Czech Technical University in Prague
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High pT jets in RunII of the ATLAS Experiment

MASTER'S DEGREE PROJECT

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Zadani prace

Statement

Prohlasuji…

V Praze dne ....

Jan Lochman

Acknowledgment

Dekuji...

Jan Lochman

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Jety s vysokou příčnou hybností v RunII experimentu ATLAS

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Contents

Introduction

Chapter 1

QCD

Is the purpose of theoretical physics to be no more than a cataloging of all the things that can happen when particles interact with each other and separate? Or is it to be an understanding at a deeper level in which there are things that are not directly observable (as the underlying quantized fields are) but in terms of which we shall have a more fundamental understanding?

Julian Schwinger

The theoretical framework of particle physics is called Standard Model (SM). The SM describes the way how the fundamental components of matter interact with each other through strong, weak and electromagnetic interactions. Mathematically the SM is gauge quantum field theory with local internal symmetries of the direct product group $SU(3) \times SU(2) \times U(1)$. Gauge bosons are assigned to generators of this symmetry - there are 8 massless gluons from $SU(3)$ intermediating strong interaction between quarks and 3 massive $W^{\pm}, Z$ bosons with 1 massless boson γ for electroweak $SU(2) \times U(1)$ sector. Higgs mechanism has to be introduced in electroweak sector to assign $W^{\pm}, Z$ bosons mass and as consequence the new particle - Higgs boson - emerges in the SM theory. All bosons have integer spin.

In addition to the bosons the SM introduces spin-1/2 fermions which are divided into three quark and three lepton families. Fermions are assumed to be point-like because there is no evidence for their internal structure to date. All fermions interact weakly, if they have electrical charge, they interact electromagnetically as well. Quarks are the only fundamental fermions which do interact strongly. System of fundamental particles of the SM is shown in figure 1.1.

Quarks bind together to form hadrons and there are hunderds (?source?) of known hadrons up to date. Theory describing the interaction between quarks is called Quantum Chromodynamics (QCD) which key features will be discussed in this chapter. The reasoning for quark existence and for the description their strong interaction as $SU(3)$ gauge

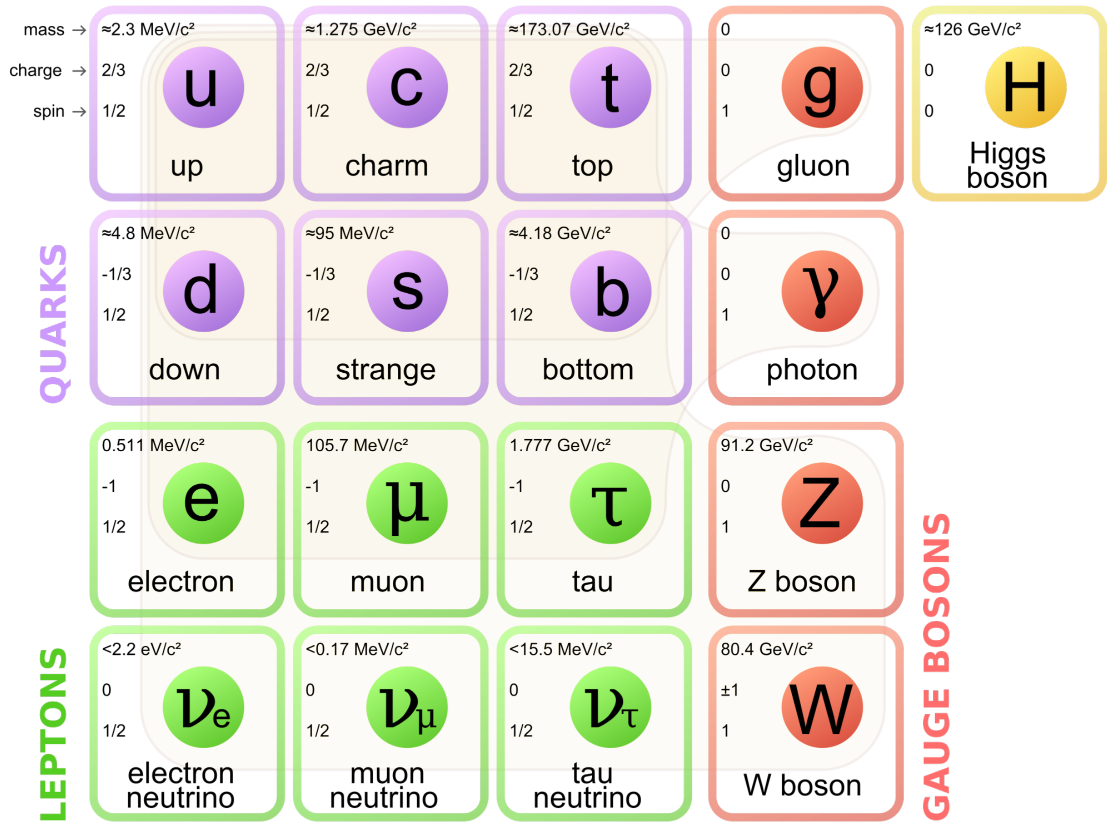

Figure 1.1: The system of fundamental particles of the SM. Figure from [1]

theory will be presented. Running coupling constant will be discused to split QCD into perturbative and non-perturbative regions - two regions, where QCD has to use different mathematical approach for description of strong interaction. Most of ideas presented here is overtaken from the following textbook [2].

1.1 Theoretical Ansatz

1.2 Experimental Ground

1.3 QCD as Gauge Theory

1.4 Perturbative QCD

1.5 Non-Perturbative QCD

Chapter 2

QCD on ATLAS

Chapter 3

ATLAS Detector

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Bibliography

[1] Standard model — Wikipedia, the free encyclopedia. `http://en.wikipedia.org/wiki/Standard_Model`, 2015.

[2] W. Greiner, D.A. Bromley, S. Schramm, and E. Stein. *Quantum Chromodynamics.* Springer, 2007.