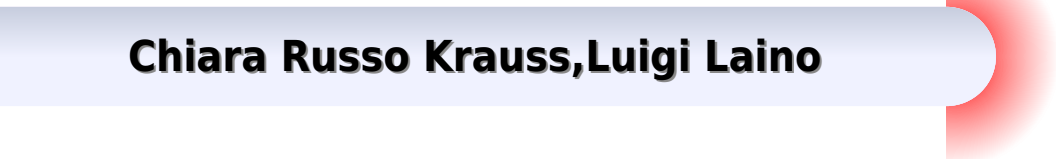


Dennis Lehmkuhl
Gregor Schiemann
Erhard Scholz
Editors

Towards a Theory of Spacetime Theories

Towards Spacetime Theories Einstein Studies

Chiara Russo Krauss, Luigi Laino



Towards Spacetime Theories Einstein Studies:

Towards a Theory of Spacetime Theories Dennis Lehmkuhl, Gregor Schiemann, Erhard Scholz, 2017-01-05 This contributed volume is the result of a July 2010 workshop at the University of Wuppertal Interdisciplinary Centre for Science and Technology Studies which brought together world wide experts from physics philosophy and history in order to address a set of questions first posed in the 1950s How do we compare spacetime theories How do we judge objectively which is the best theory Is there even a unique answer to this question The goal of the workshop and of this book is to contribute to the development of a meta theory of spacetime theories Such a meta theory would reveal insights about specific spacetime theories by distilling their essential similarities and differences deliver a framework for a class of theories that could be helpful as a blueprint to build other meta theories and provide a higher level viewpoint for judging which theory most accurately describes nature But rather than drawing a map in broad strokes the focus is on particularly rich regions in the space of spacetime theories This work will be of interest to physicists as well as philosophers and historians of science working with or interested in General Relativity and or Space Time and Gravitation more generally *The Non-Fundamentality of Spacetime* Kian Salimkhani, 2023-10-06 This book argues that our current best theories of fundamental physics are best interpreted as positing spacetime as non fundamental It is written in accessible language and largely avoids mathematical technicalities by instead focusing on the key metaphysical and foundational lessons for the fundamentality of spacetime According to orthodoxy spacetime and spatiotemporal properties are regarded as fundamental structures of our world Spacetime fundamentalism however faces challenges from speculative theories of quantum gravity roughly speaking the project of applying the lessons of quantum mechanics to gravitation and spacetime This book demonstrates that the non fundamentality of spacetime does not rely on speculative physics alone Rather one can give an interpretation of general relativity that supports some form of spacetime non fundamentalism The author makes the case for spacetime non fundamentalism in three steps First he confronts the standard geometrical interpretation of general relativity with Brown and Pooley s dynamical approach to relativity theory Second he considers an alternative derivation of the Einstein field equations namely the classical spin 2 approach and argues that it paves the way for a refined dynamical approach to general relativity Finally he argues that particle physics can serve as a continuity condition for the metaphysics of spacetime *The Non Fundamentality of Spacetime* will be of interest to scholars and advanced students working in philosophy of physics philosophy of science and metaphysics **Foundations of Space-Time Theories** John Earman, Clark N. Glymour, John J. Stachel, 1977-11-25 *Foundations of Space Time Theories* was first published in 1977 Minnesota Archive Editions uses digital technology to make long unavailable books once again accessible and are published unaltered from the original University of Minnesota Press editions The essays in this volume are based on the papers given at a conference on the philosophical aspects of the space time theory held under the auspices of the Minnesota Center for Philosophy of Science

Understanding Space-Time Robert DiSalle, 2006-04-27 Presenting the history of space time physics from Newton to Einstein as a philosophical development DiSalle reflects our increasing understanding of the connections between ideas of space and time and our physical knowledge He suggests that philosophy s greatest impact on physics has come about less by the influence of philosophical hypotheses than by the philosophical analysis of concepts of space time and motion and the roles they play in our assumptions about physical objects and physical measurements This way of thinking leads to interpretations of the work of Newton and Einstein and the connections between them It also offers ways of looking at old questions about a priori knowledge the physical interpretation of mathematics and the nature of conceptual change Understanding Space Time will interest readers in philosophy history and philosophy of science and physics as well as readers interested in the relations between physics and philosophy

The Routledge Companion to Philosophy of Physics Eleanor Knox, Alastair Wilson, 2021-09-28 The Routledge Companion to Philosophy of Physics is a comprehensive and authoritative guide to the state of the art in the philosophy of physics It comprises 54 self contained chapters written by leading philosophers of physics at both senior and junior levels making it the most thorough and detailed volume of its type on the market nearly every major perspective in the field is represented The Companion s 54 chapters are organized into 12 parts The first seven parts cover all of the major physical theories investigated by philosophers of physics today and the last five explore key themes that unite the study of these theories I Newtonian Mechanics II Special Relativity III General Relativity IV Non Relativistic Quantum Theory V Quantum Field Theory VI Quantum Gravity VII Statistical Mechanics and Thermodynamics VIII Explanation IX Intertheoretic Relations X Symmetries XI Metaphysics XII Cosmology The difficulty level of the chapters has been carefully pitched so as to offer both accessible summaries for those new to philosophy of physics and standard reference points for active researchers on the front lines An introductory chapter by the editors maps out the field and each part also begins with a short summary that places the individual chapters in context The volume will be indispensable to any serious student or scholar of philosophy of physics

Relativity Principles and Theories from Galileo to Einstein Olivier Darrigol, 2021-12-22 Motion is always relative to some thing Is this thing a concrete body like the earth is it an abstract space or is it an imagined frame Do the laws of physics depend on the choice of reference Is there a choice for which the laws are simplest Is this choice unique Is there a physical cause for the choice made These questions traverse the history of modern physics from Galileo to Einstein The answers involved Galilean relativity Newton s absolute space the purely relational concepts of Descartes Leibniz and Mach and many forgotten uses of relativity principles in mechanics optics and electrodynamics until the relativity theories of Poincaré Einstein Minkowski and Laue radically redefined space and time to satisfy universal kinds of relativity Accordingly this book retraces the emergence of relativity principles in early modern mechanics documents their constructive use in eighteenth and nineteenth century mechanics optics and electrodynamics and gives a well rooted account of the genesis of special and general relativity in the early twentieth century As an exercise in

long term history it demonstrates the connectivity of issues and approaches across several centuries despite enormous changes in context and culture As an account of the genesis of relativity theories it brings unprecedented clarity and fullness by broadening the spectrum of resources on which the principal actors drew

CPT Invariance and the Spin-Statistics Connection Jonathan Bain, 2016-04-08 This book seeks to answer the question What explains CPT invariance and the spin statistics connection These properties play foundational roles in relativistic quantum field theories RQFTs are supported by high precision experiments and figure into explanations of a wide range of phenomena from antimatter to the periodic table of the elements to superconductors and superfluids They can be derived in RQFTs by means of the famous CPT and Spin Statistics theorems but the author argues these theorems cannot be said to explain these properties at least under standard philosophical accounts of scientific explanation This is because there are multiple in some cases incompatible ways of deriving these theorems and secondly because the theorems fail for the types of theories that underwrite the empirical evidence non relativistic quantum theories and realistic interacting RQFTs The goal of this book is to work towards an understanding of CPT invariance and the spin statistics connection by first providing an analysis of the necessary and sufficient conditions for these properties and second by advocating a particular account of explanation appropriate for this context

Philosophers and Einstein's Relativity Chiara Russo Krauss, Luigi Laino, 2023-09-30 This book offers an up to date insight into the early philosophical debate on Einsteinian relativity The essays explore the reception and interpretation of Einstein's ideas by some of the most important philosophical schools of the time such as logical positivism Reichenbach neo Kantianism Cassirer Natorp critical realism Sellars and radical empiricism Mach The book is aimed at physicists and historians of science researching the epistemological implications of the theory of relativity as well as to scholars in philosophy interested in understanding how leading philosophical figures of the early twentieth century reacted to the relativistic revolution

Hajnal Andréka and István Németi on Unity of Science Judit Madarász, Gergely Székely, 2021-05-31 This book features more than 20 papers that celebrate the work of Hajnal Andréka and István Németi It illustrates an interaction between developing and applying mathematical logic The papers offer new results as well as surveys in areas influenced by these two outstanding researchers They also provide details on the after life of some of their initiatives Computer science connects the papers in the first part of the book The second part concentrates on algebraic logic It features a range of papers that hint at the intricate many way connections between logic algebra and geometry The third part explores novel applications of logic in relativity theory philosophy of logic philosophy of physics and spacetime and methodology of science They include such exciting subjects as time travelling in emergent spacetime The short autobiographies of Hajnal Andréka and István Németi at the end of the book describe an adventurous journey from electric engineering and Maxwell's equations to a complex system of computer programs for designing Hungary's electric power system to exploring and contributing deep results to Tarskian algebraic logic as the deepest core theory of such questions

then on to applications of the results in such exciting new areas as relativity theory in order to rejuvenate logic itself **The Structural Foundations of Quantum Gravity** Dean Rickles, Steven French, Juha T. Saatsi, 2006-11-16 Quantum gravity is the name given to a theory that unites general relativity Einstein's theory of gravitation and spacetime with quantum field theory our framework for describing non gravitational forces The Structural Foundations of Quantum Gravity brings together philosophers and physicists to discuss a range of conceptual issues that surface in the effort to unite these theories focusing in particular on the ontological nature of the spacetime that results Although there has been a great deal written about quantum gravity from the perspective of physicists and mathematicians very little attention has been paid to the philosophical aspects This volume closes that gap with essays written by some of the leading researchers in the field Individual papers defend or attack a structuralist perspective on the fundamental ontologies of our physical theories which offers the possibility of shedding new light on a number of foundational problems It is a book that will be of interest not only to physicists and philosophers of physics but to anyone concerned with foundational issues and curious to explore new directions in our understanding of spacetime and quantum physics **Space-time** Jonathan Allday, 2019-05-28 Read an exclusive interview with Dr Allday where he discusses the importance of the monumental first image of the black hole here This book suitable for interested post 16 school pupils or undergraduates looking for a supplement to their course text develops our modern view of space time and its implications in the theories of gravity and cosmology While aspects of this topic are inevitably abstract the book seeks to ground thinking in observational and experimental evidence where possible In addition some of Einstein's philosophical thoughts are explored and contrasted with our modern views Written in an accessible yet rigorous style Jonathan Allday a highly accomplished writer brings his trademark clarity and engagement to these fascinating subjects which underpin so much of modern physics Features Restricted use of advanced mathematics making the book suitable for post 16 students and undergraduates Contains discussions of key modern developments in quantum gravity and the latest developments in the field including results from the Laser Interferometer Gravitational Wave Observatory LIGO Accompanied by appendices on the CRC Press website featuring detailed mathematical arguments for key derivations *The Potential of Fields in Einstein's Theory of Gravitation* Zafar Ahsan, 2019-07-17 This book presents a detailed study of the Lanczos potential in general relativity by using tetrad formalisms It demonstrates that these formalisms offer some simplifications over the tensorial methods and investigates a general approach to finding the Lanczos potential for algebraic space time by translating all the tensorial relations concerning the Lanczos potential into the language of tetrad formalisms and using the Newman Penrose and Geroch Held Penrose formalisms In addition the book obtains the Lanczos potential for perfect fluid space time and applies the results to cosmological models of the universe In closing it highlights other methods apart from tetrad formalisms for finding the Lanczos potential as well as further applications of the Newman Penrose formalism Given its scope the book will be of interest to pure mathematicians theoretical physicists and cosmologists

and will provide common ground for communication among these scientific communities **Beyond Einstein** David E. Rowe, Tilman Sauer, Scott A. Walter, 2018-06-18 *Beyond Einstein Perspectives on Geometry Gravitation and Cosmology* explores the rich interplay between mathematical and physical ideas by studying the interactions of major actors and the roles of important research communities over the course of the last century **Space, Time and Einstein** J.B. Kennedy, 2014-12-18 This introduction to one of the liveliest and most popular fields in philosophy is written specifically for a beginning readership with no background in philosophy or science Step by step analyses of the key arguments are provided and the philosophical heart of the issues is revealed without recourse to jargon maths or logical formulas The book introduces Einstein's revolutionary ideas in a clear and simple way along with the concepts and arguments of philosophers both ancient and modern that have proved of lasting value Specifically the theories of the ancient Greek philosophers Zeno Euclid and Parmenides are considered alongside the ideas of Newton Leibniz and Kant as well as the giants of twentieth century physics Einstein and Lorentz The problems at the heart of the philosophy of space and time such as change motion infinity shape and inflation are examined and the seismic impact made by relativity theory and quantum theory is assessed in the light of the latest research The writing is lucid and entertaining allowing a beginning readership to grasp some difficult concepts while offering the more experienced reader a succinct and illuminating presentation of the state of the debate *Space Time and Einstein* shows the reader the excitement of scientific discovery and the beauty of theory in the search for answers to these fundamental questions **Einstein's Unification** Jeroen van Dongen, 2010-06-10 Why did Einstein tirelessly study unified field theory for more than thirty years In this book the author argues that Einstein believed he could find a unified theory of all of nature's forces by repeating the methods he thought he had used when he formulated general relativity The book discusses Einstein's route to the general theory of relativity focusing on the philosophical lessons that he learnt It then addresses his quest for a unified theory for electromagnetism and gravity discussing in detail his efforts with Kaluza Klein and surprisingly the theory of spinors From these perspectives Einstein's critical stance towards the quantum theory comes to stand in a new light This book will be of interest to physicists historians and philosophers of science **The Ontology of Spacetime II**, 2008-06-17 The sixteen papers collected in this volume are expanded and revised versions of talks delivered at the Second International Conference on the Ontology of Spacetime organized by the International Society for the Advanced Study of Spacetime John Earman President at Concordia University Montreal from 9 to 11 June 2006 Most chapters are devoted to subjects directly relating to the ontology of spacetime The book starts with four papers that discuss the ontological status of spacetime and the processes occurring in it from a point of view that is first of all conceptual and philosophical The focus then slightly shifts in the five papers that follow to considerations more directly involving technical considerations from relativity theory After this Time Becoming and Change take centre stage in the next five papers The book ends with two excursions into relatively uncharted territory a consideration of the status of Kaluza Klein theory and an

investigation of possible relations between the nature of spacetime and condensed matter physics respectively Space and time in present day physics and philosophy Relatively low level of technicality easily accessible Introduction from scratch of the debates surrounding time Broad spectrum of approaches coherently represented **The Philosophy and Physics of Noether's Theorems** James Read, Nicholas J. Teh, 2022-09-29 A centenary volume that celebrates extends and applies Noether's 1918 theorems with contributions from world leading researchers NASA's Beyond Einstein Program National Research Council, Division on Engineering and Physical Sciences, Board on Physics and Astronomy, Space Studies Board, Committee on NASA's Beyond Einstein Program: An Architecture for Implementation, 2008-01-19 Beyond Einstein science is a term that applies to a set of new scientific challenges at the intersection of physics and astrophysics Observations of the cosmos now have the potential to extend our basic physical laws beyond where 20th century research left them Such observations can provide stringent new tests of Einstein's general theory of relativity indicate how to extend the Standard Model of elementary particle physics and if direct measurements of gravitational waves were to be made give astrophysics an entirely new way of observing the universe In 2003 NASA working with the astronomy and astrophysics communities prepared a research roadmap entitled Beyond Einstein From the Big Bang to Black Holes This roadmap proposed that NASA undertake space missions in five areas in order to study dark energy black holes gravitational radiation and the inflation of the early universe to test Einstein's theory of gravitation This study assesses the five proposed Beyond Einstein mission areas to determine potential scientific impact and technical readiness Each mission is explored in great detail to aid decisions by NASA regarding both the ordering of the remaining missions and the investment strategy for future technology development within the Beyond Einstein Program Concepts of Space Max Jammer, 2013-08-16 Historical surveys consider Judeo-Christian notions of space Newtonian absolute space perceptions from 18th century to the present more Numerous quotations and references Admirably compact and swiftly paced style Philosophy of Science **Ether and Modernity** Jaume Navarro, 2018-08-30 Ether and Modernity offers a snapshot of the status of an epistemic object the ether or aether in the early twentieth century The contributed papers show that the ether was often regarded as one of the objects of modernity hand in hand with the electron radioactivity or X-rays and not simply as the stubborn residue of an old-fashioned long-discarded science The prestige and authority of scientists and popularisers like Oliver Lodge and Arthur Eddington in Britain Phillip Lenard in Germany or Dayton C Miller in the USA was instrumental in the preservation defence or even re-emergence of the ether in the 1920s Moreover the consolidation of wireless communications and radio broadcasting indeed a very modern technology brought the ether into audiences that would otherwise never have heard about such an esoteric entity The ether also played a pivotal role among some artists in the early twentieth century the values of modernism found in the complexities and contradictions of modern physics such as wireless action or wave-particle puzzles a fertile ground for the development of new artistic languages in literature as much as in the pictorial and performing arts Essays on the

intellectual foundations of Umberto Boccioni's art the linguistic techniques of Lodge and Ernst Mach's considerations on aesthetics and physics witness to the imbricate relationship between the ether and modernism Last but not least the ether played a fundamental part in the resurgence of modern spiritualism in the aftermath of the Great War This book examines the complex array of meanings strategies and milieus that enabled the ether to remain an active part in scientific and cultural debates well into the 1930s but not beyond This portrait may be easily regarded as the swan song of an epistemic object that was soon to fade away as shown by Paul Dirac's unsuccessful attempt to resuscitate some kind of aether in 1951 with which this book finishes

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