ADVANCED SOLAR PHYSICS AND SPACE WEATHER
List 3

1. Describe the motion of an electrically charged particle in a magnetic field. Provide examples of such particle motion in nature, including contexts in heliophysics, astrophysics, and everyday life.

What magnetic force acts on an electrically charged particle when it moves perpendicular to a homogeneous magnetic field with a magnetic induction **B** of 1000 Gs (Gauss), at a velocity of 20% of the speed of light? Perform calculations for both electrons and protons.

2. What is the gyro-motion of particles in a magnetic field? Describe and explain this phenomenon using mathematical equations. Provide examples of this type of particle motion observed in the Sun. Additionally, present the relevant equations and provide explanations for the following concepts:
a) angular gyrofrequency
b) Larmor frequency
c) Larmor radius

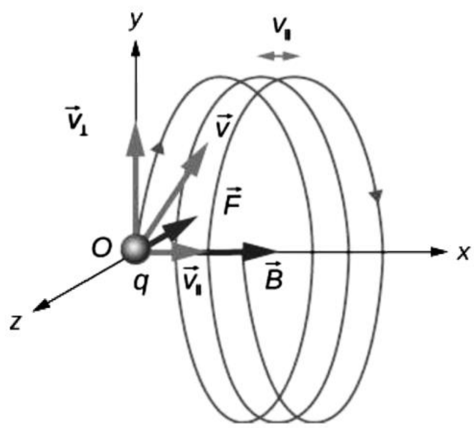
How can we describe the cyclotron frequency for electrons and ions using appropriate equations?

What physical parameters can be determined from observations of cyclotron or synchrotron emission?

3. What is the plasma frequency? This question should be discussed both conceptually and in the form of a mathematical expression. On which parameters does the plasma frequency depend? In what ways can the plasma frequency be utilised during observations or in the analysis of solar phenomena?
Provide examples of plasma frequency values characteristic of the solar atmosphere, and compare them with corresponding values observed in the Earth's ionosphere.

4. A charged particle enters a homogeneous magnetic field with a certain velocity. What should be the angle between the magnetic induction vector **B** and the particle's velocity vector **v** such that this angle (pitch angle) of the helical trajectory (distance between consecutive turns of the spiral/helix) is equal to the radius of the helix?

The pitch angle refers to the horizontal distance between successive loops (circles) of the helical path along which the particle moves - see the accompanying diagram. The motion along the component of velocity parallel to the magnetic field determines the pitch *p* of the helix (i.e. the particle's trajectory), which corresponds to the distance between consecutive turns of the spiral. This distance is equal to the product of the parallel velocity component $\boldsymbol{v}_{||}$ and the period *T* of the circular motion associated with one complete turn of the helix (one circle).



It should be used that for a charged particle of mass *m* and charge *q*, moving with vector of velocity ***v*** perpendicular to a magnetic field induction ***B***, the radius of curvature (*r*) of its trajectory is proportional to the product of its mass and velocity, and inversely proportional to the product of its charge and the magnetic field induction.

What would occur if the angle calculated in the exercise were 0° or 90°?

Krzysztof Radziszewski