



Physics of Complex Systems Master *Kickoff meeting*

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September 7 2020



Welcome... and congratulations !

PCS complex systems

ACCUEIL CURSUS CANDIDATURES ALUMNI PARTENAIRES FR en

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 di Torino, 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 problématiques de « big data » ou de « machine learning ».

Calendar of the year

- Documents
- Internships & PhD
- FAQ

Physics of Complex Systems
@SystemesComplexes



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UP, SU, PSaclay,
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 18
- Special session on doctoral studies (*a priori* October 19)
- Autumn break Oct 26 - 30  (no exams before Xmas)
- Tour of labs, Nov 16 - 20
- Second semester courses presentation mid November
- Winter break : 3 weeks (Dec 19 – Jan 10) 
- Exams Jan 11 – 22
- Mini break (3 days) + 2 days *Journées Physique Statistique*
- **Second semester courses** : Feb 1 → March 19
- Exams March 29 - April 2
- Internships → defense in July (France)

More details available on the web

iPCS version

- First semester common
- Start of internship earlier : Feb 1
- Internship sandwiches
- Trieste “Spring” College : Feb 22 → March 19**

2016



The poster for the 2016 Spring College on the Physics of Complex Systems, held from May 21 to June 19, 2016, in Trieste, Italy. It features the ICTP logo and a list of topics including statistical physics, complex systems, and interdisciplinary research. The deadline for applications is 28 February 2016.

2017



The poster for the 2017 Spring College on the Physics of Complex Systems, held from April 22 to May 20, 2017, in Trieste, Italy. It features the ICTP logo and a list of topics including statistical physics, complex systems, and interdisciplinary research. The deadline for applications is 31 January 2016.

2018



The poster for the 2018 Spring College on the Physics of Complex Systems, held from April 10 to May 5, 2017, in Trieste, Italy. It features the ICTP logo and a list of topics including statistical physics, complex systems, and interdisciplinary research. The deadline for applications is 15 January 2017.

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 internship is not supposed to start
after the Spring College**

First semester schedule

S3 - Physics of Complex Systems (PCS) - 2020 / 2021

MONDAY (UP)		TUESDAY (SU, Jussieu)		WEDNESDAY (UP)		THURSDAY (SU, Jussieu)		FRIDAY (SU, Jussieu)	
		08:30 10:30	Advanced nonlinear physics <i>L. Foret & N. Pavloff</i> T24/25 108 (1/9-15/9) T23/24 103	08:30 10:30	Statistical field theory <i>J.-B. Fournier</i> ODG 153	08:30 10:30	Mathematical tools <i>G. Roux</i> T23/24 202 (3/9-17/9) T23/24 103	08:30 10:30	Computational science <i>M. Weigt</i> T24/34 101 (4/9-18/9) T23/24 105
10:00 12:00	Nonlinear physics and dynamical systems <i>C. Nore</i> SG 1021	10:45 12:45	Quantum field theory <i>J. Serreau</i> T24/25 108 (1/9-15/9) T23/24 103	10:45 12:45	Statistical physics of simple & complex fluids <i>M. Durand & G. Foffi</i> C 222A	10:45 12:45	Biophysics <i>M. Lenz</i> T23/24 202 (3/9-17/9) T23/24 103	10:45 12:45	Stochastic processes <i>D. Mouhanna & C. Deroulers</i> T24/34 101 (4/9-18/9) T23/24 105
13:30 15:30	Statistical field theory <i>J.-B. Fournier</i> SG 1021	13:45 15:45	Nonequilibrium and active systems <i>J. Tailleur</i> T24/25 102 (1/9-15/9) T23/24 107	13:45 15:45	Stochastic processes <i>D. Mouhanna & C. Deroulers</i> ODG 255			13:45 15:45	Numerical simulations <i>P. Viot</i> T24/34 101 (4/9-18/9) T23/24 107
16:00 18:00	Advanced statistical mechanics <i>L. Cugliandolo</i> C 222A								

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

UP


SU

UP

SU

SU

The exams

- In January and 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, more packed**

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/>



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Calendar of the year



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See in particular Documents + Internships & PhD

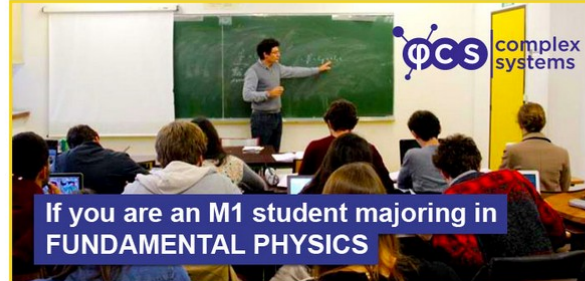


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matter, the interface between social sciences and physics, soft matter, biological systems, complexity in the quantum realm, or questions raised in the context of « big data » and « machine learning ».



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.

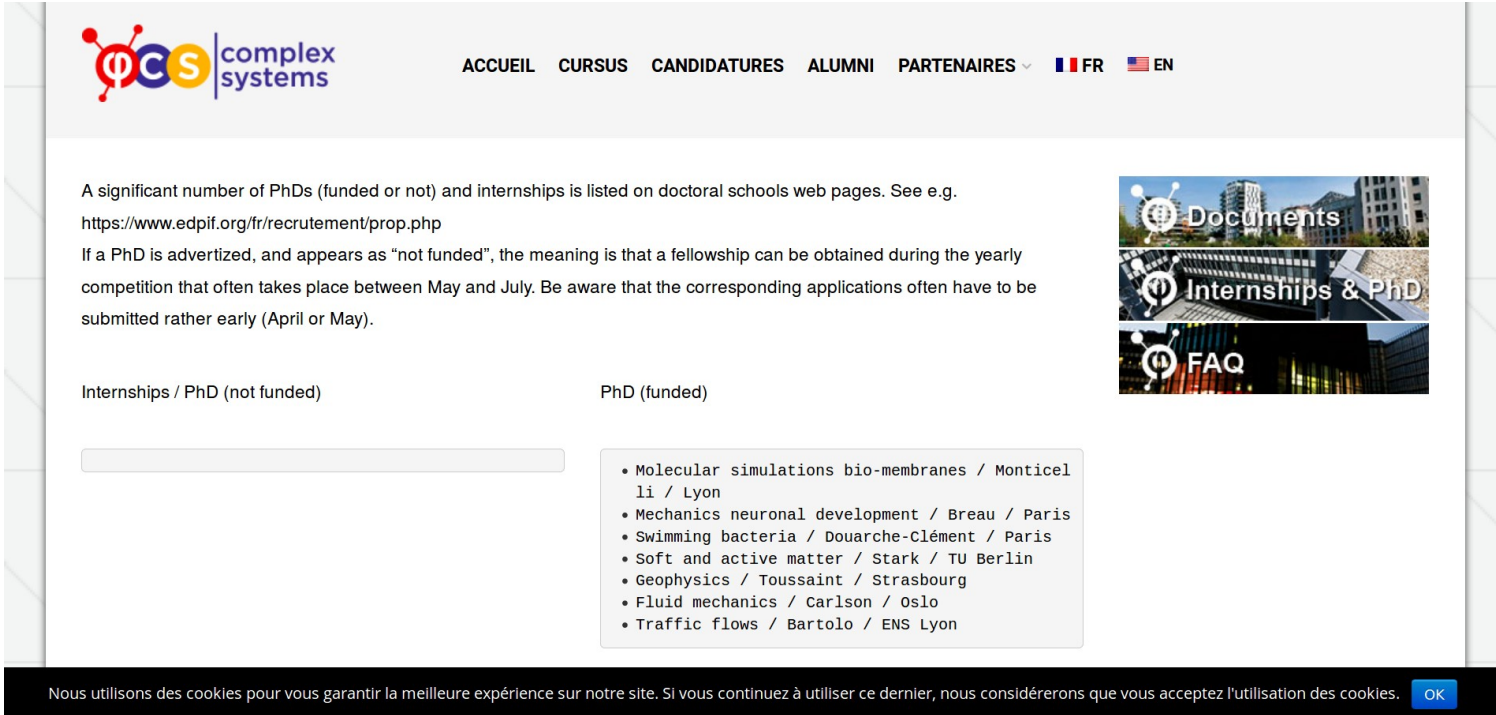
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18 19 20 21 22 23 24
25 26 27 28 29 30



[Follow @Phys_CS_Master](#)

Internships & PhDs

- Doctoral schools websites
- Laboratory web sites
- PCS site



The screenshot shows the homepage of the PCS complex systems website. The header features the PCS logo (a stylized red and blue 'PCS' with a network diagram) and the text 'complex systems'. Navigation links include ACCUEIL, CURSUS, CANDIDATURES, ALUMNI, and PARTENAIRES, followed by language flags for FR and EN. The main content area has a paragraph about PhD listings on doctoral school websites, a URL (https://www.edpif.org/fr/recrutement/prop.php), and a note about the timing of PhD applications. Below this, there are two columns: 'Internships / PhD (not funded)' with an empty search bar, and 'PhD (funded)' with a list of research topics and institutions. On the right side, there are three stacked images with labels: 'Documents', 'Internships & PhD', and 'FAQ'. A footer at the bottom contains a cookie consent message in French and an 'OK' button.

PCS complex systems

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A significant number of PhDs (funded or not) and internships is listed on doctoral schools web pages. See e.g. <https://www.edpif.org/fr/recrutement/prop.php>

If a PhD is advertised, and appears as "not funded", the meaning is that a fellowship can be obtained during the yearly competition that often takes place between May and July. Be aware that the corresponding applications often have to be submitted rather early (April or May).

Internships / PhD (not funded)

PhD (funded)

- Molecular simulations bio-membranes / Monticelli / Lyon
- Mechanics neuronal development / Breaux / Paris
- Swimming bacteria / Douarche-Clément / Paris
- Soft and active matter / Stark / TU Berlin
- Geophysics / Toussaint / Strasbourg
- Fluid mechanics / Carlson / Oslo
- Traffic flows / Bartolo / ENS Lyon

Documents

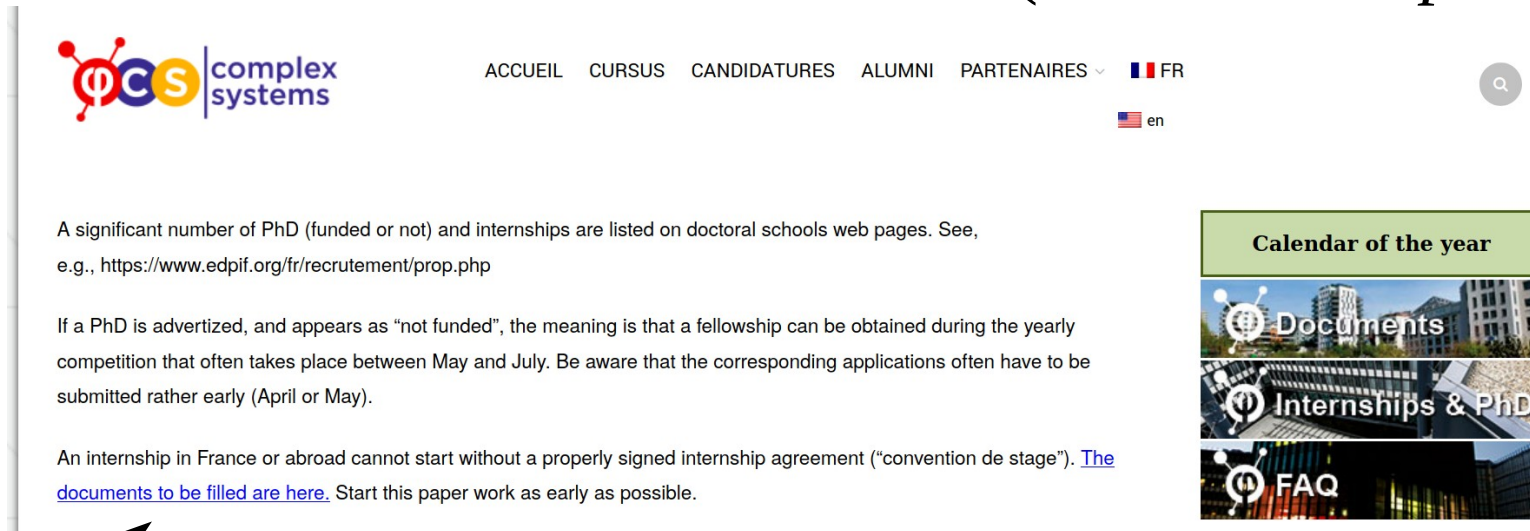
Internships & PhD

FAQ

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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
- Relevant docs on the web site (see *Internship & PhD*)



The screenshot shows the homepage of the 'complex systems' website. The header includes the logo, navigation links (ACCUEIL, CURSUS, CANDIDATURES, ALUMNI, PARTENAIRES), and language options (FR, en). The main content area contains three paragraphs of text. The first paragraph mentions doctoral schools and provides a URL. The second paragraph discusses the timing of PhD applications. The third paragraph mentions the 'convention de stage' and links to documents. On the right, there is a sidebar with a 'Calendar of the year' section containing links to 'Documents', 'Internships & PhD', and 'FAQ'. Arrows point from the text in the main content area to the corresponding links in the sidebar.

complex systems

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 en

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If a PhD is advertized, and appears as “not funded”, the meaning is that a fellowship can be obtained during the yearly competition that often takes place between May and July. Be aware that the corresponding applications often have to be submitted rather early (April or May).

An internship in France or abroad cannot start without a properly signed internship agreement (“convention de stage”). [The documents to be filled are here.](#) Start this paper work as early as possible.

Calendar of the year

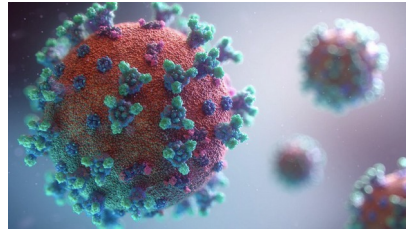
-  Documents
-  Internships & PhD
-  FAQ

- Mid October : a session dedicated to doctoral studies

Misc

- Conditions for internship defense for iPCS
 - Defense in July 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 20.
 - you graduate later than July, too late for French grade, you then **defend in July in France** and later in Italy (autumn usually). **Two defenses**
- Prolongation of rooms @ cité U
 - you may need your room for the second semester





OK



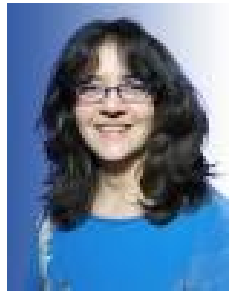
Not OK



Presentation of courses : compulsory / 18 ECTS

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

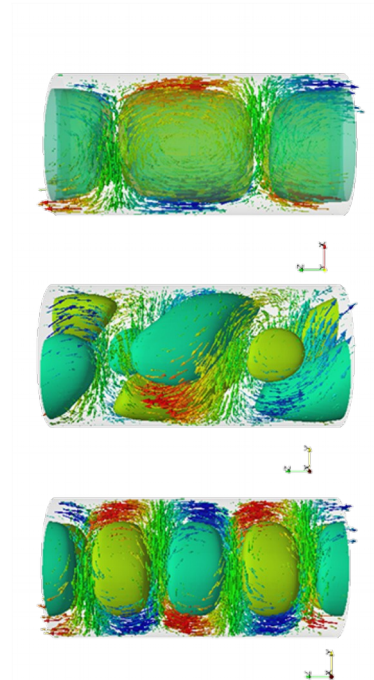
+ 4 elective courses, choose among 8 → 70 possibilities



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)



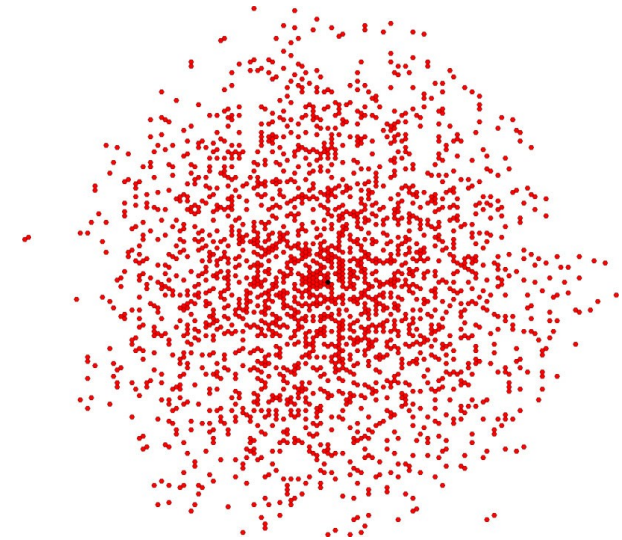
D. Mouhanna

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 → illustrate formal notions and their universal character

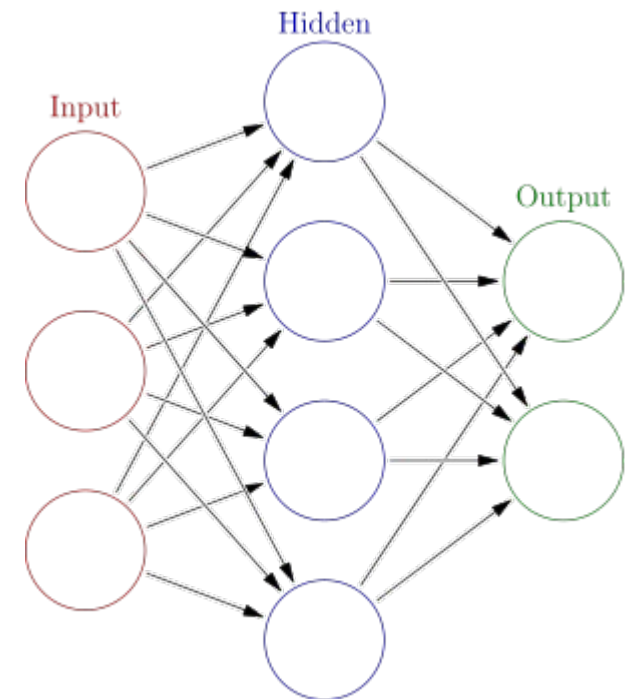




Computational science

M. Weigt

- Keywords
Information theory, ML, MC, statistics
- Crossroads statistics, computer science, neurosciences, physics
- Introduce core concepts and techniques of ML, both for **supervised** and **unsupervised** learning
- Hands on

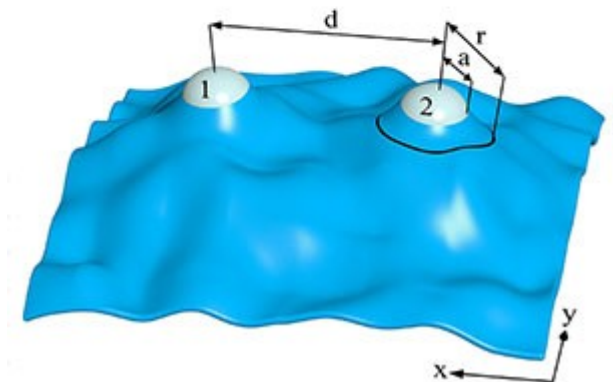
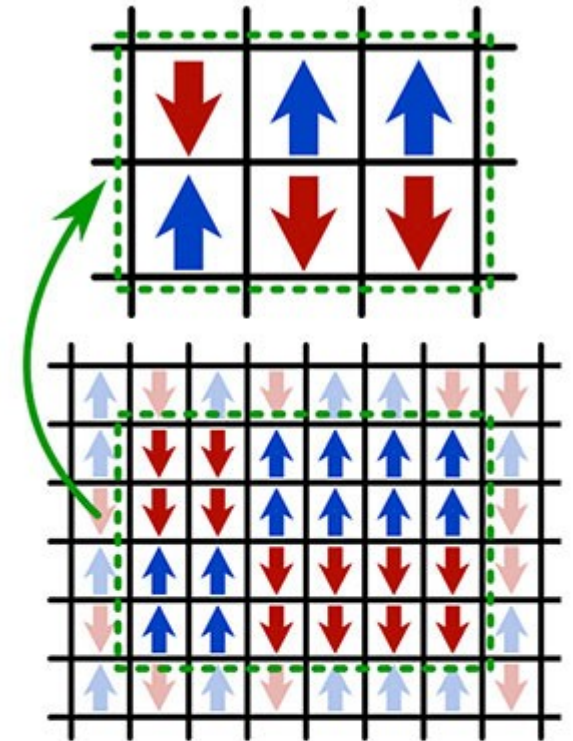




Statistical field theory

J.B. Fournier

- 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

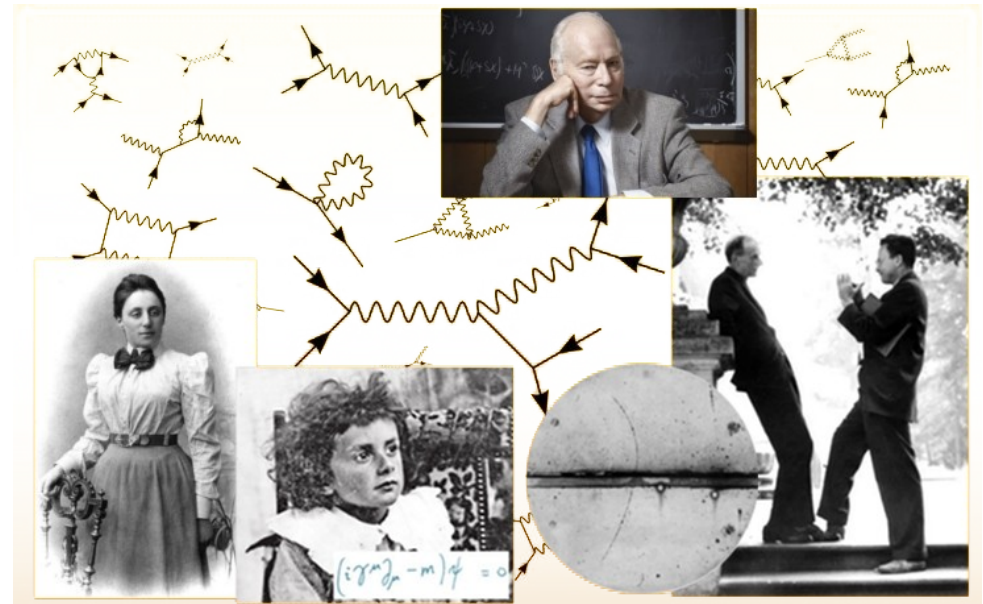
- *Advanced statistical mechanics (Cugliandolo) → wait a bit*
- Advanced non linear physics (Foret-Pavloff)
- Non equilibrium and active systems (Tailleur)
- Numerical simulations (Viot)
- Statistical physics of simple and complex fluids (Durand-Foffi)
- Biophysics (Lenz)
- Quantum field theory (Serreau)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

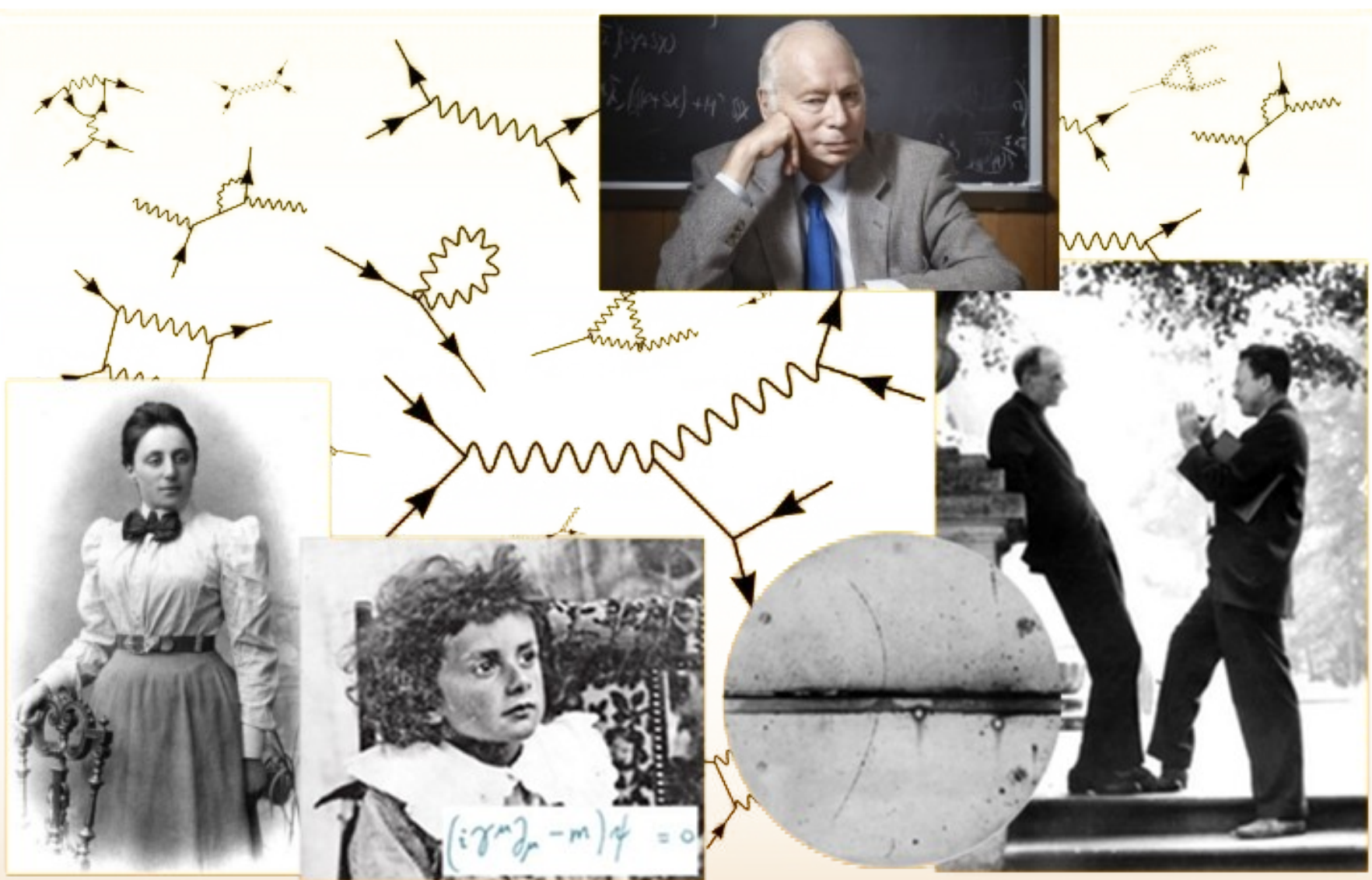


Quantum field theory

J. Serreau

- Basics, **unification of Quantum mechanics and Special relativity**
- Issues ? Solutions ?
- Successes : prediction of antiparticles, Casimir effect...
- Tools : canonical quantization, path integrals, Klein Gordon, Dirac equations
- **Symmetry**









Weinberg