



MASTER'S PROGRAMME IN PARTICLE PHYSICS AND ASTROPHYSICAL SCIENCES (PARAS)

Orientation for Master's Degree students

Erik Brücken

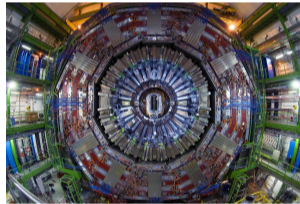


RESEARCH RELATED TO PARAS PROGRAMME

Theoretical and experimental particle physics

Physics of particle colliders and early universe, quantum field and string theory, particle collider data analysis, particle detector construction

$$\begin{aligned} \mathcal{L} = & -\frac{1}{4} F^{\mu\nu} F_{\mu\nu} \\ & + i \bar{\Psi} \not{D} \Psi \\ & + \bar{\Psi}_i Y_{ij} \Psi_j \phi + \text{h.c.} \\ & + |D_\mu \phi|^2 - V(\phi) \end{aligned}$$



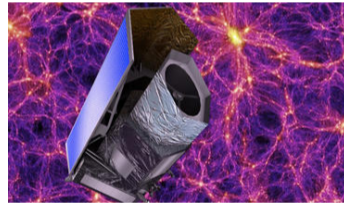
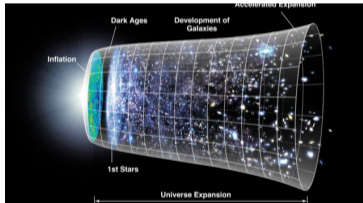
- What are the laws governing the elementary particles?
- What is the origin of mass?
- Is there a Theory of Everything, i.e. a theory unifying all fundamental forces and describing all elementary particles?



RESEARCH RELATED TO PARAS PROGRAMME

Theoretical and observational cosmology

Physics of the very early universe, the origin of matter, dark energy, dark matter and the structure of the universe.



- What are the laws governing the very early universe?
- What are the origins of dark energy and dark matter?
- What are the mechanisms behind an expanding universe?



RESEARCH RELATED TO PARAS PROGRAMME

Theoretical and observational astronomy

Gravitational waves, physics of black holes, galaxy formation and evolution, star formation, planetary science.



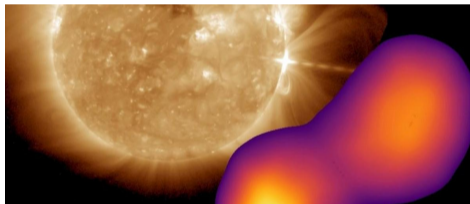
- What are the laws governing black holes?
- What are the mechanisms of galaxy and star formation?
- How can a potential asteroid impacting earth be spotted sufficiently early to be able to counteract?



RESEARCH RELATED TO PARAS PROGRAMME

Space physics

Space weather and sustainable space



- How can space weather detrimental to technical systems on ground and in space be better predicted?
- How can orbit safety of satellites and space missions be maintained considering the increased amount of space debris?
- What is the most efficient way of satellite and space mission propulsion?



PARAS PROGRAMME

The programme consists of two study tracks:

Particle physics and cosmology

- Theoretical and experimental particle physics
- Theoretical and observational cosmology

Astrophysical sciences

- Theoretical and observational astronomy
- Space physics



PARAS DEGREE STRUCTURE

For the degree you need to study at least **120 credits** consisting of:

- **90 credits** advanced studies including the Master's thesis of 30 credits,
- **30 credits** of other studies from ParAs or other programmes.



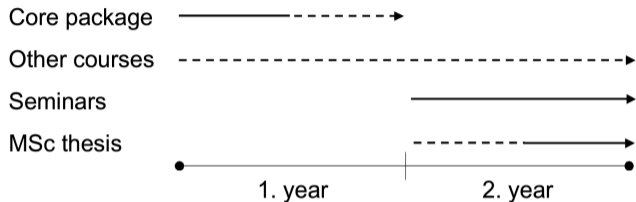
COURSES

Mandatory courses are lectured each academic year, others usually every second academic year.

- [MSc thesis](#) (30 cr)
- [ParAs seminars](#) (30 cr)
- Particle physics & cosmology study track (core package):
 - PAP332 [Introduction to Particle Physics I](#) (5 cr)
 - PAP325 [Introduction to Particle Physics II](#) (5 cr)
 - or
 - FYS2081 [Cosmology I](#) (5 cr) – this course can be added to “other studies”
 - PAP326 [Cosmology II](#) (5 cr)
- Astrophysical Sciences study track (core package)
Two out of the following three courses (student's choice):
 - PAP302 [Open problems in modern astrophysics](#) (5 cr)
 - PAP303 [Statistical Inverse Methods](#) (5 cr)
 - PAP304 [Plasma Physics](#) (5 cr)



TIMING OF STUDIES



Example study plans for the various study tracks can be found online:

- ParAs model timetable for [Cosmology](#)
- ParAs model timetable for [Theoretical Particle Physics](#)
- ParAs model timetable for [Particle Physics Instrumentation](#)
- ParAs model timetable for [Experimental Particle Physics](#)
- [Astrophysical sciences](#): Courses recommended by different research groups



MODEL TIMETABLE FOR COSMOLOGY (START AUTUMN 2025)

Academic year 2025 / 26

Autumn 2025

Spring 2026

Period 1	Period 2	Period 3	Period 4
TCM304 Math. methods of physics IIIa	PAP326 Cosmology II	PAP348 General Relativity I	PAP349 General Relativity II
PAP332 Introduction to particle physics I	PAP302 Open Problems in Modern Astrophysics 2/2	PAP351 Stellar magnetic activity (even years)	PAP351 Stellar magnetic activity (even years, continues)
PAP302 Open problems in mod. Astrophysics 1/2	TCM305 Mathematical Methods of Physics IIIb	MATR386 Physics of positrons in solids and defects (even years)	MATR386 Physics of positrons in solids and defects (even years, continues)
FYS2081 Cosmology I (needed for part II)	PAP325 Introduction to Particle Physics II	BSCS2015 Data Analysis with Python	BSCS2015 Data Analysis with Python (continues)

Academic year 2026 / 27

Autumn 2026

Spring 2027

Period 1	Period 2	Period 3	Period 4
PAP301 ParAs Seminar Course	PAP301 ParAs Seminar Course (continues)	PAP301 ParAs Seminar Course (continues)	PAP301 ParAs Seminar Course (continues)
PAP350 MSc thesis work	PAP350 MSc thesis work (continues)	PAP350 MSc thesis work (continues)	PAP350 MSc thesis work (continues)
TCM327 Quantum Field Theory I	TCM328 Quantum Field Theory II	TCM329 Quantum Field Theory III	PAP353 Gravitational Lensing
PAP347 Theories beyond the standard model (even years) (Quantum field theory as prerequisite)	PAP347 Theories beyond the standard model (even years, continues) (QFT as prerequisite)		TCM332 Quantum Field Theory III

Note:

Obligatory courses

Advanced courses

Other studies

All courses reward 5 ECTS

Total amount of ECTS: 120



GUIDANCE OF STUDIES

Seek guidance from:

- The education coordinators, especially **Janna Koivisto**
- Your own designated academic **mentors** / **PSP supervisor**
- Anyone in the ParAs **steering group**



CURRENT PARAS PROGRAMME STEERING BOARD

Director: Erik Brücken, University Lecturer, particle physics instrumentation

Vice director: Adnane Osmane, Associate Professor, space physics

Education coordinator: Janna Koivisto

Steering group members:

- **Niko Jokela**, University Lecturer, theoretical particle physics
- **Peter Johansson**, Professor, astronomy
- **Joonas Nättilä**, Associate Professor, astrophysics
- **Anca Tureanu**, Professor, theoretical particle physics
- **Kenneth Österberg**, Professor, experimental particle physics

Student representatives

- **Jeff Schymiczek** (deputy member **Jan Loder**)
- **Esra Verspui** (deputy member **Anne Keski-Vakkuri**)

Expert members

- **Alexi Vuorinen**, Professor, theoretical particle physics and cosmology
- **Matti Kalliokoski**, Docent, particle physics instrumentation



MORE INFORMATION ON PARAS

[Moodle page ParAs](#)

The main communication platform with the students and teachers of the programme. Contains concise information on the most relevant aspects of the Master's studies in ParAs.

[Master's programme in Particle Physics and Astrophysical Sciences](#)

General page on the university site, mostly for the use of international applicants, but contains useful information for all students in a rather compact form.

[Instructions for Students](#)

Instructions for starting, planning and completing studies. Note: check that you are logged in and have ParAs selected.