Universitat Autònoma de Barcelona

2017/2018

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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Use of languages

Principal working language: english (eng)

External teachers

Giuliano Panico

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.

Skills

- 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

1. The SM of particle physics: symmetries, consistency, and reasons for improvement
2. Grand Unified Theories: Charge quantization, gauge-coupling unification, SU(5) models, predictions for proton decay

3. The strong CP-problem and axions
4. The hierarchy problem
5. Supersymmetry: Motivation, the MSSM, Supersymmetry breaking, LHC signatures
6. Composite Higgs models: Technicolor, Higgs as Pseudo-Goldstone boson, LHC signatures
7. Extra dimensions: Motivation, Kaluza-Klein idea, ADD and RS scenario, AdS/CFT correspondence, Gauge-Higgs unification

Methodology

Theory Lectures and Exercises.

Activities

Title	Hours	ECTS	Learning outcomes
Type: Directed			
Theory Lectures	44	1.76	1, 2, 3
Type: Supervised			
Preparation of a subject	36	1.44	1, 2, 3
Type: Autonomous			
Exercises	60	2.4	1, 2, 3

Evaluation

Exercises as homework and a presentation.

Evaluation activities

Title	Weighting	Hours	ECTS	Learning outcomes
Exercises	60%	5	0.2	1, 2, 3
Presentation of a subject	40%	5	0.2	1, 2, 3

Bibliography

1) T. Cheng and L. Li, ``Gauge Theory of Elementary Particle Physics'', Oxford University Press 1988

2) H. Georgi, ``The Future Of Grand Unification'', Prog. Theor. Phys. Suppl. 170 (2007) 119; S.Raby hep-ph/0608183.

3) S. P. Martin, ``A Supersymmetry Primer'', arXiv:hep-ph/9709356.

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

5) R. Rattazzi, ``Cargese lectures on extra dimensions'', arXiv:hep-ph/0607055.