

Preface

Polarization physics represents the section of physics devoted to investigate the statistical and dynamical characteristics of processes associated with spin, which is one of the fundamental characteristics of elementary particles and nuclei. The spin is a tool to investigate and test fundamental questions in all type of well known interactions like the electroweak, strong and gravitation fields. This occurs for reason that all elementary particles involved in those interactions have the integer or half-integer spins.

During more than century development, polarization physics has created serious theoretical and methodical foundations leading to many discoveries. Its development became particularly fast in last two decades in connection with the “spin crisis” phenomenon discovered in 1987 by European Muon Collaboration (EMC) at CERN.

Large polarization effects have been revealed in the production of hyperons and strong spin effects have been found in the exclusive and inclusive production of hadrons. Investigations on polarization physics are conducted at the largest proton and electron accelerators and colliders. The great successes are reached in engineering methods of polarization physics. These successes concern the development of the methods for obtaining and accelerating polarized particles and the polarimetry methods for such beams. Impressive results have been obtained in the development of high-current and highly polarized ion sources for accelerators, as well as polarized targets.

To summarize the results of polarization physics the polarization community organizes the biannual High Energy Spin Physics Symposia, started in 1974 at the Argonne National Laboratory (Chicago); follow-up meetings were at Argonne 1976 and 1978, Lausanne 1980, Brookhaven 1982, Marseille 1984, Protvino 1986, Minneapolis 1988, Bonn 1990, Nagoya 1992, Bloomington 1994, Amsterdam 1996 and Protvino 1998. In 2000 in Osaka this Symposium was united with another polarization meeting under the title “The Symposia on Polarization Phenomena in Nuclear Physics”, started at Basel in 1960 and conducted every five years at Karlsruhe 1965, Madison 1970, Zürich 1975, Santa Fe 1980, Osaka 1985, Paris

1990 and Bloomington 1994, the last one being in parallel to the High Energy Spin Physics meeting. The new Conference was named as The 14th International Spin Physics Symposium, followed by meetings at Brookhaven 2002, Trieste 2004, Kyoto 2006, Charlottesville (Virginia) 2008, and in 2010 19th International Spin Physics Symposium was held in Juelich (Germany). Between symposia, workshops on various important sections of polarization physics were organized.

The time has come to gather the basic results of polarization physics, to systematize them so that they were accessible to a wide audience.

A number of monographs were devoted to this field, but they have an appreciable theoretical bias. In addition into those monographs were not included many important works on the theoretical and experimental polarization physics done by Soviet and later by Russian physicists. We aim to fill this gap.

In this book, we aimed to compile and systematize theoretical, experimental, and particularly methodical aspects of polarization physics and to present them in the accessible form. We include in book the experimental data starting approximately around the middle of 1970s when the polarization of Λ —hyperons was discovered at Fermilab and a lot of polarization results became available from high energy accelerators over the world.

This book is primarily designed for final-year and post-graduate students of faculties of physics of technical universities and assumes the corresponding basic knowledge. At the same time, to assist the study of the material, we tried to present the basic terms and definitions with the corresponding explanations. The most recent results are taken for the presentation of the corresponding fields. When writing the book, we use our lectures for students and wider audience, as well as our original papers, review articles and presentations at conferences.

The book consists of three parts. The parts are divided into chapters (numbered sequentially as 1, 2, etc. throughout the book) and the chapters are divided into sections (having common numbering throughout the book: Section 1.1, Section 1.2, first number denoting to which section chapter belong). Some sections are divided into subsections (numbered as Section 1.1.1, Section 1.1.2, etc.). The numbering of the formulas, tables, and figures is the same as numbering of sections in each chapter. The lists of references are given after each chapter. A reference mentioned in the text is indicated by the surname of the first author and the surname of the second author, if there are two authors only, or et al., if there are more than two authors, and the publication year. If a list of references contains several works of one author in one year, these works are marked by letters (a, b, c, etc.) after the publication year.

In order to unify the notations of the spin observables we introduce Sect. 13.4, under the title “The Ann Arbor Convention” adopted in 1977. It might be useful in identifications of the different labeling of polarization observables used in various scientific papers.

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