Spin Dynamics And Snakes In Synchrotrons

Research and development of high energy accelerators began in 1911. Since then, progresses achieved are:The impacts of the accelerator development are evidenced by the many ground-breaking discoveries in particle and nuclear physics, atomic and molecular physics, condensed matter physics, biology, biomedical physics,

nuclear medicine, medical therapy, and industrial processing. This book is intended to be used as a graduate or senior undergraduate textbook in accelerator physics and science. It can be used as preparatory course material in graduate accelerator physics thesis research. The text covers historical accelerator development, transverse betatron motion, synchrotron motion, an introduction to linear accelerators,

and synchrotron radiation phenomena in low emittance electron storage rings, introduction to special topics such as the free electron laser and the beam-beam interaction. Hamiltonian dynamics is used to understand beam manipulation, instability and nonlinearity. Each section is followed by exercises, which are designed to reinforce the concept discussed and to solve a realistic accelerator design

problem.
The idea of colliding two particle beams to fully exploit the energy of accelerated particles was first proposed by Rolf Wideröe, who in 1943 applied for a patent on the collider concept and was awarded the patent in 1953. The first three colliders — AdA in Italy, CBX in the US, and VEP-1 in the then Soviet Union — came to operation about 50 years ago in the mid-1960s. A number of other colliders

followed. Over the past decades, colliders defined the energy frontier in particle physics. Different types of colliers — proton-proton, proton-antiproton, electron-positron, electron-proton, electron-ion and ion-ion colliders — have played complementary roles in fully mapping out the constituents and forces in the Standard Model (SM). We are now at a point where all predicted SM

constituents of matter and forces have been found, and all the latest ones were found at colliders. Colliders also play a critical role in advancing beam physics, accelerator research and technology development. It is timely that RAST Volume 7 is dedicated to Colliders. Contents:High Energy Colliding Beams: What Is Their Future? (B Richter)Proton-Proton and Proton-Antiproton Colliders (W Scandale)El ectron-Positron Circular

Colliders (K Oide)Ion Colliders (W Fischer and J M Jowett) Electron-Proton and Electron-Ion Colliders (I Ben-Zvi and V Ptitsyn) Linear Colliders (A Yamamoto and K Yokoya)Muon Colliders (R B Palmer) The Photon Collider (J Gronberg)Collider Beam Physics (F Zimmermann)Collision Technologies for Circular Colliders (E Levichev)Andy Sessler: The Full Life of an Accelerator Physicist (K-

J Kim, R J Budnitz and H Winick) Readership: Physicists and engineers in accelerator science and industry. Keywords:Colliders;Accelerator Physics;Andrew Sessder;Accelerator Research

As we enter the high energy regime covered by RHIC and HERA, depolarization effects become strong, so that depolarization resonances begin to overlap. As a result, the ''good old days'' of the ZGS and AGS--when

techniques for dealing with isolated resonances were sufficient--are now in the past, and a new generation of spin dynamics questions have to be addressed and new techniques have to be developed. Exciting results were presented at this workshop ranging from the recent rapid R & D advances on polarized H- sources to deeper understanding of the subtle spin dynamics involving Siberian snakes. This summary is an attempt to give some

of the highlights.
Spin Dynamics and Snakes in SynchrotronsWorld Scientific Publishing Company
A Modern View
Spin Motion with Snakes and Jump-quads, G[gamma]
Spin Dynamics Modeling in the AGS Based on a Stepwise Ray-tracing Method
18th International Spin Physics Symposium
Special Topics In Accelerator Physics
Proceedings of the 7th International Conference on the Structure of

Baryons, Santa Fe, New Mexico, 3-7 October 1995

The AGS provides a polarized proton beam to RHIC. The beam is accelerated in the AGS from G[gamma]= 4.5 to G[gamma] = 45.5 and the polarization transmission is critical to the RHIC spin program. In the recent years, various systems were implemented to improve the AGS polarization transmission. These upgrades include the double partial snakes configuration and the tune jumps system. However, 100% polarization transmission through the AGS acceleration cycle is not yet reached. The current efficiency of the polarization transmission is

estimated to be around 85% in typical running conditions. Understanding the sources of depolarization in the AGS is critical to improve the AGS polarized proton performances. The complexity of beam and spin dynamics, which is in part due to the specialized Siberian snake magnets, drove a strong interest for original methods of simulations. For that, the Zgoubi code, capable of direct particle and spin tracking through field maps, was here used to model the AGS. A model of the AGS using the Zgoubi code was developed and interfaced with the current system through a simple command: the AgsFromSnapRampCmd.

Interfacing with the machine control system allows for fast modelization using actual machine parameters. Those developments allowed the model to realistically reproduce the optics of the AGS along the acceleration ramp. Additional developments on the Zgoubi code, as well as on post-processing and pre-processing tools, granted long term multiturn beam tracking capabilities: the tracking of realistic beams along the complete AGS acceleration cycle. Beam multiturn tracking simulations in the AGS, using realistic beam and machine parameters, provided a unique insight into the mechanisms behind the evolution of the beam

emittance and polarization during the acceleration cycle. Post-processing softwares were developed to allow the representation of the relevant quantities from the Zgoubi simulations data. The Zgoubi simulations proved particularly useful to better understand the polarization losses through horizontal intrinsic spin resonances The Zgoubi model as well as the tools developed were also used for some direct applications. For instance, some beam experiment simulations allowed an accurate estimation of the expected polarization gains from machine changes. In particular, the simulations that

involved involved the tune jumps system provided an accurate estimation of polarization gains and the optimum settings that would improve the performance of the AGS.

Research and development of high energy accelerators began in 1911. Since then, milestones achieved are: (1) development of high gradient dc and rf accelerators,(2) achievement of high field magnets with excellent field quality,(3) discovery of transverse and longitudinal beam focusing principles,(4) invention of high power rf sources,(5) improvement of ultra-high vacuum technology,(6) attainment of high brightness (polarized/unpolarized)

electron/ionsources,(7) advancement of beam dynamics and beam manipulation schemes, such as beam injection, accumulation, slow and fast extraction, beam damping and beam cooling, instability feedback, laser-beam interaction and harvesting instability for high brilliance coherent photon source. The impacts of the accelerator development are evidenced by the many ground-breaking discoveries in particle and nuclear physics, atomic and molecular physics, condensed matter physics, biology, biomedical physics, nuclear medicine, medical therapy, and industrial processing. This book is intended to be used

as a graduate or senior undergraduate textbook in accelerator physics and science. It can be used as preparatory course material in graduate accelerator physics thesis research. The text covers historical accelerator development, transverse betatron motion, synchrotron motion, an introduction to linear accelerators, and synchrotron radiation phenomena in low emittance electron storage rings, introduction to special topics such as the free electron laser and the beam-beam interaction. Attention is paid to derivation of the action-angle variables of the phase space, because the transformation is important for understanding

advanced topics such as the collective instability and nonlinear beam dynamics. Each section is followed by exercises, which are designed to reinforce concepts and to solve realistic accelerator design problems. Contents:Introduction:Historical DevelopmentsLayout and Components of AcceleratorsAccelerator ApplicationsTransverse Motion:Hamiltonian for Particle Motion in AcceleratorsLinear Betatron MotionEffect of Linear Magnet ImperfectionsOff-Momentum OrbitChromatic AberrationLinear CouplingNonlinear ResonancesCollective Instability

and Landau DampingSynchro-Betatron HamiltonianSynchrotron Motion:Longitudinal Equation of MotionAdiabatic Synchrotron MotionRF Phase and Voltage ModulationsNonadiabatic and Nonlinear Synchrotron MotionBeam Manipulation in Synchrotron Phase SpaceFundamentals of RF SystemsLongitudinal Collective InstabilitiesIntroduction to Linear AcceleratorsPhysics of Electron Storage Rings:Fields of a Moving Charged ParticleRadiation Damping and ExcitationEmittance in Electron Storage RingsSpecial Topics in Beam Physics:Free Electron Laser (FEL)Beam-Beam InteractionClassical Mechanics and

Analysis:Hamiltonian DynamicsStochastic Beam DynamicsModel Independent AnalysisNumerical Methods and Physical Constants:Fourier TransformCauchy Theorem and the Dispersion RelationUseful Handy FormulasMaxwell's EquationsPhysical Properties and Constants Readership: Accelerator, high-energy, nuclear, plasma and applied physicists.

To preserve proton polarization through acceleration, it is important to have a correct model of the process. It has been known that with the insertion of the two helical partial Siberian snakes in the Alternating Gradient Synchrotron (AGS), the MAD model

of AGS can not deal with a field map with offset orbit. The stepwise ray-tracing code Zgoubi provides a tool to represent the real electromagnetic fields in the modeling of the optics and spin dynamics for the AGS. Numerical experiments of resonance crossing, including spin dynamics in presence of the snakes and Q-jump, have been performed in AGS lattice models, using Zgoubi. This contribution reports on various results so obtained.

A fundamental aspect of particle physics is the spin of the particles. With polarized beams, the internal structure of the proton may be probed in ways that are unattainable with unpolarized

beams. The Relativistic Heavy Ion Collider (RHIC) has the unique capability of colliding protons with both transverse and longitudinal polarization at center-of-mass energies up to 500 GeV. In this paper we examine the methods used to accelerate and manipulate polarized proton beams in RHIC and its injectors. Special techniques include the use of a partial Siberian snake and an ac dipole in the AGS. In RHIC we use four superconducting helical Siberian snakes (two per ring) for acceleration, and eight superconducting helical rotators for independent control of polarization directions at two interaction regions.

Increasing the AGS Polarization
Accelerator Physics
USPAS Summer 2021 Spin Class Lectures
Zgoubi-ing AGS
Measurement and Control of Charged Particle Beams
Paddington History

This Note reports on the first, and successful, simulations of particle and spin dynamics in the AGS in presence of the two helical snakes and of the tune-jump quadrupoles, using the ray-tracing code Zgoubi. It includes DA tracking in the absence or in the presence of the two helical snakes, simulation of particle and spin motion in the snakes using their magnetic field maps, spin flipping at integer resonances in

the 36+Qy depolarizing resonance region, with and without tune-jump quadrupole gymnastics. It also includes details on the setting-up of Zgoubi input data files and on the various numerical methods of concern in and available from Zgoubi.

The development of high energy accelerators began in 1911, when Rutherford discovered the atomic nuclei inside the atom. Since then, progress has been made in the following: (1) development of high voltage dc and rf accelerators, (2) achievement of high field magnets with excellent field quality, (3) discovery of transverse and longitudinal beam focusing principles, (4) invention of high power rf sources, (5)

improvement of high vacuum technology, (6) attainment of high brightness (polarized/unpolarized) electron/ion sources, (7) advancement of beam dynamics and beam manipulation schemes, such as beam injection, accumulation, slow and fast extraction, beam damping and beam cooling, instability feedback, etc.The impacts of the accelerator development are evidenced by the many ground-breaking discoveries in particle and nuclear physics, atomic and molecular physics, condensed matter physics, biomedical physics, medicine, biology, and industrial processing.This book is intended to be used as a graduate or senior

undergraduate textbook in accelerator physics and science. It can be used as preparatory course material for graduate accelerator physics students doing thesis research. The text covers historical accelerator development, transverse betatron motion, synchrotron motion, an introduction to linear accelerators, and synchrotron radiation phenomena in low emittance electron storage rings, introduction to special topics such as the free electron laser and the beam-beam interaction. Attention is paid to derivation of the action-angle variables of the phase space, because the transformation is important for understanding advanced topics such as the collective instability

and nonlinear beam dynamics. Each section is followed by exercises, which are designed to reinforce the concept discussed and to solve a realistic accelerator design problem.
The Relativistic Heavy Ion Collider (RHIC) operation as the polarized proton collider presents unique challenges since both luminosity(L) and spin polarization(P) are important. With longitudinally polarized beams at the experiments, the figure of merit is LP4. A lot of upgrades and modifications have been made since last polarized proton operation. A 9 MHz rf system is installed to improve longitudinal match at injection and to increase luminosity. The beam dump was upgraded to

increase bunch intensity. A vertical survey of RHIC was performed before the run to get better magnet alignment. The orbit control is also improved this year. Additional efforts are put in to improve source polarization and AGS polarization transfer efficiency. To preserve polarization on the ramp, a new working point is chosen such that the vertical tune is near a third order resonance. The overview of the changes and the operation results are presented in this paper. Siberian snakes are essential tools to preserve polarization when accelerating polarized beams to higher energy. At the same time, the higher order resonances still can cause polarization loss. As seen

in RHIC, the betatron tune has to be carefully set and maintained on the ramp and during the store to avoid polarization loss. In addition, the orbit control is also critical to preserve polarization. The higher polarization during this run comes from several improvements over last run. First we have a much better orbit on the ramp. The orbit feedback brings down the vertical rms orbit error to 0.1mm, much better than the 0.5mm last run. With correct BPM offset and vertical realignment, this rms orbit error is indeed small. Second, the jump quads in the AGS improved input polarization for RHIC. Third, the vertical tune was pushed further away from 7/10 snake resonance. The tune

feedback maintained the tune at the desired value through the ramp. To calibrate the analyzing power of RHIC polarimeters at any energy above injection, the polarized hydrogen jet target runs for every fill with both beams. Based on the known analyzing power, there is very little polarization loss between injection and 100 GeV. An alternative way is to measure the asymmetry at 100 GeV followed by ramping up to 250 GeV and back down to 100 GeV and then to measure the asymmetry again at 100 GeV. If the asymmetry after the down ramp is similar to the measurement before the up ramp, polarization was also preserved during the ramp to 250 GeV. The analyzing power at

storage energy can then be extracted from the asymmetries measured at 100 GeV and 250 GeV. The tune and orbit feedbacks are essential for the down ramp to be possible. The polarized proton operation is still going on. We will push bunch intensity higher until reaching the beam-beam limit. The even higher intensity will have to wait for the electron lenses to compensate the beam-beam effect. To understand the details of spin dynamics in RHIC with two snakes, spin simulation with the real magnet fields have been developed recently. The study will provide guidance for possible polarization loss schemes. Further polarization gain will requires a polarized source

upgrade; more careful setup jump quads in the AGS to get full benefit; and control emittance in the whole accelerator chain. Particle accelerators are essential tools for scientific research in fields as diverse as high energy physics, materials science and structural biology. They are also widely used in industry and medicine. Producing the optimum design and achieving the best performance for an accelerator depends on a detailed understanding of many (often complex and sometimes subtle) effects that determine the properties and behavior of the particle beam. Beam Dynamics in High Energy Particle Accelerators provides an introduction to the concepts

underlying accelerator beam line design and analysis, taking an approach that emphasizes the elegance of the subject and leads into the development of a range of powerful techniques for understanding and modeling charged particle beams. Contents:Electromagnetism and Classical Mechanics:Electromagnetic Fields in Accelerator ComponentsHamiltonian for a Particle in an Accelerator Beam LineSingle-Particle Linear Dynamics:Linear Transfer Maps for Common ComponentsLinear Optics in Uncoupled Beam LinesCoupled OpticsLinear Imperfections in Storage RingsEffects of Synchrotron RadiationSingle-Particle

Nonlinear Dynamics:Examples of Nonlinear Effects in Accelerator Beam LinesRepresentations of Transfer MapsSymplectic IntegratorsMethods for Analysis of Single-Particle DynamicsCollective Effects:Space ChargeScattering EffectsWake Fields, Wake Functions and ImpedanceCoherent Instabilities Readership: Undergraduate students who are looking for an introduction to beam dynamics, and graduate students and researchers in the field. Key Features:Basic ideas are introduced from the start using an approach that leads logically into the development of more advanced concepts and techniques. In particular, linear dynamics is treated consistently

using a Hamiltonian formalism, which provides a suitable foundation not only for perturbation theory, but also for more modern techniques based on Lie operators. The use of a consistent approach makes the progress from introductory to advanced material as straightforward as possibleThe treatment of nonlinear dynamics using Lie operators provides a number of powerful techniques for the analysis of accelerator beam lines. Lie operators are generally found only in more advanced and specialized treatments of nonlinear dynamics. Beam Dynamics in High Energy Particle Accelerators provides an accessible introduction to the subject, and

illustrates the use of techniques such as Lie transforms and normal form analysis through examples of particular relevance for beam dynamicsAs well as providing a clear description of the important topics in beam dynamics and an explanation of the physical principles, attention is given to techniques of particular importance for computer modeling of beam dynamics. For example, there is a chapter on symplectic integration that gives explicit formulae for methods that are of some importance in accelerator modeling codes, but have not previously been presented in a book of this kindKeywords:Accelerator Physics;Beam Dynamics;Particle

AcceleratorsReviews: "This is a recommendable addition to the literature, covering its topics clearly and thoroughly." CERN Courier

Spin Dynamics and Snakes in Synchrotrons

The Partial Snake Experiment at the AGS. Progress Report, 15 August 1992--14 August 1994

High Energy Spin Physics

Ecclesiastical, biographical, topographical. Parts 3-5

Challenges And Goals For Accelerators In The Xxi Century

Spin 96 - Proceedings Of The 12th International Symposium On High-energy Spin Physics

Accelerators as research and industrial tools are increasingly becoming a

key driver of the advances of a modern society. As accelerators and its science evolved to meet the ever-increasing needs of society, the field of accelerator physics has evolved and deepened over the past few decades, and many of its branches developed into special topics of research by their own rights. It is appropriate at this time to start accumulating this hard-earned expertise by the accelerator physics community. With this view, a selection of these special topics is presented in this volume, Special Topics in

Accelerator Physics. Although not exhaustive, they are chosen to present accelerator physics as a diversified and exciting field and written based on the practicing and teaching experiences of the author accumulated over the past decades. The book is presented as an advanced textbook. The material on each topic has been intended to be self-contained. The reader is assumed to have a basic knowledge of accelerator physics to put the material in some context.

The 9th International

Symposium on High Energy Spin Physics, held in Bonn, 6-15 September 1990, attracted 280 participants from 16 countries. This meet ing covered not only fundamental experimental and theoretical spin phenomena but also technological developments in polarized beams and targets. For the first time intermediate energy spin physics with electron machines was discussed extensively. Highlights included the work on polarized high energy electron beams at LEP and TRISTAN and the failure of

the standard model in connection with spin phenomena, in particular the growth of the spin asymmetry in violent proton-proton scattering. Also the presentation of different models in con nection with the still-unsolved 'proton spin crisis' and the proposals for four different experiments to determine the spin structure functions caused lively and sometimes controversial discussions. The Organizing Committee would like to thank all speakers for their excel lent talks, the conveners for the

organization of the parallel sessions, and the International Advisory Committee for their advice. Four workshops preceded the symposium. 160 participants, among them many young physicists, discussed mainly technological spin problems. These papers are published in separate proceedings. We gratefully acknowledge the enthusiastic help of the members of our institute in preparing and running the conference and the workshops, especially Mrs. D. FaSbender, Mrs. E.

Wendorf, Mrs. J. Wetzel, and Dr. U.Idschok.
The success in the standard model and to the continuing research for a better understanding of the quantum chromodynamics has resulted in a great interest in spin physics among high energy and nuclear physics. Advances in accelerator technology have also spurred renewed interest in accelerating and storing highly aligned spin particles in synchrotrons and storage rings. The development of polarized ion sources and polarized electron sources have seen

remarkable progress. With these advances in ion sources, there is a growing interest in the acceleration and maintenence of this polarization. This book is intended to be used as a graduate/senior undergraduate textbook in accelerator physics and sciences. The subject deals with acceleration and storage of polarized beams in high energy synchrotrons. The material covers the equation of motion for polarized beams in synchrotrons, spin depolarizing resonances, practical methods used in

overcoming spin resonances, effects of spin rotators — called Siberian snakes — on the polarization vector, snake resonances, Sokolov–Ternov radiative polarization of electrons, and design principles of spin rotators. Experimental results of many polarized beam experiments are compared with theoretical analyses. Each chapter is also followed by exercises, which are intended to reinforce the concepts discussed, to derive useful formulae for applications, and to provide an introduction to some

published literatures related to the polarized beam dynamics.
Electron storage rings play a crucial role in many areas of modern scientific research. In light sources, they provide intense beams of x-rays that can be used to understand the structure and behavior of materials at the atomic scale, with applications to medicine, the life sciences, condensed matter physics, engineering, and technology. In particle colliders, electron storage rings allow experiments that probe the laws of

nature at the most fundamental level. Understanding and controlling the behavior of the beams of particles in storage rings is essential for the design, construction, and operation of light sources and colliders aimed at reaching increasingly demanding performance specifications. Introduction to Beam Dynamics in High-Energy Electron Storage Rings describes the physics of particle behavior in these machines. Starting with an outline of the history, uses, and structure of electron

storage rings, the book develops the foundations of beam dynamics, covering particle motion in the components used to guide and focus the beams, the effects of synchrotron radiation, and the impact of interactions between the particles in the beams. The aim is to emphasize the physics behind key phenomena, keeping mathematical derivations to a minimum: numerous references are provided for those interested in learning more. The text includes discussion of issues relevant to machine design

and operation and concludes with a brief discussion of some more advanced topics, relevant in some special situations, and a glimpse of current research aiming to develop the "ultimate" storage rings.

Volume 1: Conference Report

Spin Physics

Proceedings of the Conference held in Bloomington, IN, September 1994

Ann Arbour, Michigan, 6-9 November 2002

Scientific and Technical Aerospace Reports

Nonlinear Dynamics And Collective Effects In Particle Beam Physics - Proceedings Of The International Committee On Future Accelerators Arcidosso Italy 2017

This book of proceedings is an up-to-date review of the advances made in the past two decades on the production, control and exploitation of bright electron and light beams for science — in particular, innovative manipulation and control, in linear and circular accelerators, of high brightness charged

particle beams. In the conceptual, theoretical and experimental framework of nonlinear beam dynamics and collective cooperative effects, the book provides an update of the state-of-the-art theoretical formulations, techniques and technologies, innovative concepts and scientific results obtained at existing accelerator facilities. Challenges and solutions, proposed or implemented, for the operation of third and fourth generation storage rings as synchrotron radiation

sources and circular colliders for high energy particle physics, as well as radiofrequency linear accelerators for Compton/Thomson scattering-based light sources and free electron lasers, are reviewed and discussed. The complementarity between single-pass and recirculating light sources in energy, timing and spectral operational modes also emerges.
In the two year funding period from August 15, 1992--August 14, 1994, the authors progresses can be summarized as follows: (1)

the solenoidal partial snake was installed in the AGS synchrotron in May, 1993 and was subsequently successfully tested; (2) the internal polarimeter for the AGS was assembled, tested and installed in the AGS; (3) the 200 MeV polarimeter at the LINAC was tested; (4) the AGS polarized ion source was renovated; (5) the first phase of the polarized beam experiments was successfully accomplished in April 1--8, 1994, of polarized proton acceleration up to G{sub {gamma}} (almost equal to)

20; (6) they are currently renovating tune jump quadrupoles in order to accelerate polarized proton up to 25 GeV/c. The full test of these experiments will be in 1995. During this funding period, the principal investigator has spent about 20% of his research time on this project, which includes the design and manufacturing of the solenoid partial snake, beam dynamics issues of the AGS with the 5% solenoid partial snake and spin dynamics of synchrotrons with snakes

in general. The graduate student, Mr. H. Huang has spent 100% of his research time working on spin dynamics. The graduate student is currently staying at BNL for the E880 experiment preparation.

This comprehensive volume covers the most recent advances in the field of spin physics, including the latest research in high energy and nuclear physics and the study of nuclear spin structure. The comprehensive coverage also includes polarized proton and electron

acceleration and storage as well as polarized ion sources and targets. Many significant new results and achievements on the different topics considered at the symposium are presented in this book for the first time. Contents: Present Understanding of the Nucleon Spin Structure (A Metz)Understanding Transversity: Present and Future (V Barone)Results and Future Prospects for Muon (g - 2) (B L Roberts)First Results from RHIC Spin Program and Future Prospects (N

Saito)Speculations in Hadron Spectroscopy (J M Richard)Nucleon Form Factors (K de Jager)Experimental Status of the GDH Sum Rule (H Arends)Polarized Structure Functions with Neutrino Beams (S Forte)Higher Twists Resummation in Inclusive and Semi-Inclusive Spin-Dependent DIS (O V Teryaev)A New Angular Momentum Sum Rule (E Leader)Single Spin Asymmetry Measurements for ?0 Inclusive Productions in p + p? ? ?0 + X and ?- + p? ? ?0+ X Reactions at 70 and 40 GeV Respectively

(S B Nurushev)Polarisation in the eRHIC Electron (Positron) Ring (D P Barber)Polarisation Build Up in COMPASS 6LiD Target (J Koivuniemi)and other papers (a total of 170 contributions) Readership: Researchers and graduate students in spin physics, including experimental, theoretical and accelerator physics. Keywords:Spin;Fundamental Symmetries;QCD;Nuclear Physics;Hadronic Physics;Polarized Targerts;Polarized Beams;PolarimetryKey Features:

Readership: Nuclear physicists. keywords: Snake Resonances
Energy Research Abstracts (With CD-ROM)
Epac 96
Volume 7: Colliders

Lists citations with abstracts for aerospace related reports obtained from world wide sources and announces documents that have recently been entered into the NASA Scientific and Technical Information Database.
This book examines the acceleration and storage of polarized proton beams in cyclic

accelerators. Basic equations of spin motion are reviewed, the invariant spin field is introduced, and an adiabatic invariant of spin motion is derived. The text presents numerical methods for computing the invariant spin field, and displays the results in numerous illustrations. This book offers a more lucid view of spin dynamics at high energy than has hitherto been available.

EPAC 96; Proceedings of the Fifth European Particle Accelerator Conference, Sitges (Barcelona), 10 to 14 June 1996, Three Volume Set, also available on a CD-ROM, provides a comprehensive overview of

research, technology, and special applications in the field of accelerators. It serves as a source for novel ideas and familiarizes researchers with advanced concepts.

This Open Access book is drawn from lectures dispensed at the U.S. Particle Accelerator School (USPAS) Summer 2021 Spin Class, by experts in the field. It is an introduction to the dynamics of spin in charged particle accelerators, and to the accelerator components and spin manipulation techniques, including helical snakes and spin rotators, which enable and allow preserving beam polarization. It

is aimed at graduate students or upper division undergraduate students with an interest in this multi-disciplinary field, which includes the future electron-ion collider at the Brookhaven National Laboratory, high energy lepton and proton collider projects, and other electric dipole moment search storage rings. It is also aimed at physicists or engineers working in accelerator-related fields who wish to familiarize themselves with spin dynamics and polarized beam concepts, tools, components, and purposes. This is an open access book.

Handbook Of Accelerator

Physics And Engineering (2nd Edition)
Introduction to Beam Dynamics in High-Energy Electron Storage Rings
Beam Dynamics in High Energy Particle Accelerators
An Introduction to the Physics of Particle Accelerators
Proceedings of the Adriatico Research Conference
High Energy Polarized Proton Beams

The Ann Arbor Workshop on Increasing the AGS Polarization discusses the surprising spin effects discovered at lower energy accelerators, making the new multi-hundred-GeV RHIC polarized proton

collider especially important. The four Siberian snakes in the two RHIC rings successfully preserved most polarization during acceleration and storage; RHIC's main problem was the low polarization injected from the AGS. The Workshop determined a quick and practical plan for increasing the AGS polarization by using three techniques to overcome the three types of depolarizing resonances.
Edited by internationally recognized authorities in the field, this expanded and updated new edition of the bestselling Handbook, containing more than 100 new articles, is aimed at the design and operation of modern particle accelerators. It is intended as a vade mecum for professional engineers and physicists engaged in

these subjects. With a collection of more than 2000 equations, 300 illustrations and 500 graphs and tables, here one will find, in addition to the common formulae of previous compilations, hard-to-find, specialized formulae, recipes and material data pooled from the lifetime experience of many of the world's most able practitioners of the art and science of accelerators.The eight chapters include both theoretical and practical matters as well as an extensive glossary of accelerator types. Chapters on beam dynamics and electromagnetic and nuclear interactions deal with linear and nonlinear single particle and collective effects including spin motion, beam-environment, beam-beam, beam-electron, beam-ion and

intrabeam interactions. The impedance concept and related calculations are dealt with at length as are the instabilities associated with the various interactions mentioned. A chapter on operational considerations includes discussions on the assessment and correction of orbit and optics errors, real-time feedbacks, generation of short photon pulses, bunch compression, tuning of normal and superconducting linacs, energy recovery linacs, free electron lasers, cooling, space-charge compensation, brightness of light sources, collider luminosity optimization and collision schemes. Chapters on mechanical and electrical considerations present material data and important aspects of component design including heat

transfer and refrigeration. Hardware systems for particle sources, feedback systems, confinement and acceleration (both normal conducting and superconducting) receive detailed treatment in a subsystems chapter, beam measurement techniques and apparatus being treated therein as well. The closing chapter gives data and methods for radiation protection computations as well as much data on radiation damage to various materials and devices.A detailed name and subject index is provided together with reliable references to the literature where the most detailed information available on all subjects treated can be found.

Siberian Snakes provide a practical means of obtaining polarized proton

beams in large accelerators. The effect of snakes can be understood by studying the dynamics of spin precession in an accelerator with snakes and a single spin resonance. This leads to a new class of energy independent spin depolarizing resonances, called snake resonances. In designing a large accelerator with snakes to preserve the spin polarization, there is an added constraint on the choice of the vertical betatron tune due to the snake resonances. 11 refs., 4 figs.

The September 1994 symposium was held in conjunction with the Eighth International Symposium on Polarization Phenomena in Nuclear Physics a field with which it has both scientific and technological concerns

in common. Sessions are devoted to strong interactions at high energy, electroweak interactio

Baryons '95

Polarized Beam Dynamics and Instrumentation in Particle Accelerators

Second Edition

Handbook of Accelerator Physics and Engineering

Reviews of Accelerator Science and Technology

Accelerator Physics (Fourth Edition)

The volume presents an up-to-date survey of spin physics at the very high energies of present and future colliders. Topics discussed include the theory of high-energy spin

physics, deep-inelastic scattering, polarization experiments at colliders, the production of high-energy polarized electron and proton beams, the construction of intense polarized sources and high-energy polarimeters. It will represent a significant reference in the field and an informative text for non-specialists as well, with rather complete keynote overview reports by some physicists who have contributed most to the subject. In addition, it will document the

character of frontier research symposium of the Conference, with specialized reports of leading experts in the various items of the field. Contents:The Context of High Energy QCD Spin Physics (R L Jaffe)SPIN Collaboration and Polarized Proton Beams (A D Krisch)Spin Physics at RHIC: A New Twist on the Heavy Ion Experiments (M J Tannenbaum)The Problem of the Spin of the Proton and Elastic Neutrino-Proton Scattering (S M Bilenky et al)Handedness: Status and

Puzzles (A Efremov et al)SLD Physics with Polarized Beams (J R Johnson)Longitudinal Electron Polarization at HERA and Prospects for Proton Polarization at Very High Energy (D P Barber)Collider Spin Physics at RHIC and STAR (A Yokosawa)Spin Structure of the Nucleon and Further Perspectives of Spin Physics from PHENIX (N Saito)Evolution of the Spin-Splitter Concept (N Akchurin et al)Summary of Experimental Data on High Energy Spin Physics (S B Nuruschev)and other papers

Readership: High energy physicists. keywords: This Note reports on the first simulations of and spin dynamics in the AGS using the ray-tracing code Zgoubi. It includes lattice analysis, comparisons with MAD, DA tracking, numerical calculation of depolarizing resonance strengths and comparisons with analytical models, etc. It also includes details on the setting-up of Zgoubi input data files and on the various numerical methods of concern in and available

from Zgoubi. Simulations of crossing and neighboring of spin resonances in AGS ring, bare lattice, without snake, have been performed, in order to assess the capabilities of Zgoubi in that matter, and are reported here. This yields a rather long document. The two main reasons for that are, on the one hand the desire of an extended investigation of the energy span, and on the other hand a thorough comparison of Zgoubi results with analytical models as the 'thin lens'

approximation, the weak resonance approximation, and the static case. Section 2 details the working hypothesis : AGS lattice data, formulae used for deriving various resonance related quantities from the ray-tracing based 'numerical experiments', etc. Section 3 gives inventories of the intrinsic and imperfection resonances together with, in a number of cases, the strengths derived from the ray-tracing. Section 4 gives the details of the numerical simulations of resonance crossing,

including behavior of various quantities (closed orbit, synchrotron motion, etc.) aimed at controlling that the conditions of particle and spin motions are correct. In a similar manner Section 5 gives the details of the numerical simulations of spin motion in the static case: fixed energy in the neighboring of the resonance. In Section 6, weak resonances are explored, Zgoubi results are compared with the Fresnel integrals model. Section 7 shows the computation of the {rvec n} vector in the AGS

lattice and tuning considered. Many details on the numerical conditions as data files etc. are given in the Appendix Section, pages A and sqs.

Edited by internationally recognized authorities in the field, this handbook focuses on Linacs, Synchrotrons and Storage Rings and is intended as a vade mecum for professional engineers and physicists engaged in these subjects. Here one will find, in addition to the common formulae of previous compilations,

hard to find specialized formulae, recipes and material data pooled from the lifetime experiences of many of the world's most able practitioners of the art and science of accelerator building and operation.

This volume offers an introduction to recent developments in several active topics of research at the interface between geometry, topology and quantum field theory. These include Hopf algebras underlying renormalization schemes in quantum field theory,

noncommutative geometry with applications to index theory on one hand and the study of aperiodic solids on the other, geometry and topology of low dimensional manifolds with applications to topological field theory, Chern-Simons supergravity and the anti de Sitter/conformal field theory correspondence. It comprises seven lectures organized around three main topics, noncommutative geometry, topological field theory, followed by supergravity and string theory,

complemented by some short communications by young participants of the school.

Spin Dynamics Simulations at AGS.

Workshop Summary -- Accelerator Issues

Spin 2004

Spin Structure of the Nucleon

Spin Tracking Simulations in AGS Based on Ray-tracing Methods - Bare Lattice, No Snakes - SPIN DYNAMICS IN AGS AND RHIC.

Getting down to the bottom line is what this proceedings digest is all about, as any physicist will

tell you: spin is the fundamental concept in physics. The applications are pretty universal due to the fact that, using spin-related phenomena, physicists are trying to reveal the fundamental principles of nature – and things don't come much more bottom-line than that. This volume is the proceedings of the 17th International Spin Physics Symposium which is a forum to discuss spin physics and related topics.

Edited by internationally recognized authorities in the field, this expanded edition of the bestselling Handbook first published in 1999 is aimed at the design and operation of modern

accelerators including Linacs, Synchrotrons and Storage Rings. It is intended as a vade mecum for professional engineers and physicists engaged in these subjects. With a collection of 2200 equations, 345 illustrations and 185 tables, here one will find, in addition to the common formulae of previous compilations, hard to find, specialized formulae, recipes and material data pooled from the lifetime experience of many of the world's most able practitioners of the art and science of accelerators.The eight chapters include both theoretical and practical matters as well as an extensive glossary of

accelerator types. Chapters on beam dynamics and electromagnetic and nuclear interactions deals with linear and nonlinear single particle and collective effects including spin motion, beam-environment, beam-beam and intrabeam interactions. The impedance concept and calculations are dealt with at length as are the instabilities associated with the various interactions mentioned. A chapter on operational considerations deals with orbit error assessment and correction. Chapters on mechanical and electrical considerations present material data and important aspects of component design

including heat transfer and refrigeration. Hardware systems for particle sources, feedback systems, confinement and acceleration (both normal conducting and superconducting) receive detailed treatment in a subsystems chapter, beam measurement techniques and apparatus being treated therein as well. The closing chapter gives data and methods for radiation protection computations as well as much data on radiation damage to various materials and devices.A detailed index is provided together with reliable references to the literature where the most

detailed information available on all subjects treated can be found. The past 100 years of accelerator-based research have led the field from first insights into the structure of atoms to the development and confirmation of the Standard Model of physics. Accelerators have been a key tool in developing our understanding of the elementary particles and the forces that govern their interactions. This book describes the past 100 years of accelerator development with a special focus on the technological advancements in the field, the connection of the various accelerator projects to key developments and

discoveries in the Standard Model, how accelerator technologies open the door to other applications in medicine and industry, and finally presents an outlook of future accelerator projects for the coming decades.

The topics covered in the conference ranged from the physics that can be done with polarized beams of particles (protons, electrons, gamma-rays, etc.) to the techniques and instrumentation necessary to achieve this. Topics included: nucleon structure measurements (from where does the spin of the proton and neutron come), the acceleration, storage and

polarization of particle beams and the polarized targets and sources necessary for mounting the experiments.

RHIC Polarized Proton Operation

Proceedings of the Fifth European Particle Accelerator Conference, Sitges (Barcelona), 10 to 14 June 1996 - 3 Volume Set

Trends in Collider Spin Physics

Proceedings of the 17th International Spin Physics Symposium

This book provides a concise and coherent introduction to the physics of particle accelerators, with attention being paid to the design of an accelerator for use as an experimental tool. In the second

edition, new chapters on spin dynamics of polarized beams as well as instrumentation and measurements are included, with a discussion of frequency spectra and Schottky signals. The additional material also covers quadratic Lie groups and integration highlighting new techniques using Cayley transforms, detailed estimation of collider luminosities, and new problems.

From the reviews: "This book is a very welcome and valuable addition to the accelerator literature. As noted by the authors, there is relatively little material in the book specifically for low-energy machines, but industrial users may

still find it useful to read." Cern Courier