Syllabus, prerequisites and suggestions

Syllabus

(0) A survey of past, current and future facilities for polarisation.

(1) The concept of spin in accelerators and storage rings and the Thomas-BMT equation of spin precession.

(2) The stability of spin motion on the closed orbit. Spin rotators.

(3) The Sokolov-Ternov effect and the basics of electron(positron) self polarization. Time scales.

(4) Depolarisation of electrons(positrons) due to synchrotron radiation. Spin-orbit resonance and the classification of resonances.

(5) The preservation of polarization during acceleration of protons. The modern definition and calculation of resonance strength. Full and partial Siberian Snakes.

(6) Polarised sources and the measurement of beam polarization.

(7) Examples of the use of spin-polarised beams will be included at the appropriate places.

(8) If there is time, I'll go more deeply into each topic and touch on advanced topics such as that of the invariant spin field.

Prerequisites

(1) A secure understanding of the linear optics of particle beams in rings including familiarity with the concept of symplecticity and fully coupled motion in 6-D phase space (so that synchrotron motion is properly included).

(2) An understanding of the way synchrotron radiation leads to the establishment of the emittances of stored electron beams.

(3) A secure understanding of the concept of spin and spin precession in nonrelativistic quantum mechanics. An understanding of the basic ideas surrounding nuclear magnetic resonance would be helpful.

Suggestions

It is therefore strongly(!) recommended that participants prepare for the course by

(a) following the course and tutorial by Ian Bailey, which immediately precede this course. His material on spin density matrices, the so-called interaction picture in quantum mechanics, and radiative transitions using quantum-mechanical perturbation theory are particularly relevant.

(b) and by reviewing at least the following topics:

   (1) Thomas precession and Lorentz transformations of electric and magnetic fields. See for example, J.D. Jackson "Classical Electrodynamics".

   (2) The concept of Hamiltonians in classical and quantum mechanics.

   For classical Hamiltonians, see, for example:

   Alex Chao's lectures (Summer Term 2011) Rob Appleby's lectures (Autumn Term 2011) Andy Wolski's lectures (Summer Term 2009)

   For 6-D linear dynamics see Andy Wolski's lectures of Autumn 2010

   and more recent courses covering similar material.

   (3) Electron beam dynamics with emphasis on emittance as, for example, in M. Sands SLAC-121 (1970) and/or books like those of K. Wille or H. Wiedemann on accelerator physics.

   For synchrotron radiation, see Jim Clarke's lectures of Spring 2010.

   (4) The concept of magnetic moments and their precession in magnetic fields.

   The analogous concept of precession of a gyroscope's (top's) axis in a gravitational field.

   (5) The solution of linear inhomogeneous differential equations by using integrating factors and/or by the method of variation of parameters as, for example, in G. Arfken and H. Weber, ' Mathematical Methods for Physicists".