A MOOC on High-Energy Physics for French High-Schools

*Journeys from the infinitely large to the infinitely small*

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**Sébastien Descotes-Genon** (sebastien.descotes-genon@th.u-psud.fr)
Laboratoire de Physique Théorique (CNRS/INP & Université Paris-Sud)

**Nicolas Arnaud** (narnaud@lal.in2p3.fr)
Laboratoire de l’Accélérateur Linéaire (CNRS/IN2P3 & Université Paris-Sud)
European Gravitational Observatory (Consortium, CNRS & INFN)

**Olivier Drapier** (drapier@llr.in2p3.fr)
Laboratoire Leprince-Ringuet (CNRS/IN2P3 & École Polytechnique)

**Philippe Schune** (philippe.schune@cea.fr)
Institut de Recherche sur les lois Fondamentales de l’Univers
(Commissariat à l’Énergie Atomique et aux Énergies Alternatives)
• High-school teachers and students: a target audience
  ▪ Educational and outreach projects

• The MOOC: «Voyages de l’infiniment grand à l’infiniment petit»
  ▪ Structure and contents
  ▪ Team
  ▪ Diffusion

• Current status

• Prospects and outlook
High-school educational projects in France

• Interest from students for basic science
  ▪ Intellectual curiosity, during high-school or even before
  ▪ Notions part of the curricula: special relativity, radioactivity, quantum mechanics

• Teachers looking for resources
  ▪ Not always familiar with our fields of research
    → Physics and chemistry teachers – plus occasionally mathematics
  ▪ Activities welcome to liven teaching up
  ▪ To provide examples/illustration of physics concepts, based on current research
  ▪ Recent stress on team projects to be carried out and presented by pupils
    → Analysis of documents, etc.

• We need the next generation of scientists to be trained
  ▪ And the general audience to understand better what we are doing – and why we are

  → Mutual interest
  ▪ Teachers act « Multiplication factors » (© CERN Teachers Programme)
    Teachers → Students → Families → General audience
High-school educational projects in France

• Classic actions
  ▪ Conferences
  ▪ Laboratory visits
  ▪ Educational documents
  ▪ Teacher training sessions

• IPPOG’s International Masterclasses

• Educational cosmic muon detectors
  ▪ Cosmodétecteurs
  ▪ Cosmix case
    → See talk at ICHEP 2014
  ▪ e-PERON
    → New!

• Passeport pour les deux infinis
  ▪ E-letter sent to 2,700+ teachers on a quartely basis

→ All under the common umbrella of the « physics of the two infinities »
Why a MOOC?

• Massive Open Online Course

• A more-modern media

• A wider audience to target
  ▪ Not just teachers but also their students
    → Plus science hobbyists
  ▪ Possibility of repetition
  ▪ French-speaking countries

• Independent learning by the teachers
  ▪ At their own pace

• Free (and validated) teaching material
  ▪ Classes
  ▪ Students bibliographic projects
Examples of existing MOOCs

• A (limited) digest for a French-speaking audience
  ▪ Similar resources likely exist in other languages
  
• « From particles to stars »
  ▪ Available on FUN(*)
  → Target audience: Master 1

• « Gravity! From the Big-Bang to the black holes »
  → Gravity-centric
  ▪ Available on FUN as well
  ▪ For the general audience

(*) « France University Numerical resources »)
Voyages de l’Infiniment Grand à l’Infiniment Petit

- Each path of 10 modules is divided into four sets of two-three modules each
  - Guided progression
  - Each sub-path ends with a multi-choice quiz
    → For student self-evaluation

→ Example: the « infinitely small » path
  - Basics
    - On the road to the infinitely small
    - From the atomic nucleus to the quarks
    - E=mc² and its consequences
  - Fundamental constituents of matter
    - Fundamental interactions
    - The Standard Model
    - Looking for new particles
  - Studying elementary particles
    - Particle accelerators
    - Detecting particles
  - The LHC and beyond
    - The LHC
    - Future projects
Voyages de l’Infiniment Grand à l’Infiniment Petit

• A wide topic
  ▪ Nuclear and particle physics
  ▪ Astroparticle and cosmology

• Not just an introduction of the basic theoretical concepts
  ▪ Detectors, experiments, international collaborations, prospects for the coming years
  ▪ Applications to society

• Links between two research fields so widely apart on the length scale
  ▪ From $10^{-18}$ m to $10^{26}$ m

→ Four main paths
  ▪ Infinitely small
  ▪ Infinitely large
  ▪ Links between the two
  ▪ Applications

• 10 module-long each
  ▪ 7-10 minutes video
  ▪ Static shot, a single speaker per module facing the camera
  ▪ Animations, pictures, schematics, etc. on the side
An ambitious project
  • Initial decision: make it local to the Orsay-Saclay area (southwest of Paris)
    → Ease management and communication between contributors
    → New clusters: network of labs, « Paris-Saclay University »

Editorial board – four people, see cover slide

Two partners
  • Ecole Polytechnique: film set & video editing, diffusion
  • The Paris-Saclay network of labs P2IO: funding support
    → « Physics of the 2 Infinities and of the Origins »
  • Support from the institutions of all the scientists involved:
    CNRS, CEA, Universities

Technical team from Ecole Polytechnique
  • Eric Vantroeyen: e-learning officer
  • Latifa Berkous: engineer specialized in educational projects
  • Frédéric Picazo: video edition
Voyages de l’Infiniment Grand à l’Infiniment Petit

• A graphics designer: Loic Pauzié

• End-of-studies project from « Ecole Estienne »
  ▪ Full name (translated):
    Graduate School of Arts and Printing Industry
  → Main trainings
    ✦ Printing
    ✦ Communication and design
      → Loic’s topical section was scientific illustration
    ✦ Artistic professions about books

• Loic kept on working on the MOOC as freelance after graduating
Voyages de l’Infiniment Grand à l’Infiniment Petit

• Support from high-school teachers
  ▪ To link the MOOC contents with the curricula
  ▪ To use as much as possible the same vocabulary than the teachers and students

→ Expect support from the Ministry of National Education for the MOOC diffusion
  ▪ Already using associations of physics teachers to advertise the MOOC

• About 15 different speakers from various Orsay-Saclay labs
  ▪ Two-three modules on close topics per speaker
    → Balance the load among many speakers
    → Speakers make their training profitable by recording more than one video
  ▪ Gender balance
  ▪ Physicists (both on the theory and experimental sides), engineers

• Audio in French
  ▪ Automatically-generated subtitles
    → Then vetted by hand
Voyages de l’Infiniment Grand à l’Infiniment Petit

- MOOC plateform: Coursera
  - Paths available independently, as they get completed
  - Order of initial diffusion not necessarily optimal
    - Driven by organisational constraints: speaker availabilities, etc.
      - Infinitely small: online mid-February (2018)
        - More than 700 students
      - Applications: online mid-May
        - More than 200 students
      - Links: proofreading ongoing, online around the start of the next school year
      - Infinitely large: the last of the four paths, released shortly after the third one
        - All videos shot, editing work in progress

- The four paths will be replayed regularly on Coursera
  - In addition, they will all be available on a CNRS website
    - Currently under construction
      - With additional educational resources

- Transverse paths focusing on given topics
  - Example:
    - Nuclear power, from the nucleus to the applications: medicine and energy
Outlook

• New MOOC about the physics of two infinites
  ▪ Target audience: high-school teachers and students
  ▪ Complement a wide set of educational and outreach resources already available
  ▪ In French

• Half of the MOOC (2/4 paths) already online
  ▪ The other half online by next Fall

• Long-term plans for diffusion
  ▪ Standard MOOC + pool of educational resources
  ▪ Four main paths + topical transverse paths

• Strong interest in broadening the diffusion to other French-speaking countries
  ▪ Feel free to e-mail us!
    → See cover slide