Mathematical Methods of Modern Physics

Prof. Dr. Bernd Rosenow, SS 2024

For: Bachelor: Physics (6. semester) & IPSP (6. semester), Master: Physics & IPSP & Mathematical Physics

Workload: 5 LP, 1 lecture (English) + 1 tutorial (English) per week

Exam: 1 exam (90 min), prerequisite is 50% of the points from the weekly exercise sheets

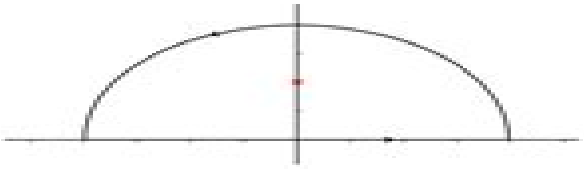
Contents:

- Complex analysis:
  - Holomorphic functions
  - Residue theorem
  - Laurent series
  - Applications to real integrals

$$f'(z_0) = \left.\frac{df(z)}{dz}\right|_{z_0}$$

$$\oint_\gamma f(z)dz = 2\pi i \sum_k \Gamma(\gamma, a_k)\,\mathrm{Res}(f, a_k)$$

$$f(z) = \sum_{n=-\infty}^{\infty} b_n z^n$$



$$\int_{-\infty}^{\infty} \frac{1}{x^2+1}dx = 2\pi i \frac{1}{2i} = \pi$$

- Distributions and Fourier transformation

$$G^<(k,E) = \int_{-\infty}^{\infty}\int_{\infty}^{\infty} \frac{1}{2\pi}\frac{e^{-ixk}e^{iEt}}{x - vt - i\delta}dxdt = 2\pi i\delta(E - vk)\Theta(-vk)$$

- Eigenvalues and eigenfunctions

Mathematical Methods Of Theoretical Physics Arxiv

V.V. Lebedev,Michail Victorovich Feigelman

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The Mathematica GuideBook for Numerics Michael Trott,2006-10-27 Mathematica is today s most advanced technical computing system featuring a rich programming environment two and three dimensional graphics capabilities and hundreds of sophisticated powerful programming and mathematical functions using state of the art algorithms Combined with a user friendly interface and a complete mathematical typesetting system Mathematica offers an intuitive easy to handle environment of great power and utility The Mathematica GuideBook for Numerics text and code fully tailored for Mathematica 5 1 concentrates on Mathematica s numerical mathematics capabilities The available types of arithmetic machine high precision and interval are introduced discussed and put to use Fundamental numerical operations such as compiling programs fast Fourier transforms minimization numerical solution of equations ordinary partial differential equations are analyzed in detail and are applied to a large number of examples in the main text and solutions to the exercises

Group Theory: Finite Discrete Groups And Applications Ioannis John Demetrius Vergados,Vasiliki-ioanna Vergadou-remediaki,2023-06-28 This book deals with the role played by symmetry in the understanding of the physical world beginning with the notion of geometric symmetries of the ancient Greek philosophers and mathematicians The recognition of the existence of symmetries led to the notion of transformations which led from one state of the system to another It was then realized that such transformations under the operation of multiplication constitute an interesting set whose study led to the branch of mathematics known as Group Theory With the emergence of quantum mechanics this theory became much more interesting and led to some additional applications The theory got another boost with the need for of the internal degrees of freedom in describing physical systems This way the notion of symmetry is no longer purely geometric and evolved into a useful tool in the study of all physical sciences For practical reasons as well as pedagogical reasons group theory is usually split into two parts The first deals with discrete groups with the group elements being countable usually finite in number while the second deals with continuous groups whose elements depend on continuous parameters This volumefocuses the discussion on discrete groups Given that group theory should be presented from a unified perspective involving not only the mathematical rigor and beauty of symmetries but also the ability to use it as a tool for applications either currently popular or expected to become so in the future this approach will surely be more beneficial to the dedicated reader It is not intended for those who would like to just look up a formula or use the results of a table without understanding their derivation *Progress of Theoretical Physics* ,2008 *Mathematical Methods in Interdisciplinary Sciences* Snehashish Chakraverty,2020-07-15 Brings mathematics to bear on your real world scientific problems Mathematical Methods in Interdisciplinary Sciences provides a practical and usable framework for bringing a mathematical approach to modelling real life scientific and technological problems The collection of chapters Dr Snehashish Chakraverty has provided describe in detail how to bring mathematics statistics and computational methods to the fore to solve even the most stubborn

problems involving the intersection of multiple fields of study Graduate students postgraduate students researchers and professors will all benefit significantly from the author s clear approach to applied mathematics The book covers a wide range of interdisciplinary topics in which mathematics can be brought to bear on challenging problems requiring creative solutions Subjects include Structural static and vibration problems Heat conduction and diffusion problems Fluid dynamics problems The book also covers topics as diverse as soft computing and machine intelligence It concludes with examinations of various fields of application like infectious diseases autonomous car and monotone inclusion problems *Advances in Theoretical and Mathematical Physics* ,2008 **Mellin-Barnes Integrals** Ievgen Dubovyk,Janusz Gluza,Gábor Somogyi,2022-12-15 In this book the authors discuss the Mellin Barnes representation of complex multidimensional integrals Experiments frontiered by the High Luminosity Large Hadron Collider at CERN and future collider projects demand the development of computational methods to achieve the theoretical precision required by experimental setups In this regard performing higher order calculations in perturbative quantum field theory is of paramount importance The Mellin Barnes integrals technique has been successfully applied to the analytic and numerical analysis of integrals connected with virtual and real higher order perturbative corrections to particle scattering Easy to follow examples with the supplemental online material introduce the reader to the construction and the analytic approximate and numeric solution of Mellin Barnes integrals in Euclidean and Minkowskian kinematic regimes It also includes an overview of the state of the art software packages for manipulating and evaluating Mellin Barnes integrals The book is meant for advanced students and young researchers to master the theoretical background needed to perform perturbative quantum field theory calculations

Fundamental Interactions and Twistor-like Methods Jerzy Lukierski,Dmitri Sorokin,2005-06-16 All papers were peer reviewed The volume contains reports on work done in areas of field theory supersymmetry string theory higher spins and related topics using group theoretical and geometrical methods which involve one way or another twistor like techniques singletons harmonics superembeddings and twistors themselves Encyclopedia of Mathematical Physics Jean-Pierre Françoise,Gregory L. Naber,Sheung Tsun Tsou,2006 The Encyclopedia of Mathematical Physics provides a complete resource for researchers students and lecturers with an interest in mathematical physics It enables readers to access basic information on topics peripheral to their own areas to provide a repository of the core information in the area that can be used to refresh the researcher s own memory banks and aid teachers in directing students to entries relevant to their course work The Encyclopedia does contain information that has been distilled organised and presented as a complete reference tool to the user and a landmark to the body of knowledge that has accumulated in this domain It also is a stimulus for new researchers working in mathematical physics or in areas using the methods originating from work in mathematical physics by providing them with focused high quality background information Editorial Board Jean Pierre Fran oise Universit Pierre et Marie Curie Paris France Gregory L Naber Drexel University Philadelphia PA USA Tsou Sheung Tsun University of Oxford

UK Also available online via ScienceDirect 2006 featuring extensive browsing searching and internal cross referencing between articles in the work plus dynamic linking to journal articles and abstract databases making navigation flexible and easy **Advances in Theoretical Physics** V.V. Lebedev,Michail Victorovich Feigelman,2009-06-01 The conference Advances in Theoretical Physics held in Chernogolovka Russia is devoted to Lev Landau s 100 year anniversary It was organized by the Landau Institute for Theoretical Physics which was established by Landau s pupils who carried on his traditions The conference reviews current progress in the main branches of theoretical physics The talks covered solid state physics and cosmology low temperature physics and optics quantum field theory and statistical physics physics of low dimensional systems and hydrodynamics **Geometry & Topology** ,2008 **Mittag-Leffler Functions, Related Topics and Applications** Rudolf Gorenflo,Anatoly A. Kilbas,Francesco Mainardi,Sergei Rogosin,2020-10-27 The 2nd edition of this book is essentially an extended version of the 1st and provides a very sound overview of the most important special functions of Fractional Calculus It has been updated with material from many recent papers and includes several surveys of important results known before the publication of the 1st edition but not covered there As a result of researchers and scientists increasing interest in pure as well as applied mathematics in non conventional models particularly those using fractional calculus Mittag Leffler functions have caught the interest of the scientific community Focusing on the theory of Mittag Leffler functions this volume offers a self contained comprehensive treatment ranging from rather elementary matters to the latest research results In addition to the theory the authors devote some sections of the work to applications treating various situations and processes in viscoelasticity physics hydrodynamics diffusion and wave phenomena as well as stochastics In particular the Mittag Leffler functions make it possible to describe phenomena in processes that progress or decay too slowly to be represented by classical functions like the exponential function and related special functions The book is intended for a broad audience comprising graduate students university instructors and scientists in the field of pure and applied mathematics as well as researchers in applied sciences like mathematical physics theoretical chemistry bio mathematics control theory and several other related areas Proceedings of the Second International Winter School on Mathematical Methods in Physics M. C. B. Abdalla,2003 **Bulletin of the Belgian Mathematical Society, Simon Stevin** ,2004 *Journal of physics : A, Mathematical and general* ,2002 **Primitive Forms and Related Subjects** □□□□,Si Li,Kyoji Saito,2019 This volume contains the proceedings of the conference Primitive Forms and Related Subjects held at the Kavli Institute for the Physics and Mathematics of the Universe IPMU University of Tokyo February 10 14 2014 The principal aim of the conference was to discuss the current status of rapidly developing subjects related to primitive forms In particular Fukaya category Gromov Witten and FJRW invariants mathematical formulation of Landau Ginzburg models and mirror symmetry were discussed The conference had three introductory courses by experts and 12 lectures on more advanced topics This volume volume contains two survey articles and 11 research articles based on the conference presentations

Bayesian Inference and Maximum Entropy Methods in Science and Engineering Kevin H. Knuth,2007-12-06 This excellent volume considers the methods applications and even the foundations of a key area of theoretical study Namely that of Bayesian probability entropy and information theory in scientific and engineering applications The material here has come out of the so called MaxEnt workshops that for more than 25 years have explored the subject Application areas include but are not limited to astronomy physics chemistry biology earth science and engineering SUSY06 Jonathan L. Feng,2007-05-15 This book contains the proceedings of the 14th International Conference on Supersymmetry and the Unification of Fundamental Interactions SUSY06 held in Irvine California in June 2006 This conference took place just before the start of the Large Hadron Collider widely anticipated to yield profound new results and provided a focus for the growing excitement in high energy physics through over 250 plenary and parallel talks Russian Journal of Mathematical Physics ,2007 Canadian Journal of Physics ,2016 **Albert Einstein Century International Conference** Jean-Michel Alimi,André Füzfa,2006-12-04 Paris France 18 22 July 2005

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