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

Journeys from the infinitely large to the infinitely small

ICHEP, Seoul – July 6, 2018

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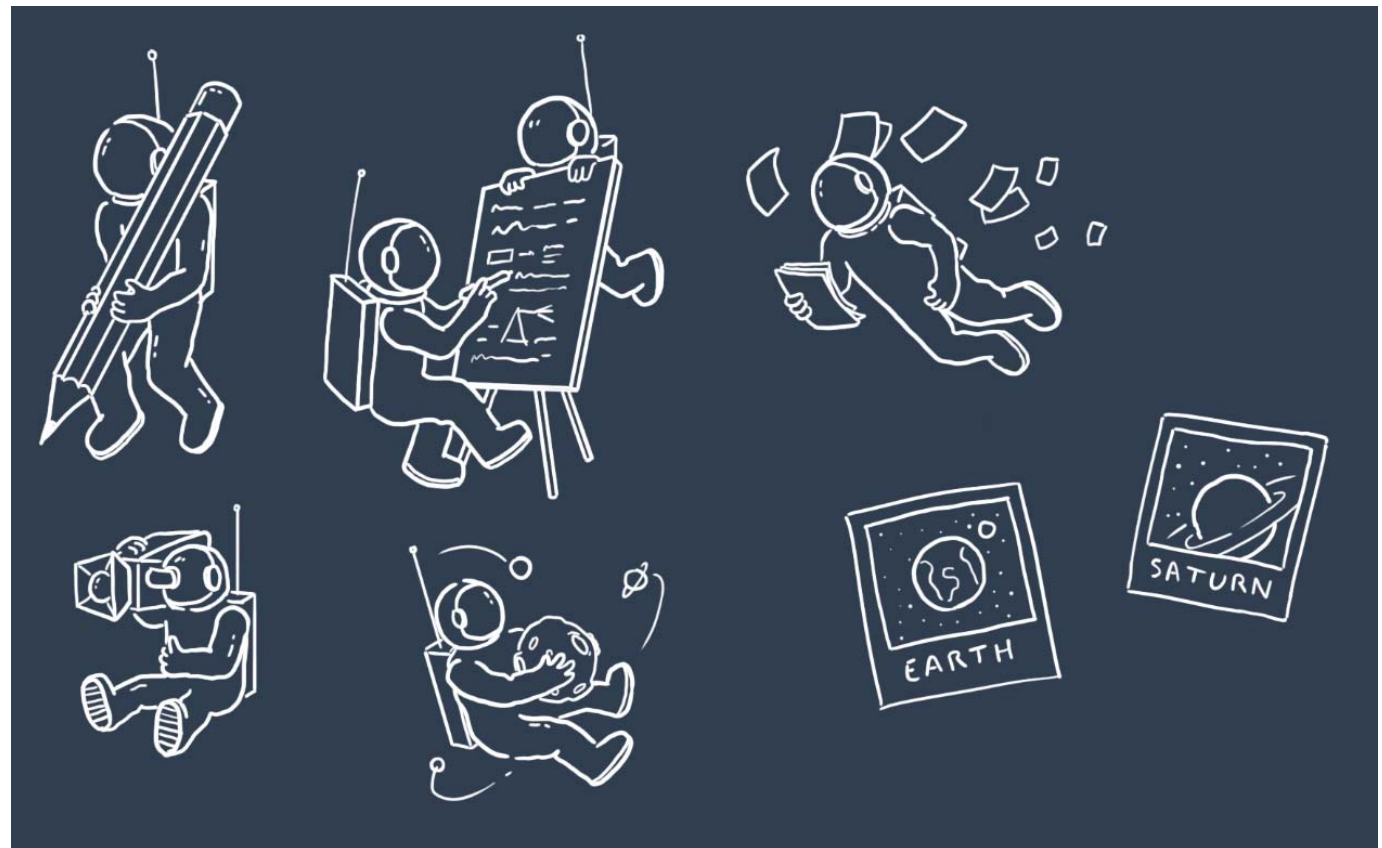
Institut de Recherche sur les lois Fondamentales de l'Univers

(Commissariat à l'Énergie Atomique et aux Énergies Alternatives)



Outline

- 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!**

A poster for the e-PERON project. The left side features a photograph of the detector setup outdoors with the text "The project In a few words" and "e-PERON". The right side contains a list of features in red text: "A panel of experiments on cosmic ray physics", "Simple, robust and modular detection system", "Remote experiments and data access Virtual lab", "From discovery (high school) to deep studies (Universities)", and "To learn contemporary physics".

The project
In a few words

e-PERON

A panel of experiments on cosmic ray physics

Simple, robust and modular detection system

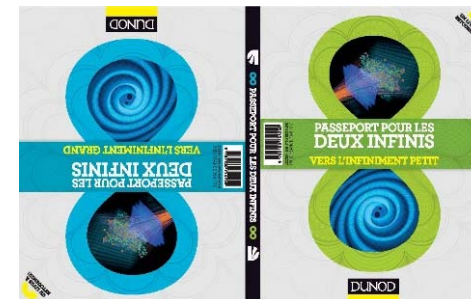
**Remote experiments and data access
Virtual lab**

From discovery (high school) to deep studies (Universities)

To learn contemporary physics

- **Passeport pour les deux infinis**

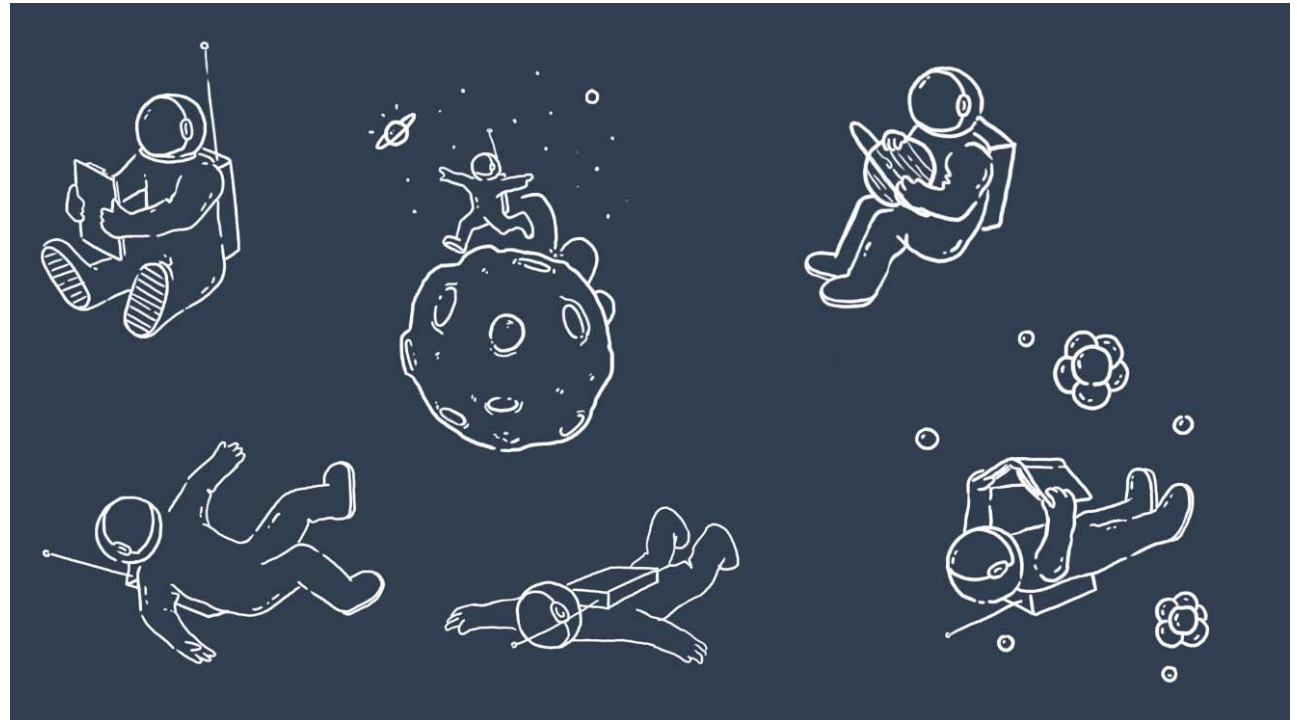
- A book (2010) reprinted twice (2013 and 2016)
- E-letter sent to **2,700+ teachers** on a **quarterly** basis



→ All under the common umbrella of the « **physics of the two infinities** »

Why a MOOC?

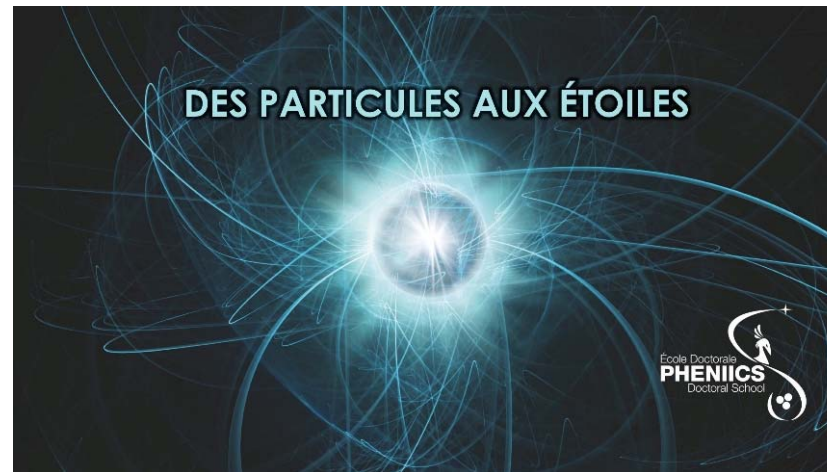
- **Massive Open Online Course**
- **A more-modern media**
- **A wider audience** to target
 - Not just **teachers** but also their **students**
→ Plus **science hobbyists**
 - Possibility of **repetition**
 - **French-speaking countries**
- **Independent learning by the teachers**
 - **At their own pace**
- **Free (and validated) teaching material**
 - **Classes**
 - **Students bibliographic projets**



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



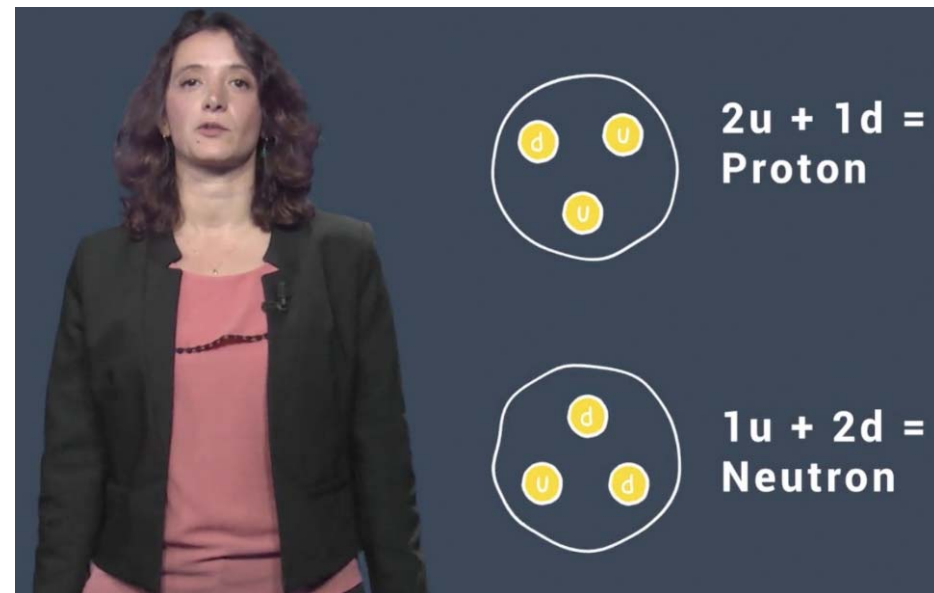
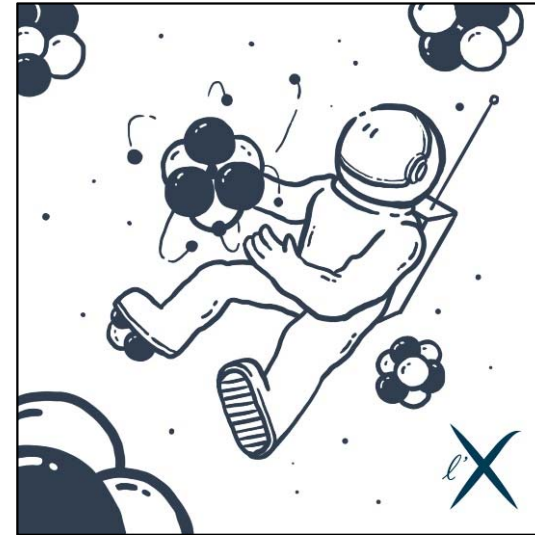
(*) « France University Numerical resources »)

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
 - ◆ $E=mc^2$ 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

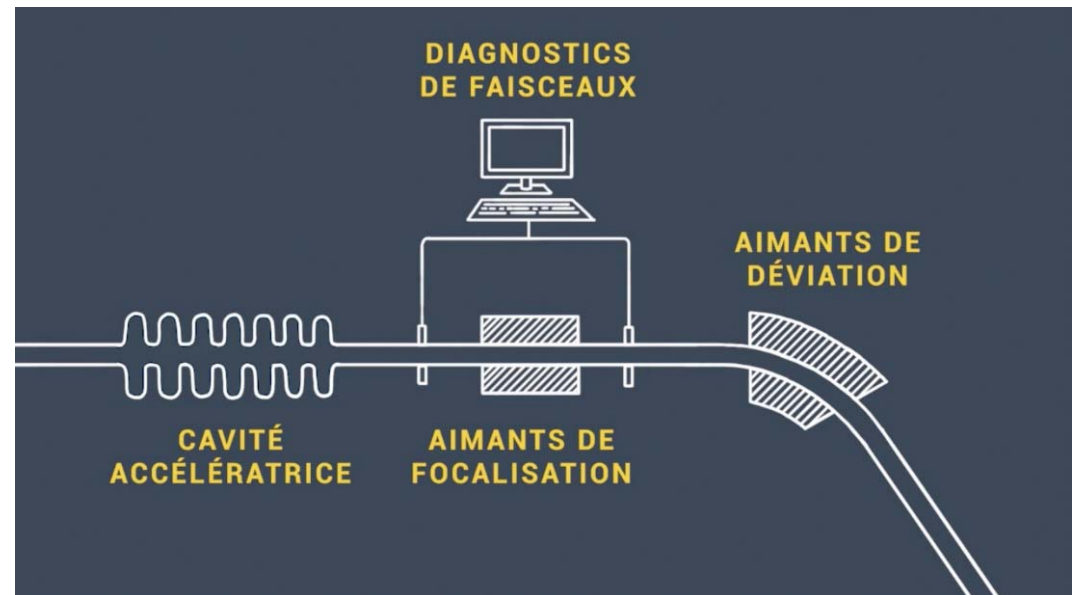


Voyages de l'Infiniment Grand à l'Infiniment Petit

- 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

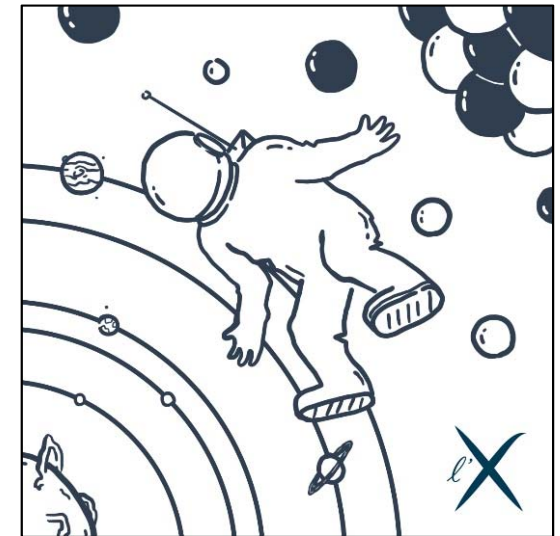
→ Four main paths

- 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



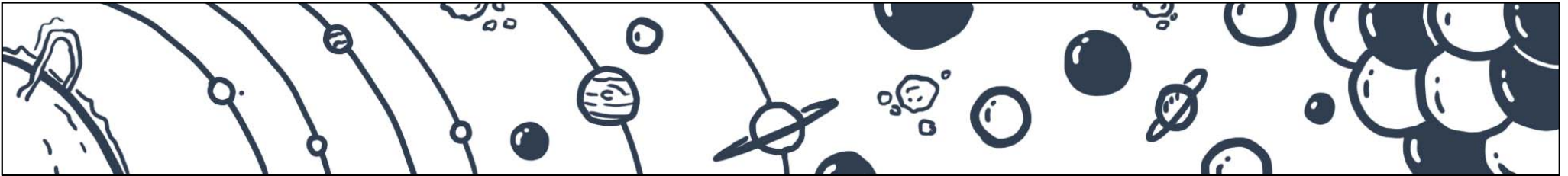
Voyages de l'Infiniment Grand à l'Infiniment Petit

- 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 platform: 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

} **Very positive feedback** received from the students

Outlook

- **New MOOC about the physics of two infinities**
 - 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