science

F. Krzakala

- Use computing tools
- Applications in stat phys, but also in interdisciplinary subjects like machine learning
- Balance physics/math/algorithms/programming
- Tutorials & homework

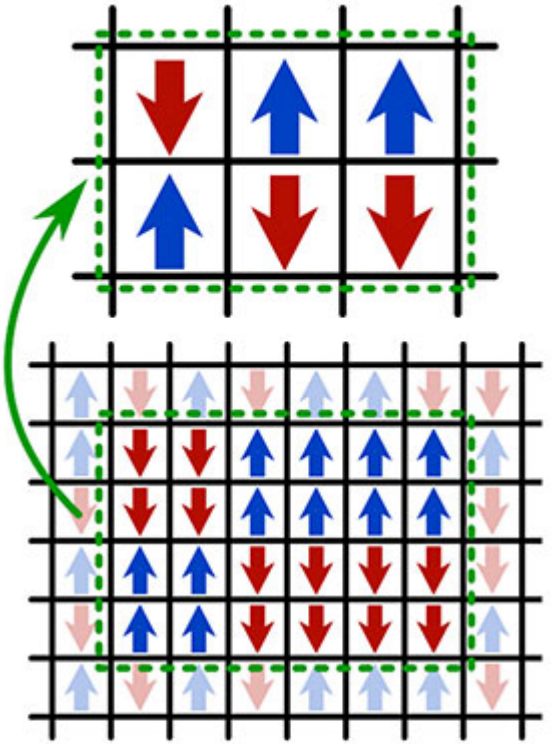


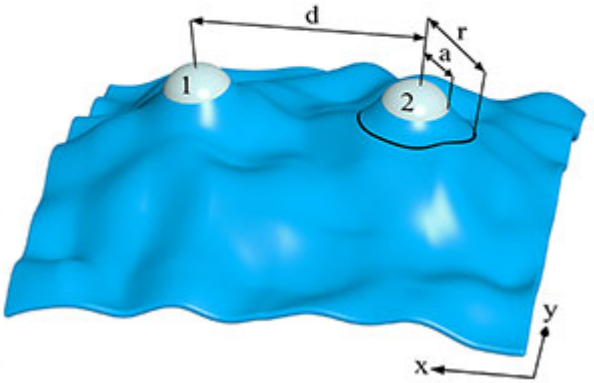


J.B. Fournier

Statistical field theory

- Describe spatial fluctuations of fields
  coarse graining / importance sym.
- Learn functional integrals, Feynman diagrams, renormalization group
- Emphasis on critical phenomena
  → understand universality
- Scaling ideas





Elective courses
choose 4 → 12 ECTS

- Mathematical tools (Roux)
- Advanced non linear physics (Foret-Pavloff)
- Advanced statistical mechanics (Cugliandolo)
- Non equilibrium and active systems (Tailleur)
- Numerical simulations (Viot)
- Statistical physics of simple and complex fluids (Durand-Foffi)
- Biophysics (Lenz)
- Quantum field theory (Serreau)