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# Reflections on Spacetime

## Foundations, Philosophy, History

Edited by

U. MAJER AND H.-J. SCHMIDT

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# Reflections On Spacetime

**Emily Adlam, Niels Linnemann, James  
Read**



## Reflections On Spacetime:

*Reflections on Spacetime* Ulrich Majer, Heinz-Jürgen Schmidt, 2013-03-14 REFLECTIONS ON SPACETIME FOUNDATIONS PHILOSOPHY AND HISTORY During the academic year 1992/93 an interdisciplinary research group constituted itself at the Zentrum für interdisziplinäre Forschung ZiF in Bielefeld Germany under the title Semantical Aspects of Spacetime Theories in which philosophers and physicists worked on topics in the interpretation and history of relativity theory The present issue consists of contributions resulting from material presented and discussed in the group during the course of that year The scope of the papers ranges from rather specialised issues arising from general relativity such as the problem of referential indeterminacy to foundational questions regarding spacetime in the work of Carnap, Weyl and Hilbert It is well known that the General Theory of Relativity (GTR) admits spacetime models which are exotic in the sense that observers could travel into their own past This poses a number of problems for the physical interpretation of GTR which are also relevant in the philosophy of spacetime It is not enough to exclude these exotic models simply by stating that we live in a non-exotic universe because it might be possible to operate time machines by actively changing the topology of the future part of spacetime In his contribution Earman first reviews the attempts of physicists to prove chronology protection theorems (CPTs) which exclude the operation of time machines under reasonable assumptions *Reflections on Quanta, Symmetries, and Supersymmetries* V.S. Varadarajan, 2011-05-20 This is a collection of essays based on lectures that the author has given on various occasions on foundation of quantum theory, symmetries and representation theory and the quantum theory of the superworld created by physicists The lectures are linked by a unifying theme: how the quantum world and superworld appear under the lens of symmetry and supersymmetry In the world of ultra-small times and distances such as the Planck length and Planck time, physicists believe no measurements are possible and so the structure of spacetime itself is an unknown that has to be first understood There have been suggestions (Volovich hypothesis) that world geometry at such energy regimes is non-archimedean and some of the lectures explore the consequences of such a hypothesis Ultimately, symmetries and supersymmetries are described by the representation of groups and supergroups The author's interest in representation is a lifelong one and evolved slowly and owes a great deal to conversations and discussions he had with George Mackey and Harish Chandra The book concludes with a retrospective look at these conversations **Constructive Axiomatics for Spacetime Physics** Emily Adlam, Niels Linnemann, James Read, 2025-06-25 The programme of constructive axiomatics promulgated by Hans Reichenbach in 1924 seeks to build up the architecture of our best theories of physics from basic axioms supposedly imbued with immediate and indubitable empirical content Taking inspiration from Reichenbach, Hermann Weyl proposed his own causal-inertial approach to the constructive axiomatization of Einstein's general relativity according to which a relativistic spacetime can be constructed solely from the trajectories of light rays and freely falling particles; this project, however, came to fruition only in 1972 with the constructive axiomatization of general relativity due to Ehlers-Pirani

and Schild EPS One century since Reichenbach and fifty years since EPS Constructive Axiomatics for Spacetime Physics is a celebration of the constructive axiomatic methodology It achieves four main tasks First it provides a thoroughgoing presentation of the EPS axiomatization closing missing loopholes identifying problematic axioms and so forth in this way one gains a much improved appreciation of the extent to which a causal inertial approach to general relativity might succeed and of what such an approach might offer Second it synthesizes and assesses the vast but disparate literature on constructive axiomatics which has arisen over the past century and sets the methodology in its proper philosophical context Third it generalizes the approach to apply to quantum spacetimes And fourth it applies the approach to the context of non relativistic spacetime physics All in all the book demonstrates that constructive axiomatics is live and kicking the book will become the go to resource for this way of philosophizing about the nature of space and time

**The stars and the earth, or, Thoughts upon space, time, and eternity [by F. Eberty].** Felix Eberty, 1846      Operational Symmetries Heinrich Saller, 2017-06-19

This book describes the endeavour to relate the particle spectrum with representations of operational electroweak spacetime in analogy to the atomic spectrum as characterizing representations of hyperbolic space The spectrum of hyperbolic position space explains the properties of the nonrelativistic atoms the spectrum of electroweak spacetime is hoped to explain those of the basic interactions and elementary particles In this book the theory of operational symmetries is developed from the numbers from Plato's and Kepler's symmetries over the simple Lie groups to their applications in nonrelativistic special relativistic and general relativistic quantum theories with the atomic spectrum for hyperbolic position and in first attempts the particle spectrum for electroweak spacetime The standard model of elementary particles and interactions is characterized by a symmetry group In general as initiated by Weyl and stressed by Heisenberg quantum theory can be built as a theory of operation groups and their unitary representations In such a framework time position and spacetime is modeled by equivalence classes of symmetry groups For a unification on this road the quest is not for a final theory with a basic equation for basic particles but for the basic operation group and its representations

*Physics Meets Philosophy at the Planck Scale* Craig Callender, Nick Huggett, 2001-01-29 Was the first book to examine the exciting area of overlap between philosophy and quantum mechanics with chapters by leading experts from around the world      *The Stars and the Earth; Or, Thoughts Upon Space, Time, and Eternity* Felix Eberty, 1861      The Stars and the Earth, Or, Thoughts Upon Space, Time, and Eternity, 1874

**Operational Quantum Theory II** Heinrich Saller, 2006-04-19 Operational Quantum Theory II is a distinguished work on quantum theory at an advanced algebraic level The classically oriented hierarchy with objects such as particles as the primary focus and interactions of the objects as the secondary focus is reversed with the operational interactions as basic quantum structures Quantum theory specifically relativistic quantum field theory is developed the theory of Lie group and Lie algebra operations acting on both finite and infinite dimensional vector spaces This book deals with the operational concepts of relativistic space time the Lorentz and Poincaré group operations and their

unitary representations particularly the elementary articles Also discussed are eigenvalues and invariants for non compact operations in general as well as the harmonic analysis of noncompact nonabelian Lie groups and their homogeneous spaces In addition to the operational formulation of the standard model of particle interactions an attempt is made to understand the particle spectrum with the masses and coupling constants as the invariants and normalizations of a tangent representation structure of a an homogeneous space time model Operational Quantum Theory II aims to understand more deeply on an operational basis what one is working with in relativistic quantum field theory but also suggests new solutions to previously unsolved problems

*The Deep Metaphysics of Space* Edward Slowik, 2016-10-12 This volume explores the inadequacies of the two standard conceptions of space or spacetime substantivalism and relationism and in the process proposes a new historical interpretation of these physical theories This book also examines and develops alternative ontological conceptions of space and explores additional historical elements of seventeenth century theories and other metaphysical themes The author first discusses the two main opposing theories of the ontology of space One known as substantivalism proposes space to be an entity that can exist independently of material things The other relationism contends that space is a relation among material things Readers will learn about specific problems with this dichotomy First Newton and Leibniz are often upheld as the retrospective forerunners of substantivalism and relationism But their work often contradicts the central tenets of these views Second these theories have proven problematic when transferred to a modern setting especially with regards to general relativity and the recent quantum gravity hypotheses The author details an alternative set of concepts that address these problems The author also develops a new classificational system that provides a more accurate taxonomy for the elements of all spatial ontologies This classification obtains successful analogies between Newton Leibniz and other natural philosophers with contemporary physical theories

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