



VRIJE  
UNIVERSITEIT  
BRUSSEL

**MASTER OF  
SCIENCE IN**  
**PHY  
SICS &  
ASTRO  
NOMY**

[www.vub.ac.be/physics-and-astronomy](http://www.vub.ac.be/physics-and-astronomy)

**120  
ECTS**



# WHY VUB

## **VUB education delivers strong individuals, critical minds & world citizens**

The Vrije Universiteit Brussel (VUB) offers high-quality English-taught programmes, supported by outstanding research. Being a student at VUB means learning in an open atmosphere of tolerance and diversity and growing into an independent and critical-thinking individual.

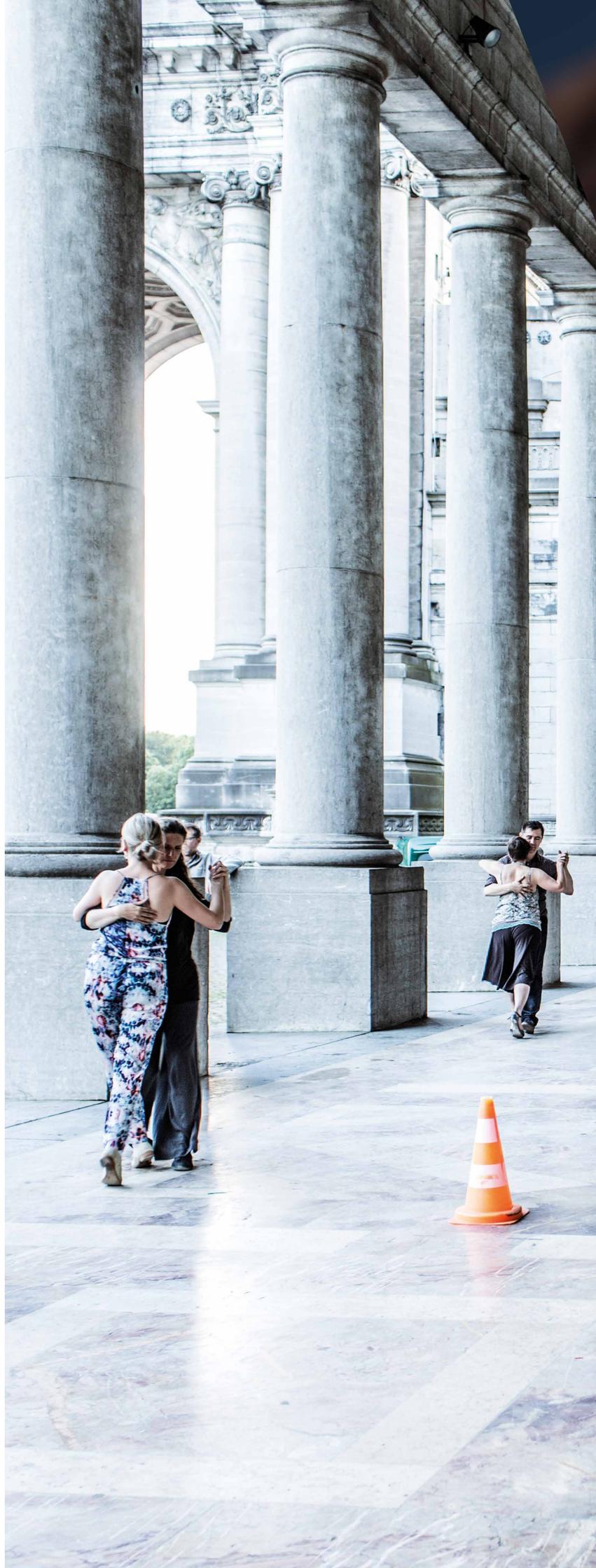
All fields of study are offered on 4 student-friendly campuses in the cosmopolitan city of Brussels. At VUB, students have easy access to their lecturers and assistants. Faculty members are available and open to answer questions; small group workshops are used to ensure close interaction and hands-on experience.

VUB is a dynamic and modern university with almost two centuries of history. There are 15.000 students, 21% of whom are international students from more than 120 different countries.

## **The basis of our academic success**

The Vrije Universiteit Brussel was founded on the principle of 'free inquiry' as formulated by the French mathematician and philosopher of science Henri Poincaré (1854-1912): 'Thinking must never submit itself, neither to a dogma, nor to a party, nor to a passion, nor to an interest, nor to a preconceived idea, nor to anything whatsoever, except to the facts themselves, because for it to submit to anything else would be the end of its existence.'

Personal growth with a positive and critical attitude, a sense of responsibility and open-mindedness, these are characteristics that you will encounter in everyone at the university, from professors and researchers to students and staff. It lies at the heart of our academic success.





## **From the infinitely small to the infinitely large, and many things in between**

Physicists and astronomers try to understand nature: from the smallest building blocks of matter and their interactions to the evolution of the universe on a cosmological scale. Ultimately, this endeavour leads to new insights that are helpful in other scientific disciplines, and to many applications in our daily lives. Although our insights go ever deeper and reach ever further, there is much we still do not understand. That is why basic research remains so important.

Physics and astronomy research at Vrije Universiteit Brussel (VUB) covers a wide spectrum: experimental elementary particle research, theoretical research on elementary particles and cosmology, applied research on semiconductor lasers, meta-materials, and the study of the principles of biological systems. Not forgetting and astrophysics, in which we look at binary star systems and how high-energy cosmic rays are produced in supernova explosions and black hole jets. And so, Physics reconciles the knowledge of the infinitely small and the infinitely large, and many things in between.

VUB takes advantage of its unique position in the capital of Belgium and Europe. One of the strong points of the master programme at VUB is the close connections to many internationally renowned research groups and the links with other departments both within VUB, like engineering (photonics), bio-engineering and biology, and with our alliance partner Universiteit Gent (UGent), our sister university Université Libre de Bruxelles (ULB), and many other universities in Belgium and abroad. In our Master of Science in Physics and Astronomy (2 years, 120 ECTS), teaching is done in small groups, with a strong component of personal interactions between teaching staff and students. Around 50% of our graduates currently move on to a PhD programme. Apart from the option to focus on research, we also offer the Minor in Economy and Business and the Minor in Education.



# MASTER OF SCIENCE IN PHYSICS AND ASTRONOMY

## 3 minors, 1 degree

This MSc programme combines the research expertise of both the Vrije Universiteit Brussel (VUB) and Universiteit Gent (UGent), allowing you to tailor your study programme to your interests. One choice you have to make in advance is which of our three minors you want to follow: Research, Economy and Business or Education (30 ECTS in Dutch). No matter which minor you choose, you have the same degree, you will have a solid training as a physicist and we offer you the possibility to participate in high-level research. There is no wrong choice!

## External Mobility

If you choose the Research minor, you will have to take up two External Mobility-courses. Which allows you to follow courses at another university or do an internship at a company or research institution. A combination of courses and internship is also possible, since there are two Mobility modules to take up. The internship will be assessed through a report and presentation.

## Wanted: physicists!

Did you know physicists are sought-after on the job market?

As in most of Europe, in Belgium physicist is among the 10 highest-paying jobs. A lot of our graduates find a job in scientific research. They work at universities, research institutes and assist in new scientific developments. In industry, physicists are in high demand due to their wide education in modelling, statistics and informatics. In banking, finance and pharmaceuticals graduates

with a degree in physics work mainly on risk analysis and modelling. Finally, physicists are also active in the field of education.

## Students as scientists

The offered courses are strongly embedded in both universities' on-going research programmes. Through intensive collaboration with members of the research groups, you will get the opportunity to develop and improve your scientific skills. The researchers at VUB have strong connections within Belgium and in- and outside Europe through research projects such as the IceCube Neutrino Observatory in Antarctica and the CMS experiment at CERN in Geneva. Many of our students have the opportunity to do an internship or research for their master's thesis at CERN during their studies. This close connection to research means our students are well prepared for a PhD-position, with around half of our graduates pursuing such a career in research.

Did you know that many VUB postdocs and faculty are leading international teams of scientists? For example Dr. Petra Van Mulders, a VUB alumnus and postdoctoral researcher at the VUB, who until recently was leading the team working on identification of particles called b-quarks at the CMS experiment at CERN.

The results of her work are now used by researchers all over the world in the attempt to determine the characteristics of the recently discovered Brout-Englert-Higgs particle.



TWO YEAR PROGRAMME	ECTS
<b>Mandatory</b>	
High-Energy Astrophysics	6
Computational Physics	6
Quantum Field Theory	6
Subatomic Physics II	6
General Relativity	6
Master's thesis	30
<b>Minor Economy and Business</b>	
Business and Economics	3
Introduction to Business	3
Electives minor Economy and Business	24
Electives minor Research *	30
<b>Minor Education</b>	
Mandatory courses (taught in Dutch)	30
Electives minor research	30
<b>Minor Research</b>	
External Mobility A	6
External Mobility B	6
Electives minor Research *	48

**\* SOME EXAMPLES OF ELECTIVES:  
MINOR RESEARCH**

Electroweak & Strong Interactions; Current topics on in Particle Physics; Simulation of Physics Phenomena & Detectors in Modern Physics; Physics & Chemistry of Nanostructures; Advanced Field Theory; Extensions of the Standard Model; Medical Physics; Current topics on Solid-state Physics; Optical Spectroscopy of Materials; Atomic & Molecular Physics; Radio Astronomy; Waves & Patterns in the Biophysics of Complex Systems; Early Universe Cosmology; Astroparticle Physics; Evolution of stars and stellar systems; Nonlinear dynamics and chaos.

For the complete overview of all courses, go to [www.vub.ac.be/physics-astronomy](http://www.vub.ac.be/physics-astronomy)

The programme is subject to change. Check [www.vub.ac.be/physics-astronomy](http://www.vub.ac.be/physics-astronomy) for the latest information about the programme.

ECTS (European Credit Transfer System): 1 credit represents 25-30 hours of study activity.

# WORKING AS A SCIENTIST

## ASTRONOMY AND ASTROPHYSICS

### Head scientist: Prof. Stijn Buitink

- Astronomy and Astrophysics Research Group
- Holder of an ERC-grant

Prof. Buitink and his team research the short bursts of radio waves that are emitted when cosmic rays interact with the Earth's atmosphere. To determine the mass, energy, and arrival direction of these cosmic particles, which consist of protons and heavier nuclei, researchers will make use of the LOFAR telescope. This is the world's biggest radio and will help us to better understand, and disentangle, the intra-galactic and extra-galactic contributions to the cosmic-ray flux. Using these techniques, Prof. Buitink is aiming to use the whole moon as, in effect, one gigantic particle detector.

At the VUB we also investigate galaxy kinematics (in particular the dark matter problem), extragalactic astronomy, the interstellar medium of galaxies, radio galaxies and active galactic nuclei.

The puzzle of stellar evolution, the study of (binary) stars that are close to the end of their lives and the sources of gravitational waves are also under study.

## APPLIED PHYSICS

### Sophie Viaene, PhD-student

Awarded Robert Brout Prize and the Solvay Award from International Solvay Institutes due to her excellent academic record and inspiring dissertation.

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*"My master's thesis and optional courses introduced me to the ideas that are now part of my PhD project in applied physics. Very recently, the geometrical techniques of general relativity have been introduced to describe the interaction of light with artificially structured materials in an elegant way, leading to revolutionary optical devices such as "Harry Potter" invisibility cloaks. In my PhD, I hope to deepen this geometrical link with combined analytical and numerical insights, by including the nonlinear feedback due to gravitation and by extending it to the quantum world."*

Sophie Viaene

VUB Ma Physics and Astrophysics, now PhD student

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The VUB Applied Physics (APHY) research group combines experimental and theoretical methods to address a wide variety of fundamental challenges in biological physics, condensed matter physics, electromagnetism, laser physics and photonics. This combination allows an imaginative, cross-disciplinary and insightful approach to complex systems.

For example, we focus on the study of metamaterials and nanophotonics, on bio-inspired approaches to machine learning (reservoir computing), on the dynamics of semiconductor lasers, non-equilibrium pattern formation and soliton dynamics, as well as on genetic transcription, cell differentiation & microbial interactions in biological systems.

**Head scientists: Prof. Jan Danckaert & Prof. Sophie de Buyl**

## CHALLENGING PROBLEMS IN THEORETICAL PHYSICS

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*"Doing a PhD enables me to combine creativity - exploring new and existing concepts - and engaging challenging problems. For my research I explore models in string theory that have the attractive property of being very symmetrical. Just like a round and even sphere has more symmetry to it than any random, often uneven, stone you pick up. For a theoretical physicist this symmetry opens doors to the ability of computing and thus knowing everything of the world the model describes. Moreover, as a first-year PhD student I'll first have the great opportunity to expand my knowledge and skills during a Solvay doctoral school that takes place in different cities in Europe. I cannot wait to get started!"*

Saskia Demulder, VUB Ma Physics and Astrophysics, now PhD student

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### Research Themes Theoretical Particle Physics

- Strings, Supergravity, Geometry & Duality
- String Cosmology
- String Holography & its applications
- Beyond the Standard Model Phenomenology & Cosmology

**Head scientists: Prof. Ben Craps & Prof. Alexander Sevrin**

## THE ICECUBE PROJECT

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*"IceCube is a neutrino observatory located at the geographic South Pole. When neutrinos interact with the ice they produce electrically charged secondary particles that in turn emit Cherenkov light, as a result of travelling through the ice faster than light travels in ice. The IceCube sensors collect this light, which is subsequently digitised and time-stamped. This information is converted into light patterns that reveal the direction and energy of muons and neutrinos. I had the opportunity to spend the summer between my two master years at the central IceCube-lab in Madison, Wisconsin. For my master's thesis I was very actively involved in the Dark Matter research the Brussels IceCube group is doing. I've been looking for an excess of neutrinos from the direction of the centre of the Earth, as that could point to a Dark Matter population in the centre of the Earth."*

Jan Kunnen, VUB Ma Physics and Astrophysics, now PhD student

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### Elementary Particle Physics

The present research programme is based on the extensive use of high-energy particle accelerators and experimental facilities at CERN (Switzerland) as well as neutrino experiments at the South Pole. Closer to home, the VUB also works on physics experiments studying neutrinos using the nuclear research reactor at the SCK-CEN in Mol, Belgium. The main goal of these experiments is the study of the strong, electromagnetic and weak interactions of the most elementary building blocks of matter. All these experiments are performed in the framework of large international collaborations and have led to important R&D activities and/or applications concerning particle detectors and computing and networking systems.

**Head scientists: Prof. Jorgen D'Hondt (President CMS experiment), Prof. Freya Blekman (CMS experiment), Prof. Steven Lowette (CMS experiment) & Prof. Nick Van Eijndhoven (IceCube experiment)**

## ADMISSION CRITERIA

Admission is based on the review of each application: proof of meeting academic and language requirements, personal motivation, etc.

### LANGUAGE REQUIREMENTS

Prospective students can provide proof of sufficient knowledge of English as language of instruction by meeting one of the following criteria:

- having successfully completed one of the following language proficiency tests:
  - TOEFL: minimum level: 213 for the computer-based test (CBT); 72 for the internet-based test (IBT); 550 for paper-based test
  - TOEIC: minimum level: 785
  - IELTS: minimum level academic module 6
  - CAE: minimum grade B
  - CPE: minimum grade C
  - ITACE for Students certificate with ERK/CEFR score B2
  - Cambridge English First (FCE)
  - Cambridge English: Business Vantage (BEC Vantage)
  - Cambridge Michigan ECCE
  - Trinity College London: ISE II, GESE Grade 7-9
  - The Pearson Test of English General (PTE General): minimum level 3
  - The Pearson Test of English Academic (PTE Academic): minimum level 59

- having successfully completed at least one year of secondary education with English as language of instruction, or having successfully completed secondary school in a Belgian institution;
- having successfully completed programme units in higher education with a minimum of 54 ECTS-credits where English was the language of instruction.

For more details on admission requirements and application: [www.vub.ac.be/en/apply](http://www.vub.ac.be/en/apply)

### DIRECT ACCESS

Bachelor of Science in Physics

Bachelor of Science in Physics and Astronomy

### OTHERS

For other bachelors in science, applied science and life sciences, admission will be evaluated based on academic records and skills.

### Application deadline

Prospective students are advised to apply as soon as possible, even if they have not yet obtained their degree. Applications can only be submitted through our website [www.vub.ac.be/en/apply](http://www.vub.ac.be/en/apply)

- Students who require a visa (non-EU/EEA nationals) need to submit their application before April 1st
- Students who do not require a visa must apply before June 1st
- Note: if the proof of English proficiency or APS certificate is not ready before the deadline, you can always submit it later instead of missing the deadline

### Tuition fees

All Flemish universities in Belgium are subsidised by the government, which results in relatively low tuition fees. The general tuition fee for our programmes is €890/year. Some master programmes have higher tuition fee for students with a non EU/EEA nationality. A detailed overview of the tuition fees can be found on: [www.vub.ac.be/en/tuition-fees](http://www.vub.ac.be/en/tuition-fees)

### Contact

[www.vub.ac.be/physics-astronomy](http://www.vub.ac.be/physics-astronomy)