

Quark–Gluon Plasma Theoretical Foundations

An annotated reprint collection

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Introduction

The purpose of this volume is to trace the development of the theoretical understanding of quark-gluon plasma, both in terms of the equation of state and thermal correlation functions and in terms of its manifestation in high energy nuclear collisions. Who among us has not wondered how tall a mountain is on a neutron star, what happens when matter is heated and compressed to higher and higher densities, what happens when an object falls into a black hole, or what happened eons ago in the early universe? The study of quark-gluon plasma is related in one way or another to these and other thought provoking questions.

Oftentimes the most eloquent exposition is given in the original papers. To this end we have made a selection of what are, in our opinion, the most important pioneering papers in this field. The early 1950's was an era when high energy multiparticle production in cosmic ray interactions attracted the attention of some of the brightest minds in physics, and so it should be no surprise that the first reprinted papers deal with the introduction of statistical models of particle production. The quark model arose in the 1960's, while QCD as such was recognized as the theory of the strong interactions in the 1970's. The behavior of matter at high temperatures and supranuclear densities became of wide interest in the nuclear and particle physics communities starting in the 1970's, which is when the concept of quark-gluon plasma became established. We have traced the history of the field up to the early 1990's.

We have three reasons for stopping at that point in time. First, most of the key theoretical concepts and formalisms arose before 1993, although many of them continue to be developed today and hopefully well into the future. Second, papers written after 1992 are much more readily available than those written before due to the advent of the World Wide Web and its electronic preprint databases and journals. Finally, in making this collection of reprints available as hardcopy we are limited in the number of pages, and we would need to delete some in the present selection in order to make room for post-1993 papers. For the same reason our subject focus must of necessity be limited, which means that we do not address in our reprint collection two wide subject areas: we do not report on the behavior

of nuclear matter under extreme conditions, nor on quark matter in neutron stars.

The broad categories into which we have placed the material reflect the diverse studies of quark-gluon plasma and its manifestation. They are: phase-space models of particle production, perturbative QCD plasma, lattice gauge theory, fluid dynamics and flow, strangeness, heavy flavor (charm), electromagnetic signals, parton cascade and minijets, parton energy loss and jet quenching, Hanbury Brown–Twiss (HBT) interferometry, disoriented chiral condensates, phase transition dynamics and cosmology, and color superconductivity. Each chapter is prefaced by an introduction, which contains a list of significant papers which is more complete than the papers we have room to reprint, though by no means exhaustive. It also contains citations to most relevant papers published up to the date of completion of this volume (fall 2002). We hope that our short reviews will help bring the reader up to date on the latest developments.

The selection of papers we cite in each chapter, and in particular the ones selected for reprinting, is solely our responsibility. It is based on our best judgement and experience in this field dating back to the mid-1970's. In order to be reprinted a paper must have been pioneering in the sense of originality and impact on the field. Generally they have been cited over a hundred times by other papers published in refereed journals. The final selection was reviewed and discussed among us repeatedly. Just because a paper is not included does not mean we do not know of it or do not have a high regard for it. We apologize in advance to the affected authors.

After making our selections we sought the independent opinions of Jean-Paul Blaizot, Laszlo Csernai, Miklos Gyulassy, Rolf Hagedorn, Ulrich Heinz, Keijo Kajantie, Frithjof Karsch, Larry McLerran, Robert Pisarski, Helmut Satz, Edward Shuryak, and Jozsef Zimanyi, to whom we are very grateful for their advice. Nevertheless the ultimate responsibility is ours and ours alone.

All of the papers cited or reprinted are original research contributions. There are three other types of publications we would like to list here in the introduction. The first is a compilation of books. The second is a list of reviews, many of which contain a significant amount of original material. The third is a list of the proceedings of the series of Quark Matter meetings, the primary series of international conferences in this field that is attended by both theorists and experimentalists.

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Joseph Kapusta, Berndt Müller, Johann Rafelski

Contents

Introduction	v
1 Phase Space Model of Particle Production	1
1.1 <i>High energy nuclear events</i> E. Fermi Prog. Theor. Phys. 5 , 570 (1950)	6
1.2 <i>On multiparticle production in a single interaction process</i> I. Pomeranchuk Proceedings of USSR Academy of Sciences 78 , 889 (1951)	20
1.3 <i>Statistical thermodynamics of strong interactions at high energies</i> R. Hagedorn Suppl. Nuovo Cimento 3 , 147 (1965)	24
1.4 <i>On the hadronic mass spectrum</i> R. Hagedorn Nuovo Cimento 52 , 1336 (1967)	64
1.5 <i>Strange anti-baryons from quark-gluon plasma</i> J. Rafelski Phys. Lett. B 262 , 333 (1991)	69
2 Perturbative QCD Plasma	77
2.1 <i>Superdense matter: neutrons or asymptotically free quarks?</i> J. C. Collins and M. J. Perry Phys. Rev. Lett. 34 , 1353 (1975)	82
2.2 <i>Fermions and gauge vector mesons at finite temperature and density. III. The ground-state energy of a relativistic quark gas</i> B. A. Freedman and L. D. McLerran Phys. Rev. D 16 , 1169 (1977).	86
2.3 <i>Theory of hadron plasma</i> É. V. Shuryak Zh. Eksp. Teor. Fiz. 74 , 408 (1978) [Sov. Phys. JETP 47 , 212 (1978)]	103
2.4 <i>Quantum chromodynamics at high temperature</i> J. I. Kapusta Nucl. Phys. B 148 , 461 (1979)	111
2.5 <i>Infrared problem in the thermodynamics of the Yang-Mills gas</i> A. D. Linde Phys. Lett. B 96 , 289 (1980)	149
2.6 <i>Covariant calculations at finite temperature: the relativistic plasma</i> H. A. Weldon Phys. Rev. D 26 , 1394 (1982)	153

2.7	<i>Spectrum of elementary Fermi excitations in quark-gluon plasma</i> V. V. Klimov Yad. Fiz. 33 , 1734 (1981) [Sov. J. Nucl. Phys. 33 , 934 (1981)]	167
2.8	<i>Soft amplitudes in hot gauge theories: a general analysis</i> E. Braaten and R. D. Pisarski Nucl. Phys. B 337 , 569 (1990)	169
3	Lattice Gauge Theory	235
3.1	<i>Lattice models of quark confinement at high temperature</i> L. Susskind Phys. Rev. D 20 , 2610 (1979)	239
3.2	<i>Quark liberation at high temperature: a Monte Carlo study of SU(2) gauge theory</i> L. D. McLerran and B. Svetitsky Phys. Rev. D 24 , 450 (1981)	248
3.3	<i>Monte Carlo study of SU(2) gauge theory at finite temperature</i> J. Kuti, J. Polónyi and K. Szlachányi Phys. Lett. B 98 , 199 (1981)	259
3.4	<i>The order of the deconfinement transition in SU(3) Yang-Mills theory</i> T. Çelik, J. Engels and H. Satz Phys. Lett. B 125 , 411 (1983)	265
3.5	<i>On the existence of a phase transition for QCD with three light quarks</i> F. R. Brown, F. P. Butler, H. Chen, N. H. Christ, Z.-H. Dong, W. Schaffer, L. I. Unger and A. Vaccarino Phys. Rev. Lett. 65 , 2491 (1990)	269
3.6	<i>Remarks on the chiral phase transition in chromodynamics</i> R. D. Pisarski and F. Wilczek Phys. Rev. D 29 , 338 (1984)	273
4	Fluid Dynamics and Flow	277
4.1	<i>On multiple production of particles during collisions of fast particles</i> L. D. Landau Izv. Akad. Nauk SSSR, Physics Series, 17 , 51 (1953); in English: L. D. Landau, <i>Collected Papers of L. D. Landau</i> , edited by D. Ter Haar, Pergamon, Oxford (1965), p569.	283
4.2	<i>Highly relativistic nucleus-nucleus collisions: The central rapidity region</i> J. D. Bjorken Phys. Rev. D 27 , 140 (1983)	300
4.3	<i>Hydrodynamics of ultra-relativistic heavy ion collisions</i> G. Baym, B.L. Friman, J.-P. Blaizot, M. Soyeur and W. Czyz Nucl. Phys. A 407 , 541 (1983)	312

4.4	<i>Single particle distribution in the hydrodynamic and statistical thermodynamic models of multiparticle production</i>	
	F. Cooper and G. Frye	
	Phys. Rev. D 10 , 186 (1974)	342
4.5	<i>Evidence for a blast wave from compressed nuclear matter</i>	
	P. J. Siemens and J. O. Rasmussen	
	Phys. Rev. Lett. 42 , 880 (1979)	346
4.6	<i>Transverse momentum analysis of collective motion in relativistic nuclear collisions</i>	
	P. Danielewicz and G. Odyniec	
	Phys. Lett. B 157 , 146 (1985)	350
4.7	<i>Anisotropy as a signature of transverse collective flow</i>	
	J.-Y. Ollitrault	
	Phys. Rev. D 46 , 229 (1992)	355
5	Strangeness	372
5.1	<i>Strangeness production in the quark-gluon plasma</i>	
	J. Rafelski and B. Müller	
	Phys. Rev. Lett. 48 , 1066 (1982) [Erratum: 56 , 2334 (1986)]	378
5.2	<i>Quarkochemistry in relativistic heavy-ion collisions</i>	
	T. S. Biró and J. Zimányi	
	Phys. Lett. B 113 , 6 (1982)	383
5.3	<i>How much strangeness production is there in ultrarelativistic nucleus-nucleus collisions?</i>	
	J. Kapusta and A. Mekjian	
	Phys. Rev. D 33 , 1304 (1986)	388
5.4	<i>Time evolution of strange-particle densities in hot hadronic matter</i>	
	P. Koch and J. Rafelski	
	Nucl. Phys. A 444 , 678 (1985)	398
5.5	<i>Separation of strangeness from antistrangeness in the phase transition from quark to hadron matter: possible formation of strange quark matter in heavy-ion collisions</i>	
	C. Greiner, P. Koch and H. Stöcker	
	Phys. Rev. Lett. 58 , 1825 (1987)	412
6	Charm	416
6.1	<i>J/ψ suppression by quark-gluon plasma formation</i>	
	T. Matsui and H. Satz	
	Phys. Lett. B 178 , 416 (1986)	419
6.2	<i>Color screening and deconfinement for bound states of heavy quarks</i>	
	F. Karsch, M. T. Mehr and H. Satz	
	Z. Phys. C 37 , 617 (1988)	426

7	Electromagnetic Signals	432
7.1	<i>Direct production of photons and dileptons in thermodynamical models of multiple hadron production</i> E. L. Feinberg Nuovo Cim. A 34 , 391 (1976)	436
7.2	<i>Quark-gluon plasma and the production of leptons, photons and psions in hadron collisions</i> É. V. Shuryak Yad. Fiz. 28 , 796 (1978) [Sov. J. Nucl. Phys. 28 , 408 (1978)]	457
7.3	<i>Muon pair production in very high energy nucleus-nucleus collisions</i> K. Kajantie and H. I. Miettinen Z. Phys. C 14 , 357 (1982)	465
7.4	<i>Direct lepton production in high-energy collisions of nuclei</i> G. Domokos Phys. Rev. D 28 , 123 (1983)	471
7.5	<i>Dilepton emission and the QCD phase transition in ultrarelativistic nuclear collisions</i> K. Kajantie, J. Kapusta, L. McLerran and A. Mekjian Phys. Rev. D 34 , 2746 (1986)	478
7.6	<i>High-energy photons from quark-gluon plasma versus hot hadronic gas</i> J. Kapusta, P. Lichard and D. Seibert Phys. Rev. D 44 , 2774 (1991) [Erratum: 47 , 4171 (1993)]	487
8	Quark-Gluon Plasma Formation	503
8.1	<i>Minijet production in high-energy nucleus-nucleus collisions</i> K. Kajantie, P. V. Landshoff and J. Lindfors Phys. Rev. Lett. 59 , 2527 (1987)	508
8.2	<i>The early stage of ultra-relativistic heavy ion collisions</i> J.-P. Blaizot and A. H. Mueller Nucl. Phys. B 289 , 847 (1987)	512
8.3	<i>Quark and gluon production in high-energy nucleus-nucleus collisions</i> K. J. Eskola, K. Kajantie and J. Lindfors Nucl. Phys. B 323 , 37 (1989)	526
8.4	<i>HIJING: A Monte Carlo model for multiple jet production in pp, pA and AA collisions</i> X.-N. Wang and M. Gyulassy Phys. Rev. D 44 , 3501 (1991)	542
8.5	<i>Dynamics of parton cascades in highly relativistic nuclear collisions</i> K. Geiger and B. Müller Nucl. Phys. B 369 , 600 (1992)	558

8.6	<i>Kinetic theory for plasmas with non-abelian interactions</i>	
	U. Heinz	
	Phys. Rev. Lett. 51 , 351 (1983)	613
9	Parton Energy Loss	617
9.1	<i>Jets as a probe of quark-gluon plasmas</i>	
	D. A. Appel	
	Phys. Rev. D 33 , 717 (1986)	620
9.2	<i>Jets in expanding quark-gluon plasmas</i>	
	J.-P. Blaizot and L. D. McLerran	
	Phys. Rev. D 34 , 2739 (1986).	626
9.3	<i>Gluon shadowing and jet quenching in A+A collisions at $\sqrt{s} = 200A$ GeV</i>	
	X.-N. Wang and M. Gyulassy	
	Phys. Rev. Lett. 68 , 1480 (1992)	633
10	Density Interferometry	637
10.1	<i>Influence of Bose-Einstein statistics on the antiproton-proton annihilation process</i>	
	G. Goldhaber, S. Goldhaber, W. Lee and A. Pais	
	Phys. Rev. 120 , 300 (1960)	641
10.2	<i>Like particle correlations as a tool to study the multiple production mechanism</i>	
	G. I. Kopylov	
	Phys. Lett. B 50 , 472 (1974)	654
10.3	<i>Pion interferometry of nuclear collisions. I. Theory</i>	
	M. Gyulassy, S. K. Kauffmann and L. W. Wilson	
	Phys. Rev. C 20 , 2267 (1979)	657
10.4	<i>Proton pictures of high-energy nuclear collisions</i>	
	S. E. Koonin	
	Phys. Lett. B 70 , 43 (1977)	683
10.5	<i>Pion interferometry for exploding sources</i>	
	S. Pratt	
	Phys. Rev. Lett. 53 , 1219 (1984)	688
10.6	<i>Pion interferometry of quark-gluon plasma</i>	
	S. Pratt	
	Phys. Rev. D 33 , 1314 (1986)	691
11	Disoriented Chiral Condensate	705
11.1	<i>Classical states of the chiral field and nuclear collisions at very high energy</i>	
	A. A. Anselm	
	Phys. Lett. B 217 , 169 (1989)	708
11.2	<i>Soft-pion emission in high-energy heavy-ion collisions</i>	
	J.-P. Blaizot and A. Krzywicki	
	Phys. Rev. D 46 , 246 (1992)	712

11.3	<i>Static and dynamic critical phenomena at a second order QCD phase transition</i>	
	K. Rajagopal and F. Wilczek	
	Nucl. Phys. B 399 , 395 (1993)	718
12	Phase Transition Dynamics and Cosmology	749
12.1	<i>Cosmic separation of phases</i>	
	E. Witten	
	Phys. Rev. D 30 , 272 (1984)	752
12.2	<i>Big bang nucleosynthesis and the quark-hadron transition</i>	
	H. Kurki-Suonio, R. A. Matzner, K. A. Olive and D. N. Schramm	
	Astrophys. J. 353 , 406 (1990)	766
12.3	<i>Bubble growth and droplet decay in the quark-hadron phase transition in the early Universe</i>	
	K. Kajantie and H. Kurki-Suonio	
	Phys. Rev. D 34 , 1719 (1986)	771
12.4	<i>Dynamics of the QCD phase transition</i>	
	L. P. Csernai and J. I. Kapusta	
	Phys. Rev. Lett. 69 , 737 (1992)	791
13	Color Superconductivity	795
13.1	<i>Superconducting quark matter</i>	
	B. C. Barrois	
	Nucl. Phys. B 129 , 390 (1977)	798
13.2	<i>Superconductivity in quark matter</i>	
	D. Bailin and A. Love	
	Nucl. Phys. B 205 , 119 (1982)	805
	Author Index	817