

Contents

1	Introduction	1
1.1	Quantum Chromodynamics	2
1.2	QCD Phase Diagram and Quark-Gluon Plasma	4
1.3	Outline	6
	References	7
2	High-Energy Heavy Ion Collisions	9
2.1	Overview	9
2.1.1	Past Achievements	9
2.1.2	Current Status and Future Prospects	11
2.2	Geometrical Setup	12
2.3	Experimental Observables	14
2.3.1	Hadronic Particle Spectra	14
2.3.2	Jets and Quarkonia	16
2.3.3	Electroweak Probes	17
2.4	Theoretical Modeling	19
2.4.1	Color Glass Condensate	19
2.4.2	Early Thermalization	21
2.4.3	Hydrodynamic Stage	21
2.4.4	Freeze-Out and Hadronic Transport	23
	References	24
3	Relativistic Dissipative Hydrodynamics with Conserved Charges	31
3.1	Relativistic Ideal Hydrodynamics	32
3.2	Relativistic Dissipative Hydrodynamics	33
3.2.1	Local Rest Frame	34
3.3	Derivation of Causal Dissipative Hydrodynamic Equations	35
3.3.1	First-Order Theory	36
3.3.2	Second-Order Theory	39
3.3.3	Onsager Reciprocal Relations	50
3.3.4	Energy and Particle Frames	52

3.3.5	Ambiguities in Phenomenological Approaches	53
3.3.6	Single-Component Systems Without Chemical Interactions	55
3.3.7	Correspondences with Other Formalisms	56
3.4	Summary	61
	References	62
4	Viscous Hydrodynamic Model and the Color Glass Condensate. . .	65
4.1	Second-Order Viscous Hydrodynamics for Longitudinal Expansion.	66
4.2	The Model	67
4.2.1	Equation of State and Transport Coefficients	67
4.2.2	Initial Conditions	68
4.3	Results	69
4.3.1	Rapidity Distributions at RHIC and LHC.	69
4.3.2	Non-boost Invariant Flow	71
4.3.3	Time Evolution of Rapidity Distribution and Flow	72
4.4	Summary	73
	References	74
5	Dissipative Hydrodynamic Model and Baryon Stopping	77
5.1	Finite-Density Relativistic Hydrodynamics with Dissipation	78
5.2	The Model	81
5.2.1	Equation of State and Transport Coefficients at Finite Baryon Density	81
5.2.2	Initial Conditions	83
5.2.3	Freeze-Out	84
5.3	Results	85
5.3.1	Net Baryon Distributions at RHIC	85
5.3.2	Effects of Cross Terms	87
5.3.3	Net Baryon Distributions at LHC	88
5.4	Summary	89
	References	91
6	Summary and Conclusion.	95
	Appendix A: Viscous Corrections at Freeze-Out.	99
	Appendix B: Thermodynamics for Relativistic Systems.	111
	Appendix C: Relativistic Kinetic Theory	115
	Appendix D: Thermodynamic Stability Conditions	119

Appendix E: Second Order Distortion of Distribution.	121
Appendix F: Relaxation of Second Order Theory	123
Appendix G: Transport Coefficients at the Linear Order	125

Relativistic Dissipative Hydrodynamic Description of the
Quark-Gluon Plasma

Monnai, A.

2014, XXI, 127 p. 29 illus., 28 illus. in color., Hardcover

ISBN: 978-4-431-54797-6