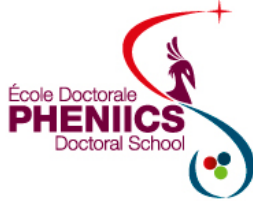


École doctorale PHENIICS  
particules, hadrons, énergie, noyau,  
instrumentation, imagerie, cosmos et simulation



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PARIS-SACLAY

GRADUATE SCHOOL  
Physique

## Doctoral School Course 2023

**Title: Phenomenology of heavy-quark and quarkonium production**

**Teacher :**

Jean-Philippe Lansberg  
IJCLab – Paris-Saclay U. – CNRS  
Contact : [Jean-Philippe.Lansberg@in2p3.fr](mailto:Jean-Philippe.Lansberg@in2p3.fr)

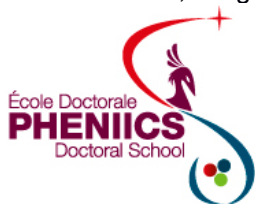
**Duration :** 30h (18h+12h) over 2 weeks (June 12-16, 2023 & June 19-23, 2023)

**Language :** English

**Prerequisite:** Elementary particle physics

**Summary**

This course will introduce the students to the phenomenology of heavy-quark and quarkonium production in different collision systems both in the inclusive and exclusive regimes. We will discuss how they can be used to learn about the nucleon and nucleus structure including their spin content, about the strongly-interacting matter produced in ultra-relativistic nucleus-nucleus collisions and more generally about the interface between the perturbative and non-perturbative aspects of QCD. The course will cover the corresponding relevant theoretical and experimental aspects. Hands-on using *NLOAccess* will be proposed.



## Tentative Programme

### Tentative Schedule:

Green : lectures - Q&A

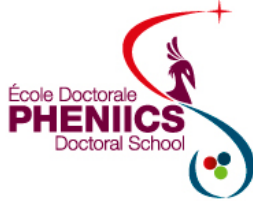
Blue: Hands-on

<b>WEEK 1</b>	10:30 – 12:30 Lectures	14:30 -16:30 Lectures - Q&A
Monday 12/6/2022	Green	Green
Tuesday 13/6/2022	Green	Green
Wednesday 14/6/2022	Green	Blue
Thursday 15/6/2022	Green	Blue
Friday 16/7/2022	Green	

<b>WEEK 2</b>	10:30 – 12:30 Lectures- Q&A	14:30 -16:30 Hands-on
Monday 19/6/2022		
Tuesday 20/6/2022	Green	Blue
Wednesday 21/6/2022	Green	Blue
Thursday 22/6/2022	Green	Blue
Friday 23/6/2022		

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### **Topics covered:**

- The November Revolution and the discovery of the charm quark
- Light vs heavy quarks
- What is a quarkonium ?
- Introduction to heavy-quark- and quarkonium-production models
- Excited states, production modes and decay channels
- Phenomenology at leading order
- QCD radiative corrections
- Phenomenology at next-to-leading order
- Lessons from the past and understanding theoretical uncertainties
- Quarkonia and Parton Distribution Functions
- Hadroproduction vs Photoproduction
- Ultra-peripheral collisions
- Double Parton Scattering studies in associated-quarkonium production
- Transverse Momentum Distribution studies in inclusive production
- Generalised Parton Distributions studies in exclusive production
- Nuclear effects involved in hard scatterings in proton-nucleus collisions
- Introduction to the Quark-Gluon Plasma
- QGP studies with heavy quark(onia)
- Back to proton-nucleus and proton-proton collisions

### **Location :**

IJCLab – Orsay  
Building 100