1. Record Nr. UNISA996466729403316

Autore	Shuryak E. V.
Titolo	Nonperturbative topological phenomena in QCD and related theories / / Edward Shuryak
Pubbl/distr/stampa	Cham, Switzerland : , : Springer, , [2021] ©2021
ISBN	3-030-62990-2
Descrizione fisica	1 online resource (529 pages)
Collana	Lecture Notes in Physics ; ; 977
Disciplina	539.7548
Soggetti	Quantum chromodynamics Gauge fields (Physics) Quantum field theory
Lingua di pubblicazione	Inglese
Formato	Materiale a stampa
Livello bibliografico	Monografia
Nota di contenuto	Intro -- Preface -- Acknowledgments -- Contents -- Notations and Units -- Some Abbreviations Used -- Units -- Space-Time and Other Indices, Standard Gamma Matrices -- Angular Momentum in Four Dimensions and t'Hooft Symbol -- About the Author -- 1 Introduction -- 1.1 What Are the ``Nonperturbative Topological Phenomena''? -- 1.2 Brief History of Non-Abelian Gauge Theories and Quantum Chromodynamics -- 1.3 Introduction to Chiral Symmetries and Their Breaking -- 1.3.1 Spontaneous Breaking of the SU(Nf)A Symmetry -- 1.3.2 The Fate of U(1)A Symmetry -- 1.4 Introduction to Color Confinement -- 1.4.1 Polyakov Lines -- 1.4.2 Wilson Lines and Vortices -- 1.4.3 Hadronic Matter at T&lt -- Tc and the Hagedorn Phenomenon -- 1.5 Particle-Monopoles, Including the Real-Time (Minkowskian) Applications -- 1.6 Instantons and Its Constituents, the Instanton-Dyons -- 1.7 Interrelation of Various Topology Manifestations and the Generalized Phase Diagrams -- 1.8 Which Quantum Field Theories Will We Discuss? -- References -- 2 Monopoles -- 2.1 Magnetic Monopoles in Electrodynamics -- 2.2 The Non-Abelian Gauge Fields and t' Hooft-Polyakov Monopole -- 2.3 Polyakov's Confinement in Three Dimensions -- 2.4 Electric-Magnetic Duality -- 2.5 Lattice Monopoles in QCD-like Theories -- 2.6 Brief Summary -- References -- 3 Monopole Ensembles -- 3.1 Classical Charge-

Monopole Dynamics -- 3.2 Monopole Motion in the Field of Several Charges -- 3.3 Strongly Coupled QGP as a ``Dual'' Plasma with Monopoles -- 3.4 Jet Quenching Due to Jet-Monopole Scattering -- 3.5 Quantum-Mechanical Charge-Monopole Scattering Problem -- 3.6 Quark and Gluon Scattering on Monopoles and Viscosity of QGP -- 3.7 Transport Coefficients from Binary Quantum Scattering -- 3.8 Monopoles and the Flux Tubes -- 3.8.1 Flux Tubes on the Lattice, at Zero T, and Near Tc.
3.8.2 Does the Tc Indeed Represent the Monopole Condensation Temperature? -- 3.8.3 Constructing the Flux Tubes in the ``Normal'' Phase -- 3.9 Lattice Studies of the Bose-Einstein Condensation of Monopoles at the Deconfinement Transition -- 3.10 Quantum Coulomb Gases Studied by Path Integral Monte Carlo (PIMC) -- 3.11 Brief Summary -- References -- 4 Fermions Bound to Monopoles -- 4.1 Fermionic Zero Modes -- 4.2 Chiral Symmetry Breaking by Monopoles -- 4.3 More on Fermions Bound to Monopoles, in the SUSY World and Perhaps Beyond -- 4.4 Brief Summary -- References -- 5 Semiclassical Theory Based on Euclidean Path Integral -- 5.1 Euclidean Path Integrals and Thermal Density Matrix -- 5.1.1 Generalities -- 5.1.2 The Harmonic Oscillator -- 5.2 Euclidean Minimal Action (Classical) Paths: Fluctons -- 5.3 Quantum/Thermal Fluctuations in One Loop -- 5.4 Two and More Loops -- 5.5 Path Integrals and the Tunneling -- 5.6 The Zero Modes and the Dilute Instanton Gas -- 5.7 Quantum Fluctuations Around the Instanton Path -- 5.8 Transseries and Resurgence -- 5.9 Complexification and Lefschetz Thimbles -- 5.9.1 Elementary Examples Explaining the Phenomenon -- 5.9.2 Quasi-Exactly Solvable Models and the Necessity of Complex Saddles -- 5.10 Brief Summary -- References -- 6 Gauge Field Topology and Instantons -- 6.1 Chern-Simons Number and Topologically Nontrivial Gauges -- 6.2 Tunneling in Gauge Theories and the BPST Instanton -- 6.2.1 The Theta-Vacua -- 6.2.2 The One-Loop Correction to the Instanton: The Bosonic Determinant -- 6.2.3 Propagators in the Instanton Background -- 6.2.4 The Exact NSVZ Beta Function for Supersymmetric Theories -- 6.2.5 Instanton-Induced Contribution to the Renormalized Charge -- 6.3 Single Instanton Effects -- 6.3.1 Quarkonium Potential and Scattering Amplitudes -- 6.4 Fermionic Transitions During Changes of Gauge Topology.
6.4.1 The Fermionic Zero Mode of the Instanton -- 6.4.2 Electroweak Instantons Violate Baryon and Lepton Numbers -- 6.4.3 Instanton-Induced ('t Hooft) Effective Lagrangian -- 6.4.4 Instanton-Induced Quark Anomalous Chromomagnetic Moment -- 6.4.5 Instanton-Induced Diquark-Quark Configurations in the Nucleon -- 6.4.6 Instanton-Induced Decays of c and Scalar/Pseudoscalar Glueballs -- 6.4.7 Instanton-Induced Spin Polarization in Heavy Ion Collisions -- 6.5 Brief Summary -- References -- 7 Topology on the Lattice -- 7.1 Global Topology: The Topological Susceptibility and the Interaction Measure -- 7.2 ``Lattice Cooling'' and Instantons -- 7.3 A ``Constrained Cooling'': Preserving the Polyakov Line Value -- 7.4 Brief Summary -- References -- 8 Instanton Ensembles -- 8.1 Qualitative Introduction to the Instanton Ensembles -- 8.2 The Dilute Gas of Individual Instantons -- 8.3 The ``Instanton Liquid Model'' (ILM) -- 8.4 Statistical Mechanics of the Instanton Ensembles -- 8.4.1 Instanton Ensemble in the Mean Field Approximation (MFA) -- 8.4.2 Diquarks and Color Superconductivity -- 8.4.3 Instantons for Larger Number of Colors -- 8.5 Brief Summary -- References -- 9 QCD Correlation Functions and Topology -- 9.1 Generalities -- 9.1.1 Definitions and an Overall Picture -- 9.1.2 Small Distances: Perturbative Normalization of the Correlators -- 9.1.3 Dispersion Relations and Sum Rules -- 9.1.4

Flavor and Chirality Flow: Combinations of Correlators -- 9.1.5 General Inequalities Between the One-Quark-Loop Correlators -- 9.2 Vector and Axial Correlators -- 9.3 The Pseudoscalar Correlators -- 9.4 The First Order in the 't Hooft Effective Vertex -- 9.5 Correlators in the Instanton Ensemble -- 9.5.1 Mesonic Correlators -- 9.5.2 Baryonic Correlation Functions -- 9.6 Comparison to Correlators on the Lattice -- 9.7 Gluonic Correlation Functions -- 9.8 Wave Functions.
9.9 Brief Summary -- References -- 10 Light-Front Wave Functions, Exclusive Processes and Instanton-Induced Quark Interactions -- 10.1 Quark Models of Hadrons -- 10.2 Light-Front Observables -- 10.3 Quark Models on the Light Front: Mesons in the q Sector -- 10.4 Quark Models on the Light Front: Baryons as qqq States -- 10.5 Quark Models on the Light Front: Pentaquarks and the Five-Quark Sector of Baryons -- 10.6 Hard and Semihard Exclusive Processes -- 10.6.1 Vector Form Factors of the Pseudoscalar Mesons -- 10.6.2 Scalar Form Factors of the Pseudoscalar Mesons -- 10.6.3 Form Factors of Transversely Polarized Vector Mesons -- 10.7 Brief Summary -- References -- 11 The Topological Landscape and the Sphaleron Path -- 11.1 The Sphalerons -- 11.2 Instanton-Antiinstanton Interaction and the ``Streamline'' Set of Configurations -- 11.3 From the Instanton-Antiinstanton Configurations to the Sphaleron Path -- 11.4 The Sphaleron Path from a Constrained Minimization -- 11.5 Sphaleron Explosions -- 11.6 Chiral Anomaly and Sphaleron Explosions -- 11.7 Brief Summary -- References -- 12 Sphaleron Transitions in Big and Little Bangs -- 12.1 Electroweak Sphalerons and Primordial Baryogenesis -- 12.1.1 Introduction to Cosmological Baryogenesis -- 12.1.2 Electroweak Phase Transition -- 12.1.3 Sphaleron Size Distribution -- 12.1.4 The Hybrid (Cold) Cosmological Model and Sphalerons -- 12.1.5 Effective Lagrangian for CP Violation -- 12.1.6 The CP Violation in the Background of Exploding Sphalerons -- 12.1.7 Electroweak Sphaleron Explosion: Other Potential Observables -- 12.2 QCD Sphalerons -- 12.2.1 Sphaleron Transitions at the Initial Stage of Heavy Ion Collisions -- 12.2.2 Sphalerons from Instant Perturbations -- 12.2.3 QCD Sphalerons in Experiments -- 12.2.4 Diffractive Production of Sphalerons -- 12.3 Brief Summary -- References -- 13 Chiral Matter.
13.1 Examples of Chiral Matter -- 13.2 Electrodynamics in a CP-Violating Matter -- 13.3 Chiral Magnetic Effect (CME) and the Chiral Anomaly -- 13.4 Chiral Vortical Effect -- 13.5 The Chiral Waves -- 13.6 Brief Summary -- References -- 14 Instanton-Dyons -- 14.1 The Polyakov Line and Confinement -- 14.1.1 Generalities -- 14.1.2 The Free Energy of the Static Quark on the Lattice -- 14.1.3 The Color Phases -- 14.2 Semiclassical Instanton-Dyons -- 14.2.1 The Instanton-Dyon Field Configuration -- 14.3 Instanton-Dyon Interactions -- 14.3.1 Large-Distance Coulomb -- 14.3.2 The Dyon-Antidyon Classical Interaction -- 14.3.2.1 Combing the Hedgehogs -- 14.3.2.2 Following the Gradient Flow Down the Streamline -- 14.4 The Partition Function in One Loop -- 14.4.1 Electric Screening -- 14.4.2 The One-Loop Measure, Perturbative Coulomb Corrections and the ``Core'' -- 14.5 Fermionic Zero Modes -- 14.5.1 How Quark Zero Modes Are Shared Between the Dyons -- 14.5.2 The Zero Mode for the Fundamental Fermion -- 14.5.2.1 Elements of Quark ``Hopping Matrix'' -- 14.5.3 Fermionic Zero Mode for a Set of Self-Dual Dyons -- 14.6 Instanton-Dyons on the Lattice Are Seen via Their Fermionic Zero Modes -- 14.7 Brief Summary -- References -- 15 Instanton-Dyon Ensembles -- 15.1 Deformed QCD and Dilute Ensembles with Confinement -- 15.1.1 Perturbative Holonomy Potential and Deformed QCD -- 15.1.2 The Instanton-Dyons in Na=1 QCD(or N=1 SYM) -- 15.1.3 QCD(adj) with

Na&gt -- 1 at Very Small Circle: Dilute Molecular (or ``bion'') Ensembles -- 15.1.4 QCD(adj) with Na=2 and Periodic Compactification on the Lattice -- 15.2 Dense Dyon Plasma in the Mean Field Approximation -- 15.3 Statistical Simulations of the Instanton-Dyon Ensembles -- 15.3.1 Holonomy Potential and Deconfinement in Pure Gauge Theory -- 15.3.2 Instanton-Dyon Ensemble and Chiral Symmetry Breaking.
15.4 QCD with Flavor-Dependent Quark Periodicity Phases.