

that aspect of physics that they can get by without those sections.

*Why You Hear What You Hear* also has much to interest physicists and physics students. As with many other excellent acousticians, Heller's primary specialty is not acoustics—his other research areas include chemical physics, surface waves, and quantum scattering. In general, a good physicist can bring novel insights to a new field and an understanding of the standard approach. This book contains a lot of physical insight, and I think it will be the rare acoustician who does not enjoy reading it. I particularly liked the use of color coding to introduce (with a minimum of math) a graphical algorithm to represent autocorrelation. Also interesting are the author's diversions into history, including a story in which John William Strutt (Lord Rayleigh) and William Henry Bragg seem to have been mistaken about an echo transposed in pitch.

I enjoy and applaud the book's experiential approach, although the experimentalist in me would like to have seen more suggestions for experiments that go beyond the computer keyboard. Also, I should declare a bias. Instead of writing a book, I publish educational acoustics material extensively on the Web, precisely because it's so easy to include sound files and other resources.

The successful integration of the associated website invites the question: Why not an entirely electronic or web-based package? One answer is that some discussions are long and have beautiful, still graphics; those work well as a book chapter. Another reason may be the business model: A pay wall would be unpopular on the Web, but in this case the hard-copy book could possibly subsidize an extensive website. Heller's experiment deserves to work.

The author specifically addresses musicians in the introduction. Many will read the book: Musicians are often passionate enough to undertake deep study of things related to their art and have usually accepted that excellence requires a significant investment of effort. I think, though, that quite a few sales will also be to people from the other end of the music-physics spectrum and beyond: Acousticians will enjoy its interesting perspectives, and physicists and engineers outside of acoustics will find it an attractive introduction to some important parts of the discipline.

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## Extreme States of Matter in Strong Interaction Physics An Introduction

Helmut Satz

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The statistical mechanics of systems with strongly interacting constituents has recently emerged as a focal point of interest in many areas of physics. Quarks and gluons take strongly interacting dynamics to the extreme; the interactions of those constituents are so strong that the particles could not exist in isolation.

*Extreme States of Matter in Strong Interaction Physics: An Introduction* offers a tempting invitation to explore the mysteries of quark-gluon matter. Written by Helmut Satz, a patriarch of statistical quantum chromodynamics (QCD), the book describes the physics of nuclear matter that is heated or compressed to extremes of temperature and density. After reading it, a young researcher will be equipped with the concepts and basic tools necessary to begin working in the field. For a seasoned physicist, the book will serve both as a trusted and valuable reference and as a source of inspiration: The author, who does not shy away from open and unsolved problems, offers deep insights and outlines possible future research directions.

The first chapter, a review of critical behavior in thermodynamics, uses the simplest spin system, the Ising model, as an explicit example. The next chapter touches on the geometric critical behavior that arises from the formation of clusters of diverging size, as described by percolation theory. Discussions of geometric critical behavior are not common in introductory textbooks on statistical mechanics. In his explanation of why the hadron resonance gas cannot exist beyond a certain temperature, Satz introduces the concepts of bootstrap and duality and makes a beautiful and unexpected connection to the integer partitioning problem.

Satz begins his discussion of the quark-gluon plasma with simple and intuitive arguments based on the bag model of confinement developed at MIT. He then introduces modern statistical QCD, its formulation on a Euclidean spacetime lattice, and the concepts of symmetry breaking and restoration.

He also provides a comprehensive summary of what we know about QCD phase transitions based on first-principles lattice calculations.

Current experiments at the Relativistic Heavy Ion Collider at Brookhaven National Laboratory and at the Large Hadron Collider at CERN have provided detailed and precise information about the real-time dynamics of quark-gluon fireballs. Naturally, a description of the experimental probes of quark-gluon matter is a major ingredient of the book. An emphasis is put on the key "hard probes": electromagnetic radiation, jet quenching, and the suppression of heavy quarkonia, mesons comprising a quark and its antiquark. (The suppression was originally proposed by Satz and Tetsuo Matsui as a signature of deconfinement.)

The book's final chapter, which details the attempts to describe the rapid thermalization of quark-gluon matter produced in high-energy collisions, offers an intriguing analogy to the Hawking radiation of black holes. The pulse of a strong color field that accompanies the collision and the resulting acceleration of colored quarks and gluons leads to the formation of an event horizon, which in turn produces thermal radiation. A signal transmitted from inside a horizon cannot contain information and must thus be thermal. The idea is an interesting and provocative one that deserves further investigation.

Throughout the book, Satz emphasizes simple physical pictures and basic concepts, as opposed to technical details and formal derivations. In addition, the presentation is vivid and elegant; in particular, inspiring epigraphs stand out, including the fitting "But who are you, if you do not know that Phantasia has no limits?" taken from the book *The Neverending Story* (Puffin Books, 1997) by Michael Ende.

Inevitably, the book's shortcomings are counterparts of its strengths. Being compact in size, it leaves out some topics that have become a part of the modern theoretical toolbox—for example, hydrodynamics, transport, and the holographic correspondence. That means graduate students who are inspired by the book to become theorists will have to supplement it with more specialized manuscripts. Nonetheless, *Extreme States of Matter in Strong Interaction Physics* provides an insightful and succinct introduction into what has become an active area of research. I highly recommend it.

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