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Study of the Upsilon resonances with the CMS detector

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by

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Study of the Upsilon resonances with the CMS detector

To the importance of being.

Acknowledgements

I acknowledge.

Curriculum Vitæ

Guilermo Breto Rangel

Education

1789	Master of Science in Computer Science, University of California, Santa Barbara.
1492	Bachelor of Science, Web-Based University of Phoenix.

Experience

1999 – 2000	Graduate Research Assistant, University of California, Santa Barbara.

Selected Publications

Me Myself, S. Mart, and A. Nother Advisor: "Cool Paper Title," In *Proc. IEEE Intl. Conference Cool Papers (ICCP)*, August 2000.

Abstract

Study of the Upsilon resonances with the CMS detector

Guilermo Breto Rangel

This Thesis describes the Υ(nS) analysis in PbPb , pPb and pp collisions recorded by CMS during different runs. The present work studies thouroughly the suppression of the excited 2S and 3S states in PbPb collisions, relative to the ground 1S state and to the pp control dataset. For the entire phase space accessible, given by $\mid y \mid< 2.0$, $p_{\mathrm{T}} < 50$ GeV/c, 0-100% centrality, we measure the double ratio Υ(2S+3S)/Υ(1S) in PbPb relative to pp collisions to be $\chi = xx$. The relative suppression is further observed to increase with centrality. For the most central collisions, 0-30%, we measure $\chi = xx$, with a significance of over $5\,\sigma$ (p-value xx). No noticeable dependence of χ on p_{T} or rapidity is observed. The differential production cross-sections of the ground Υ(1S) and excited Υ(2S+3S) states are also measured, as a function of the dimuon transverse momentum and collision centrality. The observed Υ(1S) suppression is found to be consistent with the reduced feeddown from the suppressed excited Υ states.

Professor Manuel Caldern de la Barca Snchez
Dissertation Committee Chair

Contents

List of Figures

List of Tables

Chapter 1

Introduction

Bayesians are like Vegans, at some point they become impractical.

Meetup in the Silicon Valley

If a deconfined medium is formed in high-energy heavy-ion collisions, one of its most striking expected characteristics is the suppression of quarkonium states. This takes place as the force between the constituents of the quarkonium state, a heavy quark and its antiquark, is weakened by the color screening produced by the surrounding light quarks and gluons. The suppression is predicted to occur above a critical temperature of the medium, and sequentially, in the order of the $Q\overline{Q}$binding energy. Since the Υ(1S)is the most tightly bound state among all quarkonia, it is expected to be the one with the highest dissociation temperature. Such a suppression pattern is expected to further depend on complications arising from additional phenomena sometimes referred to as *hot* and *cold* nulcear matter effects.This work presented here aims at studying the in detail the bottomonium family of states in ultra-relativistic heavy-ion collisions. Given the momentum resolution attained, and the capability of the trigger system, CMS is unrivaled in the analysis of the upsilon family in the three environemnts studied (pp, pPb and PbPb)

1.1 Heavy Ion Physics

The study of the fundamental theory of the strong interaction — Quantum Chromodynamics (QCD) — in extreme conditions of temperature, density and parton momentum fraction (low-x) has attracted an increasing experimental and theoretical interest during the last 20 years. Indeed, QCD is not only a quantum field theory with an extremely rich dynamical content — such as asymptotic freedom, infrared slavery, (approximate) chiral symmetry, non-trivial vacuum topology, strong CP violation problem, $U_A(1)$ axial-vector anomaly, colour superconductivity, ... — but also the only sector of the Standard Model (SM) whose full *collective* behaviour — phase diagram, phase transitions, thermalisation of fundamental fields — is accessible to scrutiny in the laboratory. The study of the many-body dynamics of high-density QCD covers a vast range of fundamental physics problems (Fig. 1.1).

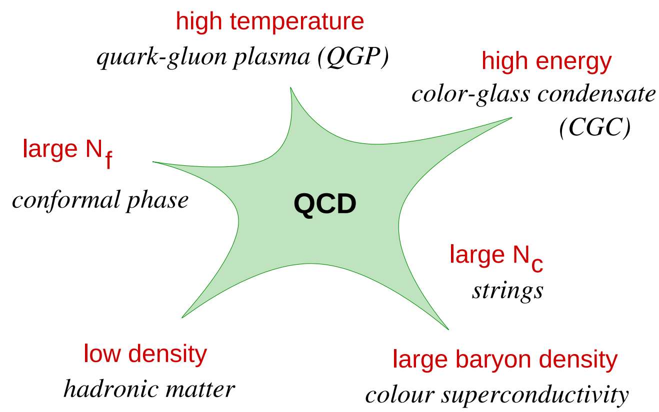


Figure 1.1: Many-body dynamics of QCD in different physics limits.

Deconfinement and chiral symmetry restoration

Lattice QCD calculations predict a new form of matter at energy densities (well) above a critical value — $\epsilon_c = (6 \pm 2) T_c^4 \approx 1$ GeV/fm^3 (Fig. 1.2), where $T_c \approx$ 150–190 MeV is the critical temperature — consisting of an extended volume of deconfined and current-mass quarks and gluons: the Quark-Gluon Plasma (QGP).

The vanishing of the chiral condensate at T_c and the sudden liberation of quark and gluon degrees of freedom are clearly visible in Fig. 1.2. The scrutiny of this new state of matter — equation-of-state (EoS), order of the phase transition, transport properties, etc. — promises to shed light on basic aspects of the strong interaction such as the nature of confinement, the mechanism of mass generation (chiral symmetry breaking, structure of the QCD vacuum) and hadroniza-

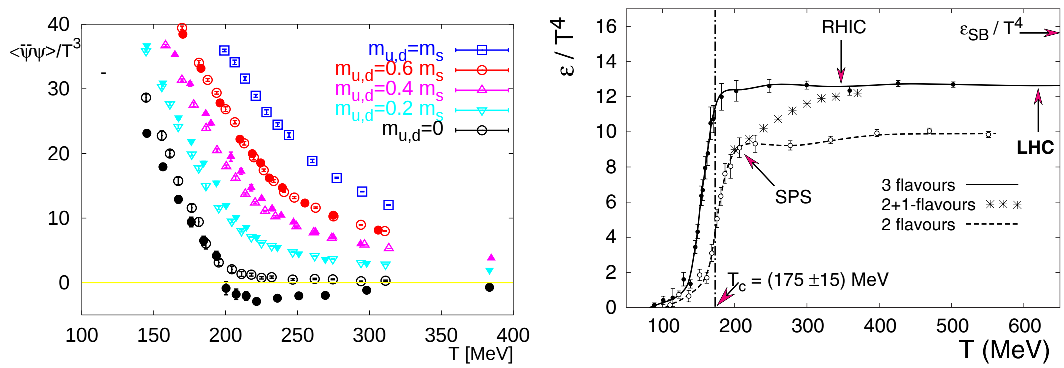


Figure 1.2: Left: The light quark chiral condensate versus the temperature computed in lattice QCD with various number of flavours and values of the u, d, s quark masses. Right: The energy density in QCD with 0, 2 and 3 degenerate quark flavours as well as with two light and one heavier (strange) quarks. The horizontal arrow shows the value of the Stefan-Boltzmann limit for an ideal quark-gluon gas

tion, which still evade a thorough theoretical description due to their highly non-perturbative nature.

In order to calculate physical observables from first principles in QCD it is not enough to know its Lagrangian. It is also necessary and important to know the true structure of its ground state. It is just the response of the true QCD vacuum which substantially modifies all the QCD Greens functions from their free counterparts.

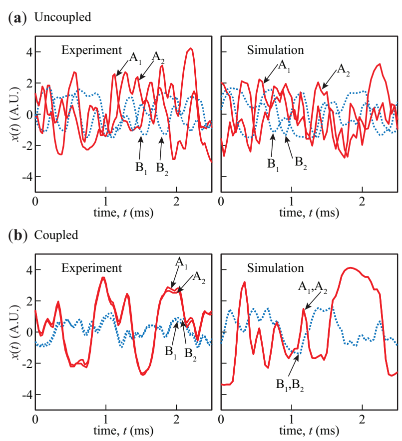
1.2 Quarkonia

A section that's not in the Table of Contents

Also read Chapter **??**.

1.3 How to make a figure

See Figure 1.3.



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1.4 And this is a table

See Table 1.1 on page 6.

Table 1.1: This caption goes into the list of tables: and this text doesn't.

a	table
can	be
very	pretty

Bibliography

Appendices