TFYA27 Elementary Particle Physics

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Chapter 1

1.1 Formal definition of course

TFYA 27 ELEMENTARY PARTICLE PHYSICS, 6 ECTS credits / 6 hp / 4 p
/Elementarpartikelfysik/ For Y4, Fys4, MFYS

- **Aim:**
  The aim with the course is to give the student a good introduction to modern particle physics. After a successful course the student can:
  
  - solve basic problems within basic nuclear physics with different formalisms, for instance within different models of the nucleus
  - use relativistic four vector formalism to solve problems within particle physics
  - use a mathematical formalism to treat some fundamental concepts within particle physics like isospin, SU(3), SU(4), SU(5), and so called gauge invariance to solve some longer theoretical issues.

- **Prerequisites:**
  A basic course in quantum mechanics including perturbation theory. Quantum dynamics and Relativity is not absolutely needed (but useful!).

- **Course organisation:**
  The course is divided into lectures and problem solving in connection to the lectures. If necessary the lectures will be given in English.

- **Course content:**

- **Course literature:**

- **Assessment:**
  Home-work problems and oral examination.
1.2 Examination

The examination will consist of two parts:

(a) A set of home-work problems handed out during the course. There will be approximately one assignment of 1-2 problems given out per week, in total approximately 10 problems. Deadline for handing in all solution will be after the end of the course in December, tentatively 20/12. The homework problems should be solved individually, but it is allowed (and even recommendable!) to discuss solutions with each other. However, for clarity I want to stress the matter of course that pure copying will not be accepted; even if you are discussing the solution strategies in groups, in the end everyone must individually think through and write down his/her own solution.

(b) An optional oral exam, tentatively in the period 7-15 January 2008, focusing on understanding of fundamental concepts.

From part (a), you may receive the grades U, 3, or 4. Tentatively, to get grades 3 respectively 4 will require approximately 50% respectively 75% of the total score. By doing a good oral exam, you may improve your grade with at most one step (i.e., U → 3, 3 → 4, or 4 → 5).
Chapter 2

2.1 Outline of textbook

(Note: This outline was written for the previous course by K-F. Berggren and R. Riklund. Although the present course will follow approximately the same outline, some deviations are likely to occur.)

The textbook contains a lot of material. Although interesting you cannot read it all for the present course. Below we outline a reasonable path through the text.

- **Chapter 1:**
  This chapter gives an introductory overview and is meant for rapid reading ("kursivt"). The chapter is elementary but is rewarding to read, e.g., Rutherford scattering and the corresponding cross-section are essential for later reference. Important concepts are introduced, e.g., isobaric spin, Yukawa exchange of pions and forces between nucleons (the field theoretic picture), and the quark-gluon plasma.

- **Chapter 2:**
  This chapter is about experimental techniques. Although the course is primarily theoretical one must recall that experiments constitute the empirical basis on which theory must rest. The chapter is for self-study.

- **Chapter 3:**
  Pages 109-113, parity, definition of isospin and statistics.

- **Chapter 4:**
  Note the Nilsson model (4.4). Magic numbers.

- **Chapter 5:**
  Section 5.2, pp 158-169, β-decay. This section is important for later reference but rapid reading should suffice. The chapter could be read at a later stage to get a better perspective on Chapter 11.

- **Chapter 7:**
  Important chapter, particle physics really starts here in the book.
  Particle data fig. 7.2. (Complete data are found in The European Physical Journal C, 3, No. 1-4, 1998),
  Definitions: baryon number, isospin, strangeness quantum numbers.
Hadrons as composite particles (p. 230).
Quarks (up, down, strange), Table 7.3.
Antiquarks.
Fundamental interactions; gauge bosons.
Feynman diagrams.

• **Chapter 8:**
Symmetries, from 8.7.3 rapid reading.

• **Chapter 9:**
Scattering theory 9.2.1 – 9.2.3.
Examples of baryon resonances 9.2.4, only rapid reading.
9.3 Fermi’s Golden Rule and Born scattering (supplementary notes) from Golden Rule (up to p. 308).

• **Chapter 10:**
The quark model introduced in this chapter is, of course, of fundamental importance. Some sections, however, must be left for rapid reading due to the limited time we have at our disposal. Let the lecture notes guide your selection.

• **Chapter 11:**
11.1 - 11.3 rapid reading.
11.4 Relativistic quantum mechanics.
11.5 - 11.10 are also important, but the rest of the chapter we have to leave because of lack of time.

• **Chapter 12:**
12.1 Scattering theory.
12.2 - 12.4 rapid reading.

• **Chapter 13:**
This is a very important chapter about the standard model. Let the lecture notes guide you through this complicated text.

• **Chapter 14:**
Be very selective and rapid. Of course, the chapter is important but we cannot include everything. Try to get an impression if theory is found to work well when confronted with experiments.

• **Chapter 15:**
What a physicist should know something about.