Calculation of predictions for non-identical particle correlations in AA collisions at LHC energies from hydrodynamics-inspired models

MASTER OF SCIENCE THESIS

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Warsaw, 8th July 2014

Obliczenia teoretycznych przewidywań korelacji cząstek nieidentycznych w zderzeniach AA przy energiach LHC pochodzących z modeli hydrodynamicznych

PRACA MAGISTERSKA

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Abstract

Streszczenie

Contents

Introduction

Chapter 1

Theory of heavy ion collisions

1.1 The Standard Model

In the 1970s, a new theory of fundamental particles and their interaction emerged. A new concept, which concerns the electromagnetic, weak and strong nuclear interactions between know particles. This theory is called *The Standard Model*. There are seventeen named particles in the standard model, organized into the chart shown below (Fig. 1.1. Fundamental particles are divided into two families: *fermions* and *bosons*.

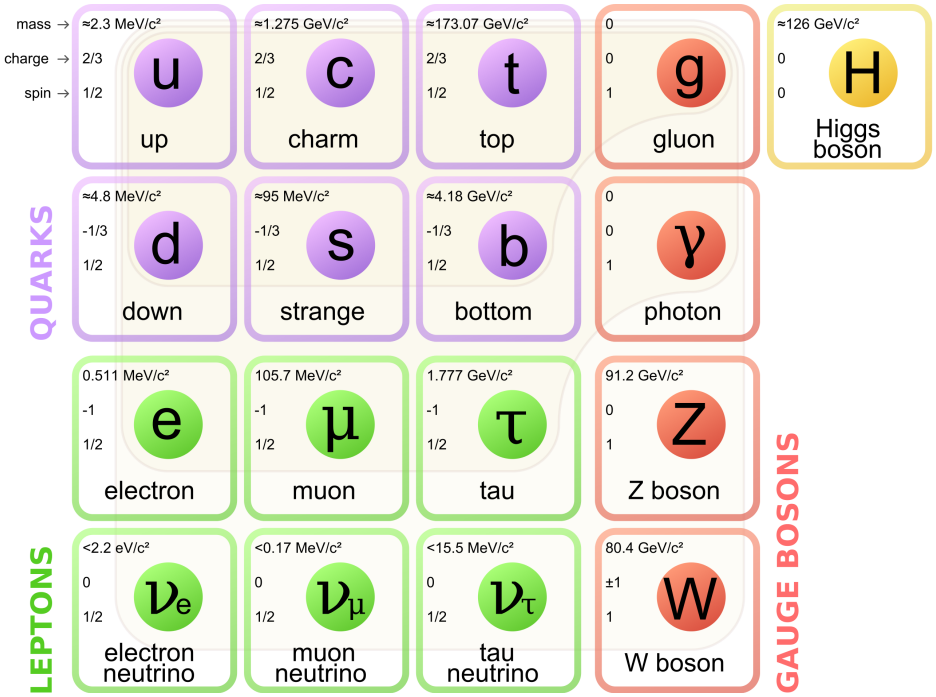

Figure 1.1: The Standard Model of elementary particles [1].

Fermions are the building blocks of matter. They are divided into two groups. Six of them, which must bind together are called *quarks*. Quarks are known to bind into doublets (*mesons*), triplets (*baryons*) and recently confirmed four-quark states.[1] Two of baryons, with the longest lifetimes, are forming a nucleus: a proton and a neutron. A proton is build from two up quarks and one down, and neutron consists of two down quarks and one up. A proton is found to be a stable particle (at least it has a lifetime larger than 10^35 years) and a free neutron has a mean lifetime about 8.8×10^2 s. Fermions, that can exist independently are called *leptons*. Neutrinos are a subgroup of leptons, which are only influenced by weak interaction. Fermions can be divided into three generations (three columns in the Figure 1.1). Generation I particles can combine into hadrons with the longest life spans. Generation II and III consists of unstable particles which form also unstable hadrons.

Bosons are force carriers. There are four fundamental forces: weak - responsible for radioactive decay, strong - coupling quarks into hadrons, electromagnetic - between charged particles and gravity - the weakest, which causes the attraction between particles with a mass. The Standard Model describes the first three. The weak force is mediated by $W^{\pm}$ and Z^0 bosons, electromagnetic force is carried by photons γ and the carriers of a strong interaction are gluons g. The fifth boson is a Higgs boson which is responsible for giving other particles mass.

1.2 Quantum Chromodynamics

1.3 Relativistic heavy ion collisions

[1] The LHCb experiment at CERN in Geneva confirmed recently existence of $Z(4430)$ - a particle consisting of four quarks [2].

Chapter 2

Therminator model

Chapter 3

Particle interferometry

3.1 HBT interferometry

3.2 Intensity interferometry in heavy ion collisions

3.2.1 Theoretical approach

Two particle wave function

Source function

Theoretical correlation function

Spherical harmonics decomposition of correlation function

3.2.2 Experimental approach

3.3 Scaling of femtoscopic radii

Chapter 4

Results

4.1 Identical particles correlations

4.2 Results of the fit

4.3 Discussion of results

Chapter 5

Summary

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[2] R. Aaij et al. (LHCb Collaboration). Observation of the resonant character of the $z(4430)^-$ state. *Phys. Rev. Lett.*, 112:222002, Jun 2014.

List of Figures