SPIN@USPAS Summer 2021
Graduate "Spin Dynamics" Homework

HOME WORK 2 / ex. 2.2: SYNCHRONIZED TORQUE

Solutions to be handed back by Wed. 9 morning (non-spinor questions)
and Friday 11 morning (spinor).

June 7, 2021

Responses, in order to be considered, have to be justified and explained - thank you

The simulation data files needed are:
Main file: synchSpinTorque.INC.dat
Optical sequence file: 60degSector.inc

The simulation input data file synchSpinTorque.INC.dat computes the circular motion of a few protons and their spins, in a uniform 5 kG field. The sequence segment [#S_60degSectorUnifB:#E_60degSectorUnifB] from 60degSector.inc (namely, a 60 deg uniforme field dipole) is grabbed by synchSpinTorque.INC.dat using an INCLUDE. These files contain some "*****"; these have to be replaced with proper numerical values, as part of the exercise. Minor modifications of the input data, including addenda or commenting, will be needed, they depend on the questions treated.

Carefully read the comments in these input data files.

For each question below, explain what you observe and compare with theory. (The pictures on the right give an idea of expected outcomes, reading and plotting from either zgoubi.SPNPRT.Out or from zgoubi.plt files).

1/ (6 points) Find the closed orbit for a 200 keV proton in that 5 kG uniform field.

2/ Introduce a 30 degree precession of the spin, rotation axis is the longitudinal axis (SPINR can be used (recommended), or a solenoidal field using SOLENOID).

2.a - (4 points) Plot S_Z (vertical spin component) versus orbital angle, over a few tens of turns.

2.b - (4 points) Plot the projection of the spin vector motion in the horizontal plane.

2.c - (4 points) Plot the projection of the spin vector motion on a sphere.

3/ Change the proton energy to 108.412 MeV, repeat questions 1/ and 2/.

How many turns are needed to flip the spin?

4/ Repeat for 370.082556 MeV.

5/ (6 points) Give the spinor representation (please use nomenclature and reference frame conventions of "Spinor Methods" lecture) of

5.a - this spin rotator;

5.b - the ring with this spin rotator.
Deduce the spin tune, and spin closed orbit vector at the solenoid. Check the numerical values.

Typical gnuplot graphics,
from zgoubi.fai style or from zgoubi.plt
output files: