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C. S. Unnikrishnan

New Relativity in the Gravitational Universe

The Theory of Cosmic Relativity and Its
Experimental Evidence

 Springer

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*To my Teachers in Kalady and Beyond
Among them are my Parents*

Preface

The fundamental theories of physics were all conceived and completed well before we acquired any significant knowledge about the extent and contents of our Universe. By 1930, we had a seemingly mature structure of theoretical physics, with the Special Theory of Relativity, the General Theory Relativity, Quantum Mechanics, and the Quantum Field Theory, as well as the complete descriptions of the interactions of electromagnetism (Maxwell electrodynamics) and gravity (Einstein's General Relativity). But, the realization about the matter content and the vast size of the Universe dawned only after 1930, when observational cosmology expanded its horizons with the aid of large telescope installations. Prior to that, the physical space was considered as largely empty. As a consequence, our fundamental theories were structured assuming explicitly that the space in which physical phenomena occur was essentially empty, devoid of matter and its gravity. In particular, the theories of dynamics and relativity, which are the basis of all of physics, have the empty space as their arena. However, factually, all physical theories are written down and tested in this 'once-given' Universe, in the unavoidable gravitational presence of its vast amount of matter. The current theories are operative in this matter-filled Universe, but their theoretical structure does not include its enormous gravity and physical consequences. *The fundamental thesis developed and proved in this monograph, Cosmic Relativity, shows that it is indeed the gravity of the matter-energy in the Universe that determines all of dynamics and relativistic effects.* The empirical proof and overwhelming support of the gravitational paradigm are evident in several crucial experiments, spanning several fields.

Matter and energy constitute the charge of gravity; *our Universe is gravitationally charged* and it affects the motion of every other gravitational charge—any form of matter with mass or energy. From this natural and simple premise, I develop all features of dynamics and relativity as the gravitational consequences of the factual matter distribution in the Universe, without further postulates or assumptions. The fundamental results that follow include the Principle of Relativity, the laws of dynamics (Newton's law of motion), the Equivalence Principle and the Universality of Free Fall, the solution to the enigma of inertia, the origin of inertial forces, the relativistic modification of spatial and temporal intervals, etc. The whole structure

of fundamental physics is held together by the gravity of the matter-filled Universe, and it has no physical support in an empty Universe. The *matter-filled Universe constitutes an absolute reference frame* for motion and it also provides a universal time, physically represented, for example, in the slowly changing temperature of the cosmic microwave background radiation. The maximal velocity of motion as well as the propagation of light are determined by cosmic gravity, in the absolute frame of the Universe.

Cosmic Relativity is a grand generalization of the Machian idea on the relation between space and matter. If there is one large gap in fundamental physics today, it is our continuing ignorance about the origin of inertia and Newtonian pseudo-forces, or forces without sources. Einstein's General Theory of Relativity inherited the enigma, but converted it to its founding postulate. The theory of Cosmic Relativity solves this problem decisively, synthesizing Galileo, Newton, Einstein, and Mach into one coherent gravitational framework. With a necessary and significant modification of Einstein's equation of general relativity to a 'centenary equation', I have achieved a consistent completion of Einstein's theory of gravity. Cosmic Relativity brings back logical integrity and consistency into the theory of relativity and provides a complete picture of the relativistic physical world, adequately satisfying to both physicists and philosophers of physics. One will see in detail how completely, and naturally, the new paradigm solves and clarifies several fundamental issues that have been debated and researched for centuries.

As one progresses through the book, getting familiar with the concepts and quantitative estimates, one will find a thrilling turn to applications in satellite-based navigation, global time transfer, propagation of light, general dynamics, tropical cyclones, spectroscopy, electron transport in helical molecules, Pauli exclusion and the spin-statistics connection, and even a comprehensive and successful *unified theory of the integer and fractional quantum Hall effects*, all tied together through the universal nature of cosmic gravity.

The crucial predictions of Cosmic Relativity on the behaviour of precision clocks in motion, on the propagation of light, on the unipolar induction in electro-dynamics, etc. are all unambiguously confirmed in experiments and empirical data. These predictions are closely linked to the role of the matter-filled gravitational Universe with its absolute cosmological time as the factual absolute reference frame for motion. The prediction that the relative velocity of light is Galilean, relative to inertial observers, and not an invariant constant, was verified in an experiment that devised a novel method for the measurement of the *genuine one-way relative speed of light*. Surprising as this may seem to most physicists, it is a fact that the one-way relative speed of light has never been experimentally scrutinized. All known experiments either compare the two-way speed of light, in which the first-order effects cancel out, or depend on spatially separated clocks to monitor the propagation, in which case there are *unverifiable* theoretical assumptions that introduce logical circularity. In any case, several crucial experiments spanning two centuries are discussed and analysed rigorously in this book to affirm the empirical basis of Cosmic Relativity.

A central result that anchors Cosmic Relativity on a strong empirical foundation is the *Galilean nature of the genuine one-way propagation of light*. The results

from my experiments and the transparent evidence from Global Navigational Satellite Systems like the GPS establish the Galilean nature of light. Considering the singular importance of this experimentally proven fact about the true nature of light, respecting the existence of the gravitational absolute frame of the Universe, I have taken pedagogic care to explain and illustrate the refutation of Einstein's hypothesis of the invariant relative velocity of light.

The cosmic gravitational paradigm of relativity and dynamics is both universal and encompassing, covering a wide basis, without the distinction between classical physics and quantum physics. Several fundamental results in spin physics amply illustrate this unity. The gravitational basis determines also the absolute notions of simultaneity, causality, and locality. Within the robust framework of Cosmic Relativity, there is no place for irrational nonlocal physical influences. This is shown in the clearest manner in a discussion on some deep aspects of quantum physics.

Historical accuracy is an important factor when we deal with the development of physics over an extended duration. I have paid particular attention to depend on primary resources in those situations where significant incidents of importance to physics are discussed.

The writing of this monograph to explain this discovery and its far-reaching consequences, finally putting together cosmology and physics in a credible consistent interconnected paradigm, was not a difficult task, because of the driving charm of the theory and the rock-solid empirical support it derived from experimental results spanning more than two centuries. However, it still required the kind support from several friends, some believing and some dismissive. In return, what I intend to present is akin to a well-harmonized symphony, with an ever-lasting significance and encompassing reach.

The necessity for a paradigm change, evident and explicit in this book, is analogous to the need for a change from a geocentric astronomy to a heliocentric astronomy, and as important, both in terms of the call to recognize the physical truth based on observational data and in terms of a conceptual leap. It is understandable that it might take some time before this cosmic gravitational paradigm for relativity and dynamics is universally accepted, but an exceptionally robust and consistent basis built on a wealth of experimental data is the unwavering strength of Cosmic Relativity.

Mumbai, India/Paris, France/St. Agrève, France
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C. S. Unnikrishnan

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The contents of this book permeate a major portion of fundamental physics. Though the entire paradigm is based on the simple realization that our vast Universe contains an enormous amount of matter and that the cosmic matter has gravity, systematically developing the detailed theory and garnering the strong empirical support required several years of sustained work.

I have talked to a large number of physicists and philosophers of science about these topics. Here, I want to remember 'Rad', Prof. V. Radhakrishnan, the enthusiastic seeker of an ever more understandable insight into the physical world.

There are a small number of my friends in the world of arts and cinema, who were fascinated by the depths of the Universe. Conversations with Prakash Moorthy and Joshy Joseph about cosmos and physics may even transform to fables.

Two streams of quiet influence from my parents were decisive, the commitment to logical integrity that was stressed by my father C. K. Sivarama Pillai and the reliance on the rational and empirical from my mother G. Kalyanikutty Amma.

My sister Karthika and my brother Hari have been unconditionally supportive, enabling my liberal choice of enquiry.

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Contents

Part I First Principles and Their Empirical Core

1	The Paradigm of Cosmic Relativity and Its Evidence	3
1.1	The First Principles	4
1.2	What is the Theory of Cosmic Relativity?	6
1.3	Why is Cosmic Relativity Necessary?	8
1.4	The Gravity of Our Universe	10
1.5	The Cosmic Gravitational Metric and the Potentials	12
1.6	A Phenomenological Assertion	16
1.7	Summary of the Primary Results of Cosmic Relativity	17
1.8	The Universal Clock of Cosmic Relativity	25
1.9	Cosmic Relativity and Its Experimental Tests	25
1.10	Cosmic Relativity and General Relativity	26
1.11	Summary	28
	References	28
2	Space and Time of Our Fundamental Theories	31
2.1	Newton's Space and Time	32
2.2	Ernst Mach's Critique and Insight	35
2.3	Space and Time in 19th Century Physics	38
2.4	Space and Time in Einstein's Relativity	42
2.5	Speculative Space and Time	48
2.6	Space and Time in the Factual Universe	50
2.7	Philosopher's Space and Time	51
2.8	Space, Time, and the Principle of Relativity	52
2.9	Summary	54
	References	55
3	Electrodynamics, Light and Relativity	57
3.1	Experiments to Determine the Speed of Light	59
3.1.1	Roemer's Method	59
3.1.2	Michelson's Measurements	61

- 3.2 The Ether: The Medium for the Propagation of the EM Waves 62
- 3.3 Stellar Aberration 63
- 3.4 The Speed of Light in Moving Media—Fresnel Drag 66
- 3.5 The Doppler Effect 67
- 3.6 Experiments Designed to Detect the Stationary Ether 71
- 3.7 The Trouton-Noble Experiment 79
- 3.8 The Birth of a New Theory of Relativity 81
- 3.9 Experiments on the Unipolar Induction 84
- 3.10 The Principle of Relativity and the Theories of Relativity 86
- 3.11 Summary 87
- References 88
- 4 The Special Theory of Relativity and its Empirical Foundations ... 91**
 - 4.1 Einstein’s Motivations for a Theory of Relativity 92
 - 4.2 The Lorentz Transformations 94
 - 4.3 The Physical Results of the Special Theory of Relativity 96
 - 4.3.1 The Doppler Effect in the STR 99
 - 4.3.2 The Unipolar Phenomena and the STR 101
 - 4.3.3 Einstein’s STR and Thermodynamics 103
 - 4.3.4 The Empirical Status of the Light Hypothesis 104
 - 4.4 The General Nature of Experimenters’ Interpretations 107
 - 4.5 The Special Theory of Relativity and Accelerated Frames 108
 - 4.6 Summary 109
 - References 111
- 5 Simultaneity and the Synchronisation of Time 113**
 - 5.1 Introduction 113
 - 5.2 Galilean Simultaneity 115
 - 5.3 Einstein’s Discussion of Simultaneity in the STR 119
 - 5.4 Einstein’s Fallacy on the Relativity of Simultaneity 121
 - 5.5 H. Bergson’s Critique of Einstein’s Relativity of Simultaneity 124
 - 5.6 The Synchronisation of Time 126
 - 5.7 Summary 130
 - References 132
- 6 The Equivalence Principles 133**
 - 6.1 The Universality of Free Fall 134
 - 6.2 The Equivalence of Inertia and Mass—The Weak Equivalence Principle 135
 - 6.3 Galileo’s Thought Experiment ‘Proof’ of the UFF 137
 - 6.4 Einstein’s Equivalence Principle 139
 - 6.5 What are Inertial Frames? 140
 - 6.6 A Stronger Equivalence Principle 142

- 6.7 A Brief Account of Experimental Tests 142
 - 6.7.1 Space Tests of the UFF and the WEP 145
 - 6.7.2 Laser Ranging to the Moon and the WEP 146
 - 6.7.3 Tests of the SEP 147
 - 6.7.4 The Active and the Passive Gravitational Masses 148
- 6.8 The First Applications of the EEP: Prelude to the GTR 149
- 6.9 On the Gravitational Origin of the UFF, WEP, and EEP 151
- 6.10 Diving Deeper: Equivalent or Identical? 152
- 6.11 The Equivalence Principle and the Quantum Theory 152
- 6.12 Summary 154
- References 154
- 7 Einstein’s General Theory of Relativity 157**
 - 7.1 The Genesis and Its Salient Points 158
 - 7.2 General Theory of Relativity (GTR) as a Theory of Gravity ... 159
 - 7.3 The GTR from an Action Principle 163
 - 7.4 The GTR as the Geometric Theory of Gravity 164
 - 7.5 Einstein’s ‘Hole Argument’ 169
 - 7.5.1 Revisiting the Hole Argument 171
 - 7.6 The GTR and Its Galilean Metrics 172
 - 7.7 Gravitation and Electrodynamics: A Comparison 175
 - 7.8 The Achievements of the GTR 176
 - 7.9 The GTR and Gravitomagnetism 177
 - 7.10 The GTR and Gravitational Waves 178
 - 7.11 The Experimental and Observational Tests of the GTR 181
 - 7.12 The GTR and Mach’s Principle 182
 - 7.13 The GTR and Cosmology 184
 - 7.14 The Unsolved Riddle of Inertia: The Incompleteness
of the GTR 186
 - 7.15 What Lies Beyond the GTR? 187
 - 7.16 Summary 188
 - References 190
- 8 Our Universe 193**
 - 8.1 Our Physical Universe Before 1930 193
 - 8.2 The Universe as Observed 196
 - 8.2.1 The Large Scale Distribution of Matter 196
 - 8.2.2 The Expansion of the Universe 197
 - 8.2.3 The Velocity-Distance Relation From
Observations 199
 - 8.3 Einstein’s Cosmological Constant 201
 - 8.3.1 The Cosmological Principle and the Expansion 202
 - 8.3.2 The Concept of a ‘Critical Density’ 206
 - 8.3.3 The Measurements of the Deceleration
Parameter 206

8.4 The Reason Behind the Expansion of the Universe 207

8.5 The Cosmic Microwave Background Radiation 210

8.6 The Large Scale Distribution of Matter 210

 8.6.1 The Dark Matter 211

 8.6.2 The Curvature of the Universe 213

 8.6.3 The Dark Energy 214

 8.6.4 The Dark Energy and the Quantum Vacuum 215

 8.6.5 An Interpretation of the Critical Density 216

8.7 The Interpretation of the Expansion of the Universe 217

8.8 The ‘Absolute’ Features of Our Universe 219

8.9 Summary 220

References 221

9 Time Dilation and the Twin-Paradox 223

 9.1 Cautionary Introduction 223

 9.2 Time Dilation in Lorentz-Poincaré Relativity 225

 9.3 Time Dilation in Einstein’s STR 225

 9.4 Langevin’s Twin-Paradox 226

 9.5 The Real Twin-Paradox in the STR 229

 9.6 The Predictions for Motional Time Dilation 230

 9.7 Experiments on Motional Time Dilation 235

 9.7.1 Time Dilation of Unstable Particles 235

 9.7.2 Experiments on Atomic Systems 237

 9.7.3 Experiments on the Comparison of Atomic
 Clocks 238

 9.8 The Hafele-Keating Experiment 239

 9.9 Popular ‘Resolutions’ of the Twin-Paradox 243

 9.9.1 Langevin’s Solution in the Acceleration 244

 9.9.2 Resolution Sans Acceleration 244

 9.10 Einstein’s Gravitational Resolution of the Paradox 247

 9.11 Summary 250

References 252

Part II The New Physical World of Cosmic Relativity

**10 Cosmic Relativity—The Theory and Its Primary Fundamental
Results 255**

 10.1 The Universe that Determines the Physics of Relativity 256

 10.2 A Hypothetical Scenario in Electrodynamics 257

 10.3 A Theory of Relativity and Dynamics Without Postulates 260

 10.4 Physics in the Gravitationally Charged Universe 261

 10.5 The Gravitational Foundation of Cosmic Relativity 262

 10.6 The Primary Results in Cosmic Relativity 264

 10.6.1 The Modification of Duration and Distance 264

 10.6.2 Interpretation in Terms of the Gravitational
 Potentials 266

10.6.3	The Time Dilation of Physical Clocks	267
10.6.4	Cosmic Relativity and the Principle of Relativity	268
10.6.5	The Propagation of Light	269
10.7	Cosmic Relativity and Dynamics	270
10.7.1	Laws of Dynamics: Newton’s Law of Motion	270
10.8	Cosmic Relativity and the Origin of Inertia	272
10.8.1	Cosmic Relativity and the Inertial Forces	273
10.8.2	The Centrifugal Force	273
10.8.3	The Coriolis Force	274
10.9	The Twist in Tropical Cyclones	277
10.10	Cosmic Relativity and the Principles of Equivalence	278
10.10.1	Newton’s Law and the WEP	280
10.10.2	‘Weightlessness’ in Free Fall and the EEP	280
10.10.3	Two Kinds of Gravitational Forces and the Geodesic Principle	283
10.10.4	The Equivalence Principle and Universality of Free Fall	284
10.11	The EEP and the Time Dilation of Clocks in an Accelerated Frame	285
10.12	Clocks and Time Dilation in Cosmic Relativity	286
10.12.1	Time Dilation in the STR	287
10.12.2	Motional Time Dilation in Cosmic Relativity	287
10.12.3	Synchronisation of Clocks in Cosmic Relativity	289
10.12.4	The Addition of Velocities in Cosmic Relativity	290
10.13	Cosmic Relativity and the Electrodynamics of Moving Media	291
10.13.1	The Doppler Shift	292
10.13.2	The Optical Aberration and the Fresnel Drag	293
10.14	The Unipolar Induction	294
10.15	Cosmic Relativity and the Spin Angular Momentum	301
10.16	Summary	302
	References	305
11	The Crucial Experimental Tests of Cosmic Relativity	307
11.1	The Nature of Propagation of Light	309
11.1.1	Past Experiments on the One-Way Propagation of Light	311
11.2	True Relative Velocity of Light—The Prediction	314
11.3	The True Relative Velocity of Light—A Prelude to a Test	315
11.3.1	The Propagation of Light in a Moving Frame	316
11.3.2	A Simple Demonstration of the Conflict Between the PoR and the Light Hypothesis	320
11.4	The Experiment on the One-Way Relative Velocity of Light	321

- 11.5 Motional Time Dilation: The Predictions 325
- 11.6 Cosmic Relativity and Clock Synchronisation 326
- 11.7 Experimental Tests of Time Dilation: Atomic Clocks 327
- 11.8 Experimental Tests of Time Dilation: GNSS and GPS 329
 - 11.8.1 Time Dilations in the GNSS Satellites 329
 - 11.8.2 The GNSS Mystery Created by the Galilean
Propagation of Light 331
- 11.9 The Absence of a Relative Time Dilation in Accelerated
Frames 334
- 11.10 The One-Way Relative Velocity of Light in Rotating
Frames 335
 - 11.10.1 An Early History of the Relevant Ideas 336
 - 11.10.2 The Experiments by G. Sagnac 337
 - 11.10.3 The Michelson-Gale Experiment 339
 - 11.10.4 The Proof of the Galilean Nature of a Rotating
Frame 340
- 11.11 Lorentz’s Relativity, Einstein’s Relativity and Cosmic
Relativity 341
- 11.12 Summary 343
- References 345
- 12 Cosmic Relativity and Quantum Dynamics 347**
 - 12.1 Cosmic Relativity and Quantum Dynamics 347
 - 12.2 The True Nature of the Schrödinger Equation 349
 - 12.3 The ‘Law of Motion’ in the Microscopic Physical World 356
 - 12.4 The Quantum Interference of Single Particles 359
 - 12.5 The Continuity Equation and the Schrödinger Equation 360
 - 12.6 L. de Broglie’s Non-existent Matter-Waves 362
 - 12.7 The Minuteness of the Quantum Zero-Point Energy 364
 - 12.8 The Dirac Equation and Relativity 364
 - 12.9 Cosmic Relativity and Quantum Mechanics 368
 - 12.10 Summary 369
 - References 370
- 13 Cosmic Gravity and the Quantum Spin 373**
 - 13.1 The Physical Meaning of Spin 376
 - 13.2 Spin as the Fundamental Gravitomagnetic Moment 377
 - 13.3 Cosmic Gravitational Effects on Spin 378
 - 13.3.1 Emphasising the ‘Spin-Phase Puzzle’ 380
 - 13.3.2 The Thomas Precession in Atoms
and the Spectral Fine Structure 382
 - 13.3.3 Geometric Phases and Cosmic Gravity 384
 - 13.4 Spin Transport in Chiral Molecules and Spintronics 388

- 13.5 Bosons, Fermions, and the Proof of the Spin-Statistics Connection 392
 - 13.5.1 The Dawn of the Spin-Statistics Connection 393
 - 13.5.2 Pauli’s Proof and His Inconclusive Tryst with the SSC 394
 - 13.5.3 Physical Proofs of the Spin-Statistics Connection? 397
- 13.6 The Proof of the Spin-Statistics Connection 398
- 13.7 Summary 402
- References 404
- 14 The Quantum Hall Effects: Gravity in Condensed Matter 407**
 - 14.1 The Hall Effect 408
 - 14.2 The Quantum Hall Effect 410
 - 14.3 The 2-D Dynamics of Electrons in a Magnetic Field 412
 - 14.3.1 The Theory of the IQHE Plateaux 414
 - 14.4 The Fractional Quantum Hall Effect 417
 - 14.5 The Current Theories of the FQHE 418
 - 14.6 The Need for a New Unified Theory 421
 - 14.6.1 Summary of the Reasons for a New Theory 422
 - 14.7 New Physics Input to the QHE—Cosmic Gravity 424
 - 14.7.1 The Quantum Degeneracy of the Landau Levels 424
 - 14.8 The Integrated Theory of the Quantum Hall Effects 427
 - 14.8.1 FQHE Beyond the Filling Factor $\nu = 1/3$ 431
 - 14.8.2 The 5/2-FQHE State and the Half-Integer States 432
 - 14.8.3 The Excitation Energy Gaps 433
 - 14.9 Electron-Hole Symmetry and the FQHE 434
 - 14.10 The Quantum Hall Effects in Graphene 435
 - 14.11 Charge and Thermal Transport by Edge States 437
 - 14.12 The Wavefunctions in the QHE 440
 - 14.13 Summary 441
 - References 443
- 15 Relativity and Quantum Entanglement 445**
 - 15.1 The Space-Time Context of the Problem 447
 - 15.2 Quantum Mechanics of Entanglement 449
 - 15.3 The EPR Argument of the Incompleteness of Quantum Mechanics 451
 - 15.4 Measurements of the Quantised Observables of the Microworld 455
 - 15.4.1 The Correlations in the LHVT 457
 - 15.5 The Proof of Strict Locality in Quantum Correlations 460
 - 15.6 Summary 463
 - References 466

- 16 Paradigms Lost and Found** 467
- 16.1 The Evolution of the Theories of Dynamics and Relativity 468
- 16.2 Completing the Theory of Gravity: Centenary Einstein’s
Equation 472
- 16.3 Physical Absolute Space and Absolute Time 472
- 16.4 Is the Cosmic Gravitational Paradigm the Ultimate
Foundation? 473
- 16.5 Concluding Notes 474
- References 475

- Index** 477

Acronyms

2DEG	Two-Dimensional Electron Gas
CEE	Centenary Einstein's Equation
CF	Composite Fermions
CISS	Chiral-Induced Spin Selectivity
CMBR	Cosmic Microwave Background Radiation
EEP	Einstein's Equivalence Principle
EMF	Electro-Motive Force
EPR	Einstein-Podolsky-Rosen (paper)
FLRW	Friedmann-Lemaître-Robertson-Walker (line element)
FQHE	Fractional Quantum Hall Effect
GNSS	Global Navigational Satellite Systems
GPS	Global Positioning System
GT	Galilean Transformations
GTR	General Theory of Relativity
IQHE	Integer Quantum Hall Effect
LHVT	Local Hidden Variable Theory
LL	Landau Level
LLL	Lowest Landau Level
LPTR	Lorentz-Poincaré Theory of Relativity
LT	Lorentz Transformations
MOSFET	Metal-Oxide-Semiconductor Field Effect Transistor
PoR	Principle of Relativity
QHE	Quantum Hall Effect
QM	Quantum Mechanics
SEP	Strong Equivalence Principle
SSC	Spin-Statistics Connection
STR	Special Theory of Relativity
UFF	Universality of Free Fall
WEP	Weak Equivalence Principle