UAB
Universitat Autònoma de Barcelona

Physics beyond the Standard Model

Code: 42860
ECTS Credits: 6

2024/2025

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

Contact

Name: Alejandro Pomarol Clotet

Email: alex.pomarol@uab.cat

Teaching groups languages

You can view this information at the end of this document.

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)

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Theory Lectures	45	1.8	1, 2, 3
Type: Supervised			
Preparation of a topic related to the course	55	2.2	1, 2, 3
Type: Autonomous			
Exercises	40	1.6	1, 2, 3

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.

Assessment

Continous Assessment Activities

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

Attendance to the lectures, exercises and develop a topic related to the course.

There will be a recovery exam for students who have submitted the exercises but failed with a grade higher than 3.5.

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

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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Language list

Name	Group	Language	Semester	Turn
(TEm) Theory (master)	1	English	second semester	afternoon