

# *Ecole doctorale Astronomie & Astrophysique d'Ile-de-France* (ED127)

OBSERVATOIRE DE PARIS (SIEGE DE L'ECOLE DOCTORALE)  
UNIVERSITES PIERRE-ET-MARIE-CURIE (PARIS VI),  
DENIS-DIDEROT (PARIS VII), PARIS SUD XI (ORSAY),  
VERSAILLES-ST QUENTIN

&

PARTENARIATS: ECOLE NORMALE SUPÉRIEURE (ULM)  
ECOLE NATIONALE DES SCIENCES GÉOGRAPHIQUES  
DIRECTION DES SCIENCES DE LA MATIERE (CEA)

## *Doctoral lectures- Cours Doctoral- 2021* *for PhD students, post-docs, and all interested*

Registration required to <<ed127.formations@ias.u-psud.fr>>

***Distant Galaxies : Observations and models from  $z>3$  up to dark ages***

***Les Galaxies Lointaines : Observations et Modèles de  $z>3$  aux âges sombres***

**Site : Institut d'Astrophysique de Paris (IAP)**

**Dates: May 31-June 4, 2021**

**(virtual by Zoom, address to be confirmed)**

**Coordinated by \*Observations : Dr François Hammer (Obs.Paris) francois.hammer@obspm.fr**

**\*Modèles : Pr Brigitte Rocca-Volmerange (IAP,Paris) brigitte.rocca@iap.fr**

**Abstract :**

Distant Galaxies at  $z>3$  will be keys to discover the galaxy formation physics, redshifts of formation in relation with cosmology, the reionization of the universe and the environment (DM haloes, clusters,..) to primeval fluctuations, but also clarifying their links with AGN and quasars or starbursts. Already discovered up to  $z>7$ , individual as deep large galaxy surveys will reveal their formation with the perspectives of future telescopes on the far-UV to farIR/submm domains, extended to X-gamma rays as the synchrotron emission. Presently models are limited at  $z=6$  by spectroscopic measurements requiring predictions for  $z>7$ . Numerical simulations, requiring a specific expertise, will be shortly compared to models .

The present lectures propose clarifying talks, exercises and discussions to help PhD students, postdocs or young researchers for their orientations as to complete their general galaxy and cosmology backgrounds.

1. General principles on star formation, mass growth, evolution of stars, metals and dust, distance effects with basic kinematics.
2. Future observations of surveys with the perspectives of JWST, Euclid and e-ELT (sensitivity, spectral and angular resolutions).
3. Models of spectro-photometrical chemical evolutions (SED, magnitudes, colors, masses, distance, redshifts, environments).

\*) "*Studying Distant Galaxies: Methods and Analyses*" Hammer et al., <https://arxiv.org/abs/1701.03794> ou <http://www.worldscientific.com/worldscibooks/10.1142/q0016>

\*\*\*) *Code Pégase.3 (Fioc & Rocca-Volmerange 2019, A&A.)* <http://www2.iap.fr/users/fioc/Pegase/Pegase.3/>

### **Monday, May 31, 2021**

**9h30-10h45 Morphological classification and spatially resolved kinematics for galaxies:**

**11h-12h30** The case of distant galaxies: mergers versus rotating disks & Tully-Fisher relation

**Francois Hammer, Observatoire de Paris**

Lunch

**15h00-16h00 Spectro-chemical evolution of galaxies with the code PEGASE.3** (versions Python and Fortran95): From UV to far-IR with metal, grain and dust effects on stellar continua, nebular lines.

**Michel Fioc, IAP and Sorbonne U.**

**16h00 -17h30 Exercises 1: Initiation to the code Pégase.3.0.1: synthetic SEDs**

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**Tuesday, June 1, 2021**

**9h30-10h45:** Galaxy evolution and star formation, distant effects

**11h-12h30:** The case of primeval galaxies

Brigitte Rocca-Volmerange, IAP and Paris-Saclay U.

Lunch

**14h00 -15h00:** H2 and ALMA over the UHDF

F. Walter, Heidelberg

**15h-17h30 Exercises 2 : Parameters (Star Formation, metals, dust,..) and colors.**

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**Wednesday, June 2, 2021**

**9h30-10h45** Properties and evolution of grains in the Universe

Frédéric Galliano, CEA

**11h-12h** Polarized dust foregrounds from Planck2018

Karim Benabed, IAP

**12h-13h** Optically invisible galaxies in the early universe,

David Elbaz, CEA

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free afternoon, après-midi libre

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**Thursday, June 3, 2021**

**9h30-11h00** Large surveys (CANDELS, VUDS, 3D-HST) and luminosity/mass functions

François Hammer, Observatoire de Paris

**11h15-12h30** Extremely deep multi-wavelength imaging surveys

Pascal Oesch, U. de Genève

Lunch

**14h00-15h15** Performances of MUSE and the future blueMUSE on high-z galaxies,

Johan Richard, CRAL, Obs. Lyon

**15h15-16h30** Galaxies in absorption at high-z

Pasquier Noterdaeme, IAP

Break

**16h45-17h15** Molecules and Dust in high-redshift Galaxies

P. Cox, IAP

**17h15-17h30** discussion

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**Friday, June 4, 2021**

**9h30-12h30 Exercises 3 : Final and summary**

lunch

**14h00-15h00** Star formation and turbulence,

Pierre Guillard, IAP and Sorbonne Université

**15h15 -16h15** Gamma-Ray-Bursts (GRB) at high-z,

Frédéric Daigne, IAP and Sorbonne Université

**16h15-17h00**

**Discussion and conclusion**