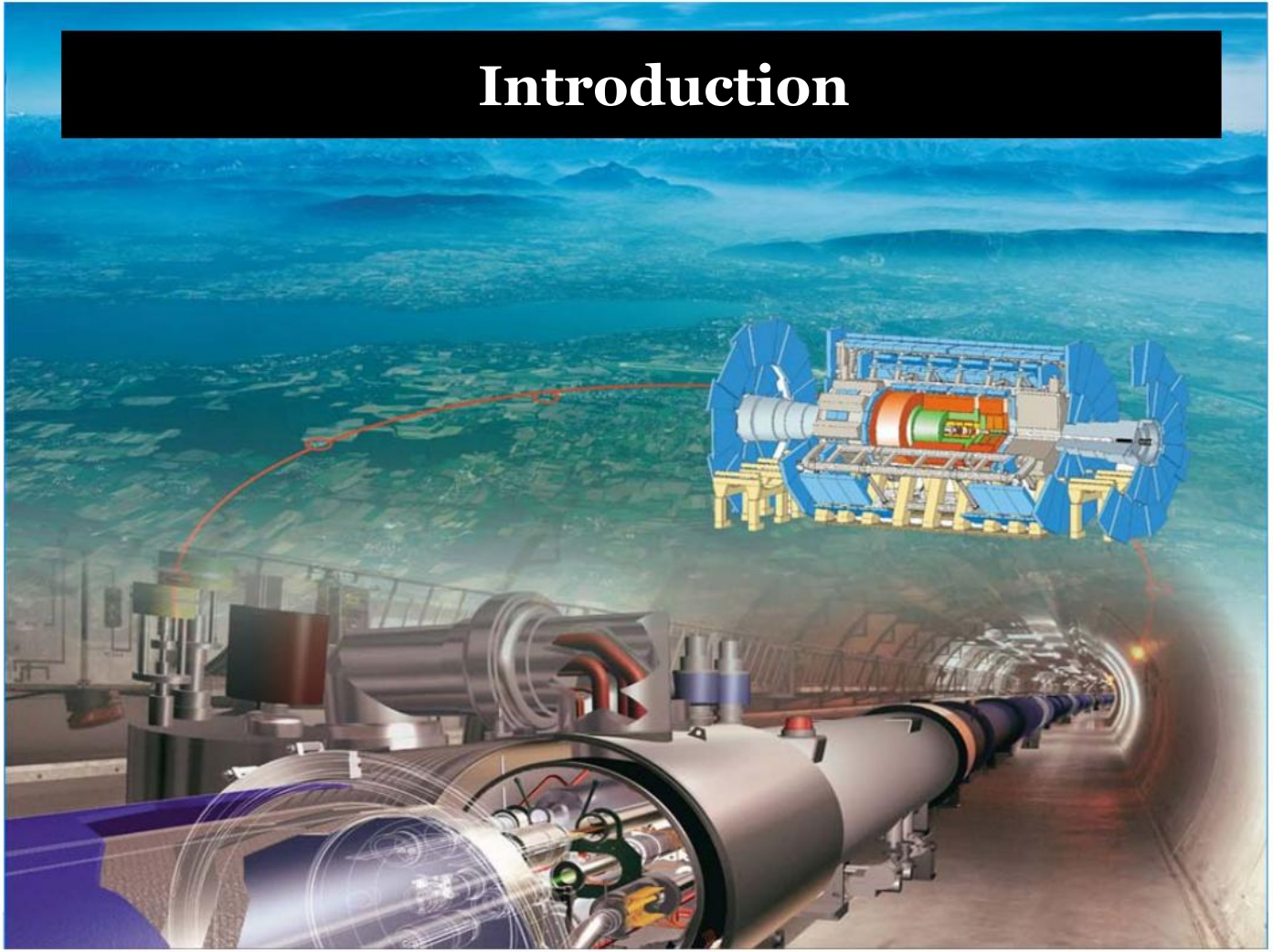
Testing the Standard Model of Elementary Particle Physics I

Introduction

Dr. Dominik Duda

5th November 2020

Introduction



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Housekeeping

- **Basic information (Module PH2044):**
  - Contact hours: 30 h
  - Credits (ECTS): 5 CP
  - Offer tutorials (optional) for deepening and widening of the acquired knowledge.
- **Module Exam:**
  - Oral examination of 30 minutes duration at the end of the semester (discussing comprehension questions, sketches and simple formulae that have been previously presented in this course)
- **Material to the lecture (and tutorial) will be uploaded to:**
  - **https://wwwatlas.mpp.mpg.de/ftp/outgoing/vorlesung/ws20**

Curriculum

1. **Standard Model of Particle Physics**
    - 1.1 (Historical) Introduction to Elementary Particle Physics
    - 1.2 Relativistic quantum mechanics
    - 1.3 Feynman Calculus
        - 1.3.1 Feynman-diagrams
        - 1.3.2 Cross sections
        - 1.3.3 Decay Rates
    - 1.4 Field Theories of Elementary Particle Physics
        - 1.4.1 Symmetries and groups
        - 1.4.2 Gauge Theories and Interactions
        - 1.4.3 Fundamental Forces and their Unification
        - 1.4.4 Origin of Particle Masses (i.e. the Higgs mechanism)

Curriculum

2. Experimental setups

- 2.1 Accelerator concepts
- 2.2 Accelerators
  - 2.2.1 LEP
  - 2.2.2 Tevatron
  - 2.2.3 HERA
  - 2.2.4 SLAC
  - 2.2.5 KEKB
  - 2.2.6 LHC
  - 2.2.7 Future colliders
- 2.3. Particle detection
  - 2.3.1 Interaction of particles with matter
  - 2.3.2 Modern particle detectors
  - 2.3.3 Particle reconstruction and identification

Curriculum

3. Recent experimental Tests on the Standard Model of Particle Physics

- 3.1 Precision Measurements of the Electroweak interaction
- 3.2 The Higgs Boson
- 3.3 B-Hadron Decays and CP Violation
- 3.4 Neutrino Masses and Oscillation

4. Extension of the Standard Model of Particle Physics

- 4.1 Open Questions (and solutions)
- 4.2 Great Unification
- 4.3 Supersymmetry
- 4.4 Dark Matter/Dark Energy
- 4.5 Extension of the scalar sector
- 4.6 Other (exotic) models

Tutorials

- Optional but encouraged !!!
- Will be lead by **Michael** and **Margherita** who will take turns.
- Will follow the lecture, but we are happy to adjust our planning if you want to learn (more) about a particular topic.
  - **Please speak up !**
- Please fill out the doodle poll (such that we can find a good time):
  - Follow this Link: https://doodle.com/poll/wxfpt8crt5skvi83?utm_source=poll&utm_medium=link

Proseminar: “Physics at the Large Hadron Collider”

- Briefing session on 9th of November 2020
  - Assign topics to participants
  - Housekeeping
- Will meet via zoom during the next weeks:
  - Zoom Link: https://mppmu.zoom.us/j/97053259255
- Might switch to in-person meetings later (depending on pandemic regulations):
  - At:

    Max-Planck-Institut für Physik,
    Föhringer Ring 6
    80805 München

Literature

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- Ch. Berger: **Elementarteilchenphysik**, Springer, 2002.
- P. Schmüser: **Feynmangraphen und Eichtheorien für Experimentalphysiker**, Springer, 2nd edition, 1995.
- I.J.R. Aitchison, A.J.G. Hey: **Gauge Theories in Particle Physics**, Vol. 1, Institute of Physics Publishing, new edition, 2002.
- W. Greiner, B. Müller: **Quantum Mechanics–Symmetries**, Springer, 2nd edition, 1994.
- Ian Brock, Thomas Schörner-Sadenius: **Physics at the Terascale**, WILEY-VCH, 2011
- D. Griffiths, **Introduction to Elementary Particles,** WILEY-VCH**,** 2008, 2nd edition
- Amitabha Lahiri, Palash B. Pal: **A first book of QUANTUM FIELD THEORY**, Alpha Science, 2nd edition, 2007