

RECENT ADVANCES
in
RELATIVITY THEORY



Volume 1
Formal Interpretations

M.C. Duffy & M. Wegener
eds.

Hadronic Press
2000

RECENT ADVANCES
in
RELATIVITY THEORY

SELECTED PAPERS

*From the Biennial Conferences on
Physical Interpretations of Relativity Theory
(1988-1996)*

*The conferences were sponsored by the
British Society for the Philosophy of Science
and held at the Imperial College, London.*

Volume One: Formal Interpretations
*Edited by M.C. Duffy and M. Wegener
and published by the*

**Hadronic Press
Institute for Basic Research
35246 US 19 North 115, POBox 1577,
Palm Harbor, FL 34682, USA
ISBN 1-57485-050-4**

= // =

CONTENTS OF VOLUME ONE

-11-

FOUR QUESTIONS CONCERNING RELATIVITY

Harold Aspden, Acres High, Hadrian Way, Chilworth, SO16 7HZ, UK

-21-

STEADY STATE COSMOLOGIES AS SCIENTIFIC RESEARCH PROGRAMS

Y.V. Balashov, Dept.Philosophy, Moscow Inst. of Physics, 141700 Russia

-27-

HYPERBOLIC GEOMETRY IN SPECIAL RELATIVITY AND ITS RELATION TO THE COSMOLOGY OF MILNE

John F. Barrett, Southampton, 40 SO19 0NS, UK

-35-

ON THE CONCEPTS OF SPACE AND TIME

Marius Borneas, Dept.Physics, Politechnic University, Timisoara, Romania

-39-

THE FUNDAMENTAL RÔLE OF THE REFERENCE FRAME REVISITED

Claude Comte, Univ. Paris vii, 2 Pl. Jussieu, 75251 Paris, France

-47-

RELATIVITY AND THE "ELIMINATION" OF ABSOLUTE TIME

William Lane Craig, 1805 Danforth Drive, Marietta, GA 30062, US

-67-

THE CONCEPT OF LORENTZ INVARIANT CLOCKS

S.K. Ghosal & P. Chakraborty, Dept.Phys., N.B. University, Darjeeling, PIN 734430 India

-73-

PROPER TIME, PROPER LENGTH AND SOME COMMENTS ON THE CONCEPTS OF TIME AND DISTANCE

Roger C. Jennison, Electronic Engineering Lab., Univ. Canterbury, Kent, UK

-84-

WHAT IS THIS: A CLOCK IN RELATIVITY THEORY?

Ludwik Kostro, Dept. Logic, Methodol. & Phil. Sc., Univ. Gdansk, Poland

-91-

TIME DILATION WITHIN SPECIAL RELATIVITY

Peter Kroes, Dept. Phil., Interfak., Techn.Univ. Delft, Nederland

-107-

PROBLEMS OF TIME SCALE IN COSMOLOGY

Francis Mathe, 44 La Clairière, 78830 Bullion, France

-111-

TOWARDS A LORENTZ-INVARIANT THEORY OF COLLAPSE

Storrs McCall, Dept. Philosophy, McGill Univ., Montreal H3A 2T7, Canada

-123-

THE RECONSTRUCTION OF SPACE-TIME AS TIME-SPACE

André Mercier (†), Dept. Theor. Physics, Univ. Berne, Switzerland

-133-

ON RELATIVITY AND CAUSALITY

W. Trevor Morris, 15 Avenue Gardens, Teddington, TW11 0BH, UK

-138-

SOME ASPECTS OF MINIMALLY RELATIVISTIC NEWTONIAN GRAVITY

*K.K. Nandi, Dept.Math., S.K. Ghosal, Dept.Phys., P. Chakraborty, Dept.Phys.
Univ.N.Bengal, Darjeeling, W.Bengal, 734430 INDIA*

-140-

TENSE LOGIC AND SPECIAL RELATIVITY

Peter Øhrstrøm, Dept. Communication, Aalborg University, Danmark

-149-

LIGHT PROPAGATION IN AN EXPANDING UNIVERSE

A. Paparodopoulos, 3 Perikleous Av., Athenai, GR-15561, Hellas

-152-

THE NATURE AND IMPLICATIONS OF THE ROBERTSON-WALKER METRIC

Simon J. Prokhovnik (†), School of Math., Univ. N.S.W., Australia

-159-

INERTIA, GRAVITATION, AND THE THEORY OF RELATIVITY

David Roscoe, Dept. Applied Math., Univ. Sheffield, S10 2TN UK

-170-

ON THE MEANING OF SPACE AND TIME

Mendel Sachs, Dept. Physics, State Univ. of N.Y. at Buffalo, USA

-177-

**DIRECT UNIVERSALITY OF ISOSPECIAL RELATIVITY
FOR GENERALIZED SPACETIMES**

Ruggero M. Santilli, Institute for Basic Research, Palm Harbor, FL, USA

-195-

TRANSIENT EFFECTS IN SPECIAL RELATIVITY

Chalmers W. Sherwin (†), 17166 Pacato Way, San Diego, CAL 92128

-201-

ON THE ONE-WAY VELOCITY OF LIGHT & ITS POSSIBLE MEASURABILITY

Torgny Sjödin, Fak. d. Wetenschappen, VUB, Brussels, Belgium

-206-

THE CONVENTIONALITY OF SIMULTANEITY! AGAIN?

Lawrence Sklar, Dept. Philosophy, University of Michigan, USA

-217-

PHILOSOPHICAL ASPECTS OF THE WORLD PICTURE OF PHYSICAL SCIENCE

A.V. Soldatov, Acad. Hist. Sc. & Technol., St. Petersburg State Marine Techn. Univ, Russia

-220-

GEOMETRY OF SPACE-TIME & FINSLER SPACES

R. Tavakol, School of Math., Queen Mary College, London E1 4NS, UK

-225-

REALITY, INTUITION, AND MIND

REFLECTIONS ON THE PHILOSOPHY OF H. POINCARÉ

S.C. Tiwari, Dept. Physics, Banares Hindu Univ., Varanasi 221005, India

-232-

CLOCKS DON'T GO SLOW, RODS DON'T CONTRACT

Barrie J. Tonkinson, 18 Flaggs Meadow, Olney, Bucks, MK46 5NL, UK

-245-

INFRA-THEORIES TO THE SPECIAL THEORY OF RELATIVITY

Håkan Törnebohm, Dept. Theory of Science, Göteborgs Universitet, Sweden

-255-

IDEAS OF COSMOLOGY: A PHILOSOPHER'S SYNTHESIS

Mogens Wegener, Højmarkvej 1, 8270 Hbj., Danmark

-275-

INDEX

PREFACE

The title given to this selection, *Recent Advances in Relativity Theory*, derives from a suggestion originally made to the academic committee by one of its members, Prof. F. Selleri. Of course, this could not have been the title given to a series of conferences: one cannot decide, but only hope, that a planned series of scientific conferences will issue in theoretical advances. In retrospect, however, one may get a feeling that the hope has not been entirely in vain.

So, by adopting the proposed title instead of the original title of the conferences

Physical Interpretations of Relativity Theory

the editors wanted to hint at the fact that the present selection of papers, which covers the years 1988-1996, in their opinion offers more than mere interpretations, or re-interpretations, of an entrenched theory of modern physics, namely that of Relativity. Indeed, already the attempt to convene not only a single meeting but a whole series of meetings focussing on this topic was a strong signal that the one and only initiator and organiser of these meetings, Dr. M.C. Duffy of University of Sunderland, did not see the subject as closed nor the usual conclusions as final. It demands courage to send such a signal to the establishment, and it presupposes both a strong health, a great administrative talent and a large measure of diplomacy to realize such an attempt. I think that I speak on behalf of all participants in these meetings when I say that their success the extent of which is yet to be judged by the readers of this volume as well as the one to follow, is due almost entirely to a single person: Michael Ciaran Duffy.

The present volume, together with the one in preparation, comprises 2×30 papers of more than 600 pp. Considering this amount to be too large for a single volume it was decided to split it up into two. Realizing that it was problematic to organize all papers according to their subject-matter, an alphabetic order was chosen for each volume. Finding it awkward to let the two volumes be distinguished by an arbitrary letter, say *Q*, an attempt was made to suggest a preliminary separation of thematic priorities by distinguishing the contents of the volumes according to the kind of interpretation favoured by the papers. So we chose to settle on a very rough division of the papers according to whether they - *prima facie* - represent what might be called *formal interpretations* (vol.1) or what might be called *material interpretations* (vol.2). Proceeding thus, a certain affinity to the original title of the meetings was preserved.

In place of an explicit organization of the material - which seems almost predestined to become "one-dimensional" - it would be possible to suggest various strategies of reading. However, in order not to impose my own views upon the reader I prefer not to be too explicit. But that much should be said: It appears that the papers of Ghosal & Chakraborty, Jennison, Kostro, Kroes, Øhrstrøm, Sjödin, Sklar, Tonkinson, and Törnebohm, constitute an important group treating crucial aspects of the formal structure of relativity theory (no priority intended). The papers of Barrett, Comte, Paparodopoulos, and Prokhorovnik, place the theory of relativity firmly within a cosmological context. Advanced mathematical possibilities are investigated by Roscoe, Santilli, and Tavakol. Central metaphysical issues are discussed by Craig and Mercier. The inclusion of purely philosophical papers is justified by the sponsorship of *BSPS*.

Mogens Wegener

INTRODUCTION

This volume contains papers written by participants in the *Physical Interpretations of Relativity Theory* conferences, sponsored by the British Society for the Philosophy of Science. The meetings, which are biennial, took place in the years 1988-1996 and are still continued; they were organised from the School of Engineering and Advanced Technology, Sunderland Polytechnic, now School of Computing, Engineering & Technology, University of Sunderland. The majority of the papers selected for inclusion in this volume were read at Imperial College, London, by their authors; but in some instances the authors were not able to read their paper at location, and their work was included in the conference proceedings as "supplementary papers". The present volume contains a first selection, and it is intended to issue others in the future.

The original objective of the meetings was to review the various interpretations of the mathematical formal structure of relativity theory, and to examine the models, analogues, and second interpretations, with which the mathematical formulations are sometimes accompanied. Relativistic ether theories and models, which interpret the accepted formal structure of relativity were included as themes fit for review. The relationship between current expositions of relativity and previous expositions, as e.g. the Poincaré-Lorentz or the Einstein-Minkowski expressions, was examined in meeting sections dealing with historical and philosophical aspects of physics. Experience gained through the meetings so far held has justified the impression that history and philosophy deepen insight into the various interpretations of the formal structure of relativity.

The use of the word "physical" in the title of the meetings implied no adverse criticism of the general prevalence of mathematical and geometrical formulations in 20th century physics. It indicated that the meetings were organised to review not only geometrised and mathematical expositions, but physical models of various kinds and experimental technique and equipment. They were also intended to review the range of meanings ascribed to the term "physical", as compared to "geometrical" or "mathematical". In order to do this, the programs were organised to bring together mathematicians, physicists, engineers, historians and philosophers in the hope that the work of each would disclose fresh and fruitful insights to colleagues working in other disciplines. The meetings fully demonstrated that much is to be gained from cross-fertilisation between those disciplines in which expertise in, and respect for, relativity theory are found.

A broad approach was taken, and papers were accepted dealing with the relationship between relativity and other basic fields in physics, such as quantum theory and cosmology. Whether or not the papers concentrated on mathematical, philosophical, experimental or other issues, the objective was to deepen insight into relativity, to provide a comprehensive review of contemporary issues, and so assist in the solution of outstanding problems. It cannot be claimed that traditional areas of dispute have been entirely removed. The controversies concerning ether formulations of relativity, the relative advantages and disadvantages of the Poincaré-Lorentz or the Einstein-Minkowski expositions, the ever-recurring discussions of the clock-paradox, and the criticisms of particular expressions of the relativity principle, have not been terminated. Nevertheless, the organisers hope that progress has been made towards bringing the several parties forward towards a fuller understanding of each other's position.

The conference objectives have remained essentially unchanged. The main objective is, and was, to explore the advantages, or disadvantages, of the various physical, mathematical and geometrical interpretations of the formal structure of relativity; to review differences of opinion concerning them; and to clarify them by calling on a range of disciplines including history, philosophy and epistemology, as well as the obvious disciplines within physical science. Permanent sections of the program include relativistic aspects of gravitation, cosmology, and space-time structure, as well as the nature of *vacuum*. Specialist sections were devoted to time, the reference frame, present-day relativistic ether theories and models, and to the relationship between physical, mathematical and geometrical concepts. The section devoted to consider the experimental aspects of relativity turned out to be particularly fruitful.

The organisers encouraged free discussion and criticism in a rational scientific spirit. The scope of the meetings was predicated on the accuracy and excellence of the principles and formal structure of relativity, special and general. They were organised to examine aspects of the various interpretations of this formal structure, including history, philosophy, methodology, in addition to technical and conceptual detail. Criticism of established opinion and theory was, of course, admitted - but it was decided to exclude papers of a polemical nature, particularly those written in an anti-Einstein, and anti-relativity spirit.

The papers selected for this second volume have been chosen in part to reflect the wide range of themes covered by the meetings and thereby to indicate the many aspects of relativity related to the interpretation of the established mathematical formal structure.

Considerable assistance was given by Sunderland Engineering Education Development Service, and School of Mechanical and Manufacturing Engineering, University of Sunderland, which provided facilities and funding to launch the conferences in 1988. Through the successive reorganisations of the engineering departments, resulting in the current School of Computing, Engineering and Technology, valuable assistance, support, and facilities, were provided which contributed greatly to the success of the conferences.

Valuable publicity for the meetings was provided by the Europhysical Society, the Fondation Louis de Broglie; London Mathematical Society; Royal Astronomical Society; Institute of Mathematics & its Applications; Institute of Physics; British Journal for Philosophy of Science; Foundations of Physics; General Relativity and Gravitation; International Journal of Theoretical Physics, and American Institute of Physics.

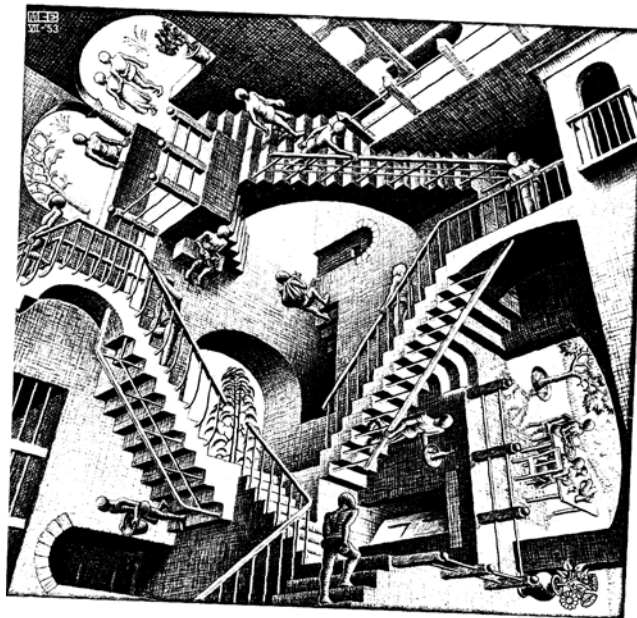
Prof. M. Wegener must be honoured for his outstanding contribution to the publication of the present selection of papers. In every way he has been the chief editor, and he has been the prime mover in contacting authors, liaising with the publishers, editing the scripts, and preparing the collected papers in standard format.

Special thanks are also due to Prof. G.H. Keswani, Dr. P. Rowlands and Dr. M. Surdin for their kind advice and assistance by selecting and refereeing the papers.

Finally, I want to express my gratitude to the Institute for Basic Research, Florida, and its director, Prof. R.M. Santilli, for their generous offer to publish this selection.

Michael C. Duffy

RECENT ADVANCES
in
RELATIVITY THEORY



Volume 2
Material Interpretations

M.C. Duffy & M. Wegener
eds.

Hadronic Press
2002

RECENT ADVANCES
in
RELATIVITY THEORY

SELECTED PAPERS

*From the Biennial Conferences on
Physical Interpretations of Relativity Theory
(1988-1996)*

*The conferences were sponsored by the
British Society for the Philosophy of Science
and held at the Imperial College, London.*

Volume Two: Material Interpretations
*Edited by M.C. Duffy and M. Wegener
and published by the*

**Hadronic Press
Institute for Basic Research
35246 US 19 North 115, POBox 1577,
Palm Harbor, FL 34682, USA
ISBN 1-57485-050-4**

= // =

CONTENTS OF VOLUME TWO

-11-

MACH-EINSTEIN DOCTRINE AND GENERAL RELATIVITY
*H.-H. v. Borzeszkowski, Inst. Theor. Phys., Techn. Univ. Berlin
& H.-J. Treder, Rosa-Luxemburg-Str. 17A, D-14482, Potsdam*

-19-

THREE LEVELS OF INTERPRETING SPECIAL RELATIVITY
*G. Cavalleri, E. Cesaroni & E. Tonni,
Univ. Cattolica del Sacro Cuore, via Trieste 17, 25121 Brescia, Italia*

-37-

MASS INFLATION WITH LORENTZIAN GRAVITY
S.V.M. Clube, Dept. Astrophysics, Keble Rd., Univ. Oxford OX1 3RH, UK

-44-

RELATIVITY AND PROBABILITY: THE LOGIC OF INTERSUBJECTIVITY
O. Costa de Beauregard, Lab. Phys. Théor., Univ. Paris 6, 4 Pl. Jussieu F75252

-51-

QUALMS CONCERNING RELATIVITY THEORY
J. Dunning Davies & G.H.A. Cole, Dept. Math., Univ. Hull, HU6 7RX, UK

-60-

ETHER, COSMOLOGY AND GENERAL RELATIVITY
M.C. Duffy, School of Comp., Engin. & Technol., Univ. of Sunderland, UK

-80-

THE MISSING TERM IN THE DIRAC FACTORIZATION
J.D. Edmonds, Dept. Phys., McNeese State Univ., Lake Charles, LA 70609, USA

-85-

A.N. WHITEHEAD ON SPECIAL RELATIVITY
Enrico Giannetto, Dipt. di Fisica, Univ. di Pavia, I-27100 Italia

-90-

HAVE PHYSICISTS BEEN ABLE TO DISPENSE WITH PHILOSOPHY?
Mehdi Golshani, Physics Dept., Sharif Univ. of Technol., Tehran, Iran

-98-

NON-INVARIANT LIGHT-SPEED AND CLOCK SYNCHRONISATION
François Goy, CH 1329 Bretonnières, Switzerland

-107-

TIME AND STATE-EVOLUTION IN MECHANICS
L.P. Horwitz, School of Physics, Tel Aviv Univ., Ramat Aviv 69978, Israel

-121-

RELATIVITY AND THE SAGNAC EFFECT
A.G. Kelly, 20 Simmons Court (Rd.), Dublin 4, Ireland

-130-

A CRITIQUE OF RELATIVITY
G.H. Keswani, B6/17 Safdarjung Enclave, New Delhi 110029, India

-156-

ON MEASUREMENT IN RELATIVITY THEORY
Willem de Muynck, Dept. Theor. Phys., Eindhoven Univ. Techn., Netherland

-169-

IS A WAVE FUNCTION COLLAPSE A REAL EVENT IN SPACE AND TIME?
Alexei V. Nesteruk, Dept. Math, Univ. Portsmouth, PO1 2EG, UK

-180-

OBSERVABLE RESULTS OF DISCRETE PHYSICS
H.P. Noyes, Stanford Linear Acceleration Center, Stanford University, CA94309
D. McGovern, Alternative Technologies, 15905 Bear Creek Rd., Boulder Creek, CA95006

-191-

TWO SHORT NOTES
Rinat Nugayev, Dept. Philos., Tatarstan Acad. Science, 420042 Kazan, Russia

-196-

A THEORY OF GRAVITATION IN FLAT SPACE-TIME
Walter Petry, Math. Inst., Univ. Düsseldorf, Univ.str.1, D-40225, Germany

-213-

MATTER WAVES AND UNIVERSAL FIELDS
M.F. Podlaha, Klafferstrass 4, Neureichenau, D94089, Germany

-218-

THE TANTALIZING TWO-SLIT EXPERIMENT
N.V. Pope, "Llys Alaw", 10 West End, Penclawdd, Swansea, SA4 3YX, UK

-228-

ASSESSING CONCEPTUAL TRENDS IN 20TH C PHYSICS
Evert Jan Post, 7933 Breen Ave., Westchester, CA 90045-3357, US

-236-

CONCEPTIONS AND MISCONCEPTIONS OF 'ETHER'
Stathis Psillos, Dept. Phil., King's College, London, WC2R 2LS, UK

-249-

AN ALGEBRA FOR RELATIVISTIC QUANTUM MECHANICS
Peter Rowlands, Dept. Phys., Univ. of Liverpool, L69 7ZE, UK

-267-

**ON A SYNTHETIC FORMULATION OF
GENERAL RELATIVISTIC SPACETIME GEOMETRY**
Heinz-Jürgen Schmidt, Dept.Phys.,Univ.Osnabrück, D-49069, Germany

-281-

ON THE ANISOTROPY OF LIGHT PROPAGATION
Franco Selleri, Dipt. di Fisica, Univ. di Bari, Via Amendola 173, I-70126, Italia

-284-

STOCHASTIC ELECTRODYNAMICS IN PHILOSOPHICAL PERSPECTIVE
N. Shanks, Dept. Phil., Southern Methodist Univ., Dallas, Texas 75275, USA

-297-

**THE WHITE-DWARF CONTROVERSY:
GENERAL IDEAS BEHIND EDDINGTON'S POSITION**
R. Simon, LAMB, Casilla 27021, Santiago 27, Chile

-302-

COSMOLOGY AND STOCHASTIC ELECTRODYNAMICS
Maurice Surdin, CFR, Lab. Mixte CNRS-CEA, 91198 Gif-sur-Yvette, France

-322-

THE ANTHROPIC PRINCIPLE IN RELATIVISTIC COSMOLOGY
L. Székely, Inst.Phil., Hung. Acad. Sci., Pf.594, BudaPest-62, 1398 Hungary

-329-

CANTOR'S CONTINUUM HYPOTHESIS AND THE QUEST FOR AN AETHER
F. Winterberg, Dept. of Physics /220, Univ. of Nevada, 89557-0058, USA

-337-

INDEX

PREFACE

The title given to this selection, *Recent Advances in Relativity Theory*, derives from a suggestion originally made to the academic committee by one of its members, Prof. F. Selleri. Of course, this could not have been the title given to a series of conferences: one cannot decide, but only hope, that a planned series of scientific conferences will issue in theoretical advances. In retrospect, however, one may get a feeling that the hope has not been entirely in vain.

So, by adopting the proposed title instead of the original title of the conferences

Physical Interpretations of Relativity Theory

the editors wanted to hint at the fact that the present selection of papers, which covers the years 1988-1996, in their opinion offers more than mere interpretations, or re-interpretations, of an entrenched theory of modern physics, namely that of Relativity. Indeed, already the attempt to convene not only a single meeting but a whole series of meetings focussing on this topic was a strong signal that the one and only initiator and organiser of these meetings, Dr. M.C. Duffy of University of Sunderland, did not see the subject as closed nor the usual conclusions as final. It demands courage to send such a signal to the establishment, and it presupposes both a strong health, a great administrative talent and a large measure of diplomacy to realize such an attempt. I think that I speak on behalf of all participants in these meetings when I say that their success the extent of which is yet to be judged by the readers of this volume as well as the one to follow, is due almost entirely to a single person: Michael Ciaran Duffy.

The present volume, together with the one already published, comprises 2×30 papers of more than 600 pp. Considering this amount to be too large for a single volume it was decided to split it up into two. Realizing that it was problematic to organize all papers according to their subject-matter, an alphabetic order was chosen for each volume. Finding it awkward to let the two volumes be distinguished by an arbitrary letter, say *Q*, an attempt was made to suggest a preliminary separation of thematic priorities by distinguishing the contents of the volumes according to the kind of interpretation favoured by the papers. So we chose to settle on a very rough division of the papers according to whether they - *prima facie* - represent what might be called *formal interpretations* (vol.1) or what might be called *material interpretations* (vol.2). Proceeding thus, a certain affinity to the original title of the meetings was preserved.

In place of an explicit organization of the material, which seems almost predestined to become "one-dimensional", it is possible to suggest various strategies of reading this volume. However, in order not to impose my own views upon the reader I prefer not to be too explicit. But that much may be said: - The contents of the volume is roughly divisible into five sections, 1) theories of ether & vacuum, 2) observation & measurement, 3) philosophical considerations, 4) mathematical developments, 5) criticism and alternatives. The papers might be grouped thus: 1) Cavalleri & al., Clube, Davies & Cole, Duffy, Podlaha, Psillos, Surdin; 2) Goy, Kelly, Muynck, Pope, Selleri; 3) Costa, Giannetto, Golshani, Noyes & McGoveran, Shanks; 4) Borzeszkowski & Treder, Horwitz, Petry, Rowlands, Schmidt, Winterberg; 4) Edmonds, Keswani, Nesteruk, Nugayev, Post, Simón, Székely. Absolutely no priorities are intended.

Special thanks to Søren Halse og Jan Petersen for their help with the proof-reading.

Mogens Wegener

INTRODUCTION

This volume contains papers written by participants in the *Physical Interpretations of Relativity Theory* conferences, sponsored by the British Society for the Philosophy of Science. The meetings, which are biennial, took place in the years 1988-1996 and are still continued; they were organised from the School of Engineering and Advanced Technology, Sunderland Polytechnic, now School of Computing, Engineering & Technology, University of Sunderland. The majority of the papers selected for inclusion in this volume were read at Imperial College, London, by their authors; but in some instances the authors were not able to read their paper at location, and their work was included in the conference proceedings as "supplementary papers". The present volume contains a first selection, and it is intended to issue others in the future.

The original objective of the meetings was to review the various interpretations of the mathematical formal structure of relativity theory, and to examine the models, analogues, and second interpretations, with which the mathematical formulations are sometimes accompanied. Relativistic ether theories and models, which interpret the accepted formal structure of relativity were included as themes fit for review. The relationship between current expositions of relativity and previous expositions, as e.g. the Poincaré-Lorentz or the Einstein-Minkowski expressions, was examined in meeting sections dealing with historical and philosophical aspects of physics. Experience gained through the meetings so far held has justified the impression that history and philosophy deepen insight into the various interpretations of the formal structure of relativity.

The use of the word "physical" in the title of the meetings implied no adverse criticism of the general prevalence of mathematical and geometrical formulations in 20th century physics. It indicated that the meetings were organised to review not only geometrised and mathematical expositions, but physical models of various kinds and experimental technique and equipment. They were also intended to review the range of meanings ascribed to the term "physical", as compared to "geometrical" or "mathematical". In order to do this, the programs were organised to bring together mathematicians, physicists, engineers, historians and philosophers in the hope that the work of each would disclose fresh and fruitful insights to colleagues working in other disciplines. The meetings fully demonstrated that much is to be gained from cross-fertilisation between those disciplines in which expertise in, and respect for, relativity theory are found.

A broad approach was taken, and papers were accepted dealing with the relationship between relativity and other basic fields in physics, such as quantum theory and cosmology. Whether or not the papers concentrated on mathematical, philosophical, experimental or other issues, the objective was to deepen insight into relativity, to provide a comprehensive review of contemporary issues, and so assist in the solution of outstanding problems. It cannot be claimed that traditional areas of dispute have been entirely removed. The controversies concerning ether formulations of relativity, the relative advantages and disadvantages of the Poincaré-Lorentz or the Einstein-Minkowski expositions, the ever-recurring discussions of the clock-paradox, and the criticisms of particular expressions of the relativity principle, have not been terminated. Nevertheless, the organisers hope that progress has been made towards bringing the several parties forward towards a fuller understanding of each other's position.

The conference objectives have remained essentially unchanged. The main objective is, and was, to explore the advantages, or disadvantages, of the various physical, mathematical and geometrical interpretations of the formal structure of relativity; to review differences of opinion concerning them; and to clarify them by calling on a range of disciplines including history, philosophy and epistemology, as well as the obvious disciplines within physical science. Permanent sections of the program include relativistic aspects of gravitation, cosmology, and space-time structure, as well as the nature of *vacuum*. Specialist sections were devoted to time, the reference frame, present-day relativistic ether theories and models, and to the relationship between physical, mathematical and geometrical concepts. The section devoted to consider the experimental aspects of relativity turned out to be particularly fruitful.

The organisers encouraged free discussion and criticism in a rational scientific spirit. The scope of the meetings was predicated on the accuracy and excellence of the principles and formal structure of relativity, special and general. They were organised to examine aspects of the various interpretations of this formal structure, including history, philosophy, methodology, in addition to technical and conceptual detail. Criticism of established opinion and theory was, of course, admitted - but it was decided to exclude papers of a polemical nature, particularly those written in an anti-Einstein, and anti-relativity spirit.

The papers selected for this second volume have been chosen in part to reflect the wide range of themes covered by the meetings and thereby to indicate the many aspects of relativity related to the interpretation of the established mathematical formal structure.

Considerable assistance was given by Sunderland Engineering Education Development Service, and School of Mechanical and Manufacturing Engineering, University of Sunderland, which provided facilities and funding to launch the conferences in 1988. Through the successive reorganisations of the engineering departments, resulting in the current School of Computing, Engineering and Technology, valuable assistance, support, and facilities, were provided which contributed greatly to the success of the conferences.

Valuable publicity for the meetings was provided by the Europhysical Society, the Fondation Louis de Broglie; London Mathematical Society; Royal Astronomical Society; Institute of Mathematics & its Applications; Institute of Physics; British Journal for Philosophy of Science; Foundations of Physics; General Relativity and Gravitation; International Journal of Theoretical Physics, and American Institute of Physics.

Prof. M. Wegener must be honoured for his outstanding contribution to the publication of the present selection of papers. In every way he has been the chief editor, and he has been the prime mover in contacting authors, liaising with the publishers, editing the scripts, and preparing the collected papers in standard format.

Special thanks are also due to Prof. G.H. Keswani, Dr. P. Rowlands and Dr. M. Surdin for their kind advice and assistance by selecting and refereeing the papers.

Finally, I want to express my gratitude to the Institute for Basic Research, Florida, and its director, Prof. R.M. Santilli, for their generous offer to publish this selection.

Michael C. Duffy