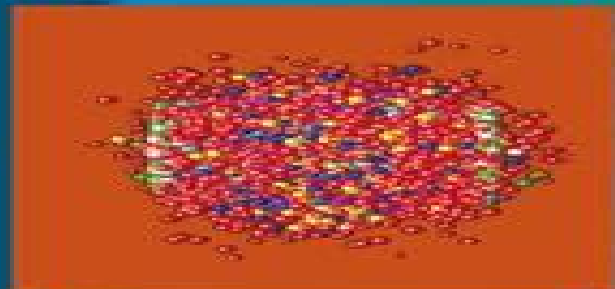
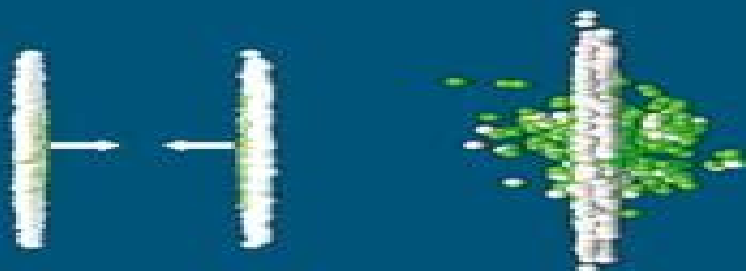


Introduction to

Relativistic Heavy Ion Physics

J. Bartke



Relativistic Heavy Ion Physics

**International School on Physics of the
Quark Gluon Plasma, Workshop on
Physics of Relativistic Heavy Ion
Collisions**

Relativistic Heavy Ion Physics:

Relativistic Heavy Ion Physics Reinhard Stock, 2010-04-01 This new volume I 23 of the Landolt B rnstein Data Collection series continues a tradition inaugurated by the late Editor in Chief Professor Werner Martienssen to provide in the style of an encyclopedia a summary of the results and ideas of Relativistic Heavy Ion Physics Formerly the Landolt B rnstein series was mostly known as a compilation of numerical data and functional relations but it was felt that the more comprehensive summary undertaken here should meet an urgent purpose Volume I 23 reports on the present state of theoretical and experimental knowledge in the field of Relativistic Heavy Ion Physics What is meant by this rather technical terminology is the study of strongly interacting matter and its phases in short QCD matter by means of nucleus nucleus collisions at relativistic energy The past decade has seen a dramatic progress and widening of scope in this field which addresses one of the chief remaining open frontiers of Quantum Chromodynamics QCD and in a wider sense the Standard Model of Elementary Interactions The data resulting from the CERN SPS BNL AGS and GSI SIS experiments and in particular also from almost a decade of experiments carried out at the Relativistic Heavy Ion Collider RHIC at Brookhaven have been fully analyzed uncovering a wealth of information about both the confined and deconfined phases of QCD at high energy density

Introduction To Relativistic Heavy Ion Physics Jerzy Bartke, 2008-12-22 This book attempts to cover the fascinating field of physics of relativistic heavy ions mainly from the experimentalist s point of view After the introductory chapter on quantum chromodynamics basic properties of atomic nuclei sources of relativistic nuclei and typical detector set ups are described in three subsequent chapters Experimental facts on collisions of relativistic heavy ions are systematically presented in 15 consecutive chapters starting from the simplest features like cross sections multiplicities and spectra of secondary particles and going to more involved characteristics like correlations various relatively rare processes and newly discovered features collective flow high pT suppression and jet quenching Some entirely new topics are included such as the difference between neutron and proton radii in nuclei heavy hypernuclei and electromagnetic effects on secondary particle spectra Phenomenological approaches and related simple models are discussed in parallel with the presentation of experimental data Near the end of the book recent ideas about the new state of matter created in collisions of ultrarelativistic nuclei are discussed In the final chapter some predictions are given for nuclear collisions in the Large Hadron Collider LHC now in construction at the site of the European Organization for Nuclear Research CERN Geneva Finally the appendix gives us basic notions of relativistic kinematics and lists the main international conferences related to this field

Relativistic Heavy Ion Physics (In 2 Volumes) Laszlo P Csernai, D D Strottman, 1991-04-22 This book gives an overview of relativistic heavy ion physics with particular emphasis on those theoretical approaches which seek an understanding and explanation of the measurements These approaches try to build a bridge between more basic theories such as lattice QCD or nucleon nucleon interactions and

complicated experimental observables involving a large number of particles. Thus mainly theoretical approaches are discussed here which are strongly and directly related to experiments and in turn they are phenomenological to some extent. These models use the available information from more complete reaction models describing the whole collision and the observables. It is suitable as a text for advanced undergraduate and graduate students both experimentalists and theorists for studies in the field of relativistic heavy ion physics. It may also serve as a handbook where basic concepts of reaction models can be found and the most important references for further reading are provided.

Introduction to Relativistic Heavy Ion Collisions L. P. Csernai, 1994-05-10 Introduction to Relativistic Heavy Ion Collisions L. P. Csernai University of Bergen Norway. Written for postgraduates and advanced undergraduates in physics, this clear and concise work covers a wide range of subjects from intermediate to ultra-relativistic energies, thus providing an introductory overview of heavy ion physics. The reader is introduced to essential principles in heavy ion physics through a variety of questions with answers of varying difficulty. This timely text is based on a series of well-received lectures given by Professor L. Csernai at the University of Minnesota and the University of Bergen where the author is based. Ultra-relativistic Heavy-ion Physics with AFTER@LHC.

, 2012 **Heavy Ion Physics From Bevalac To Rhic - Proceedings Of The Relativistic Heavy Ion Symposium, Aps Centennial Meeting '99** Richard Seto, 1999-11-15

This book represents the proceedings of a symposium held during the centennial meeting of the American Physical Society. It covers the latest results in experimental heavy ion physics from the Alternating Gradient Accelerator in the US and the SpS at CERN and summarizes the current theoretical and experimental state of the field before the commissioning of RHIC. Among the highlights are the theoretical predictions made for what the experimentalists will see in the high temperature matter expected to be formed at the new machine.

Ultrarelativistic Heavy-Ion Collisions Ramona Vogt, 2007-06-04 This book is designed for advanced undergraduate and graduate students in high energy heavy ion physics. It is relevant for students who will work on topics being explored at RHIC and the LHC. In the first part the basic principles of these studies are covered including kinematics, cross sections including the quark model and parton distribution functions, the geometry of nuclear collisions, thermodynamics, hydrodynamics and relevant aspects of lattice gauge theory at finite temperature. The second part covers some more specific probes of heavy ion collisions at these energies: high mass thermal dileptons, quarkonium and hadronization. The second part also serves as extended examples of concepts learned in the previous part. Both parts contain examples in the text as well as exercises at the end of each chapter. Designed for students and newcomers to the field. Focuses on hard probes and QCD. Covers all aspects of high energy heavy ion physics. Includes worked example problems and exercises.

RELATIVISTIC HEAVY ION PHYSICS, 2002 High energy collisions of heavy ions provide a means to study QCD in a regime of high parton density and may provide insight into its phase structure. Results from the four experiments at RHIC: BRAHMS, PHENIX, PHOBOS and STAR are presented and placed in context with the lower energy data from the AGS and SPS accelerators. The focus is on the insights these measurements

provide into the time history of the collision process Taken together the data point to the creation of a deconfined state of matter that forms quickly expands rapidly and freezes out suddenly With the new RHIC data systematic data now exists for heavy ion collisions as a function of square root s over several orders of magnitude and as a function of impact parameter These data test the interplay between hard and soft processes in a large volume system where nucleons are struck multiple times The data is consistent with creating a deconfined state jet quenching that forms quickly saturation models expands rapidly radial and elliptic flow and freezes out suddenly single freezeout and blast wave fits There are also intriguing connections with particle production in elementary systems which point to the role of the energy available for particle production on the features of the final state Many in this field are optimistic that the careful understanding of this experimental data may lead to the theoretical breakthroughs that will connect these complex systems to the fundamental lattice predictions

Phenomenology Of Ultra-relativistic Heavy-ion Collisions Wojciech Florkowski, 2010-03-24 This book gives an introduction to main ideas used in the physics of ultra relativistic heavy ion collisions The links between basic theoretical concepts discussed gradually from the elementary to more advanced level and the results of experiments are outlined so that experimentalists may learn more about the foundations of the models used by them to fit and interpret the data while theoreticians may learn more about how different theoretical ideas are used in practical applications The main task of the book is to collect the available information and establish a uniform picture of ultra relativistic heavy ion collisions The properties of hot and dense matter implied by this picture are discussed comprehensively In particular the issues concerning the formation of the quark gluon plasma in present and future heavy ion experiments are addressed

Topics in Theory and Experiment in Relativistic Heavy-ion Physics Jeremy Alford, 2015 Much can be learned about the quark gluon plasma created in relativistic heavy ion collisions by studying the particles produced In addition to particles being created from the energy released these collisions are expected to produce very strong magnetic fields Although these fields only exist for a tiny fraction of a second their existence may influence particle production I will present a theoretical analysis of heavy quarkonia subjected to a very strong magnetic field and an experimental search for hypertriton an exotic unstable isotope of hydrogen For the theoretical part of my dissertation I model the interaction of a heavy quark antiquark pair using a non relativistic Hamiltonian The Schrodinger equation is solved numerically using the model Hamiltonian including spin spin spin orbit and tensor interactions I will present the energy eigenstates as a function of the external magnetic field for all $1s$ and $1p$ bottomonium and charmonium states A very strong magnetic field is expected to modify the masses of quarkonia enough to be measured in modern collider experiments and may help to explain the suppression of J mesons observed in relativistic heavy ion collisions The changes in mass are due to the interaction with the magnetic field as well as the mixing between spin states For the experimental part of my dissertation I look for evidence of a hypertriton decaying into a deuteron proton and pion Hypertritons are created in relativistic heavy ion collisions at RHIC and the decay products are observed using the

STAR detectors The relativistic invariant mass of the hypertriton candidates is calculated using energy momentum conservation of the decay products The resulting invariant mass spectrum is then examined for an abundance of candidates near the known hypertriton mass Although the combinatorial background for a three body decay is much larger than for a two body decay the large amount of data acquired in recent years combined with the higher branching ratio for the three body decay makes it reasonable to expect that a good signal can be extracted

Relativistic Heavy Ion Physics J. Bartke,2004 **Heavy Ion Physics from Bevalac to RHIC** Relativistic Heavy Ion Symposium,Richard Seto,1999 **Jet Quenching in Relativistic Heavy Ion Collisions at the LHC** Aaron Angerami,2013-12-02 This thesis presents the first measurements of jets in relativistic heavy ion collisions as reported by the ATLAS Collaboration These include the first direct observation of jet quenching through the observation of a centrality dependent dijet asymmetry Also a series of jet suppression measurements are presented which provide quantitative constraints on theoretical models of jet quenching These results follow a detailed introduction to heavy ion physics with emphasis on the phenomenon of jet quenching and a comprehensive description of the ATLAS detector and its capabilities with regard to performing these measurements

Physics of the quark-gluon plasma and relativistic heavy-ion collisions International School on Physics of the Quark Gluon Plasma,Workshop on Physics of Relativistic Heavy Ion Collisions,1997 Fest-Commerz zur Vorfeier des 79. Geburtstages des Fürsten Bismarck am 31. März 1894 ,1894 A Short Course on Relativistic Heavy Ion Collisions Asis Kumar

Chaudhuri,2014-10-03 Some ideas concepts in relativistic heavy ion collisions are discussed To a large extent the discussions are non comprehensive and non rigorous It is intended for fresh graduate students of Homi Bhabha National Institute Kolkata Centre who are intending to pursue career in theoretical experimental high energy nuclear physics Comments and criticisms will be appreciated

Heavy Ion Physics at RHIC and in CMS and the Participation of the US Nuclear Physicists in CMS. ,2002 The field of relativistic heavy ion physics entered a new era with the start of the physics program at the Relativistic Heavy Ion Collider RHIC at Brookhaven National Laboratory on Long Island New York This dedicated facility allows extensive studies of the nuclear matter phase diagram at the highest temperatures so far available in the laboratory The goal of the program is to conclusively establish the existence of the deconfined state of nuclear matter predicted by QCD the Quark Gluon Plasma QGP and study its properties

Heavy Ion Physics from Bevalac to RHIC Richard Seto,1999 *New Insight Into Relativistic Heavy Ion Physics Through 4[pi] Data* H. H. Gutbrod,1984

The Physics and Experimental Program of the Relativistic Heavy Ion Collider (RHIC). ,2005 The primary motivation for studying nucleus nucleus collisions at relativistic and ultrarelativistic energies is to investigate matter at high energy densities ϵ much ≥ 1 GeV fm³ Early speculations of possible exotic states of matter focused on the astrophysical implications of abnormal states of dense nuclear matter Field theoretical calculations predicted abnormal nuclear states and excitation of the vacuum This generated an initial interest among particle and nuclear physicists to transform the state of the

vacuum by using relativistic nucleus nucleus collisions Extremely high temperatures above the Hagedorn limiting temperature were expected and a phase transition to a system of deconfined quarks and gluons the Quark Gluon Plasma QGP was predicted Such a phase of matter would have implications for both early cosmology and stellar evolution The understanding of the behavior of high temperature nuclear matter is still in its early stages However the dynamics of the initial stages of these collisions which involve hard parton parton interactions can be calculated using perturbative QCD Various theoretical approaches have resulted in predictions that a high temperature T approximately 500 MeV gluon gas will be formed in the first instants within $0.3 \text{ fm}/c$ of the collision Furthermore QCD lattice calculations exhibit a phase transition between a QGP and hadronic matter at a temperature near 250 MeV Such phases of matter may have existed shortly after the Big Bang and may exist in the cores of dense stars An important question is whether such states of matter can be created and studied in the laboratory The Relativistic Heavy Ion Collider RHIC and a full complement of detector systems are being constructed at Brookhaven National Laboratory to investigate these new and fundamental properties of matter

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