Universitat Autònoma de Barcelona

2023/2024

Physics beyond the Standard Model

Code: 42860
ECTS Credits: 6

Degree	Type	Year	Semester
4313861 High Energy Physics, Astrophysics and Cosmology	OT	0	2

Contact

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Teaching groups languages

You can check it through this link. To consult the language you will need to enter the CODE of the subject.
Please note that this information is provisional until 30 November 2023.

Prerequisites

It is recommended to have followed the courses Introduction to Quantum Field Theory, Advanced Quantum Field Theory and Standard Model: Fundamentals and Phenomenology.

Objectives and Contextualisation

The main purpose of this course is to give an overview of the possible new physics scenarios that could lie beyond the Standard Model of particle physics. This new physics is necessary to overcome certain drawbacks of the SM.

Competences

- Formulate and tackle problems, both open and more defined, identifying the most relevant principles and using approaches where necessary to reach a solution, which should be presented with an explanation of the suppositions and approaches.
- Understand the bases of advanced topics selected at the frontier of high energy physics, astrophysics and cosmology and apply them consistently.

Learning Outcomes

1. Critical analyse the different extensions to the standard model proposed.
2. Distinguish between the different solutions to the problems of hierarchy in the standard model.
3. Understand the problems of the standard model and the need to go beyond it.

Content

BMS1: Before the SM:
- Criteria for building models for particle physics: Effective Field Theories (EFT) and first applications
- Accidental symmetries, consistency of the EFT, no-lose theorems for discovery & naturalness issues
BSM2: Behind the SM:
- The SM as an EFT and theoretical reasons for improvement
- Unexplained experimental evidences
BSM3: Beyond the SM:
- Towards the reduction of parameters: Grand Unified Theories (charge quantization & gauge-coupling unification)
- Addressing the unnaturalness of the SM: Proposals for the strong CP problem (axions) and hierarchy problem (compositeness and supersymmetry)

Methodology

Attendance to theory lectures, exercises, and preparation of a topic related to the course (to be presented orally).

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Theory Lectures	45	1.8	1, 3, 2
Type: Supervised			
Preparation of a topic related to the course	35	1.4	1, 3, 2
Type: Autonomous			
Exercises	60	2.4	1, 3, 2

Assessment

Attendance to the lectures, exercises as homework, and an oral presentation of a topic related to the course (developed by the student).

This subject/module does not foresee the single assessment system.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Attendance to the lectures	20%	0	0	1, 3, 2
Exercises	40%	5	0.2	1, 3, 2
Oral presentation of a topic	40%	5	0.2	1, 3, 2

Bibliography

1) "Five lectures on effective field theory", David B. Kaplan (arXiv:nucl-th/0510023).

2) "Beyond the Standard Model". Alex Pomarol (CERN Yellow Report CERN-2012-001 (arXiv:1202.1391).

3) "Gauge Theory of Elementary Particle Physics", T. Cheng and L. Li (Oxford University Press 1988).

4) "The Future Of Grand Unification", H. Georgi (Prog. Theor. Phys. Suppl. 170 (2007) 119).

5) "Grand Unified Theories", S. Raby (arXiv:hep-ph/0608183).

6) "A Supersymmetry Primer", S. P. Martin (arXiv:hep-ph/9709356).

7) "Strongly interacting electroweak theories and their five-dimensional analogs at the LHC", A. Pomarol (Perspectives on LHC physics 259-282; also in Int. J. Mod. Phys. A24 (2009) 61).

Software

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