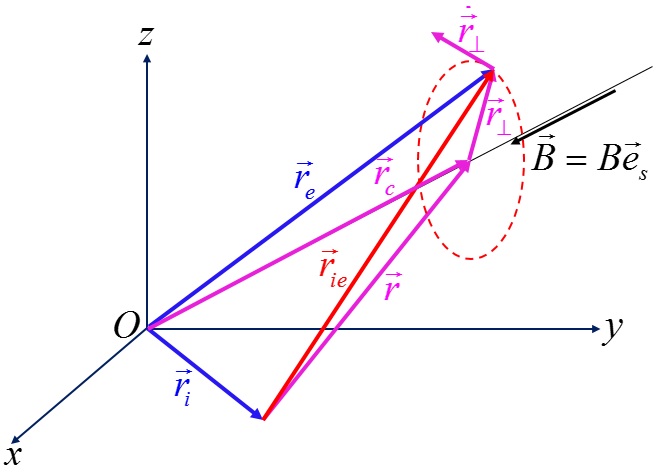
**Magnetized Electron: Kinematic of the Motion**

Equation of motion for electron in the homogeneous magnetic field  and central Coulomb field of the ion:

 (1)

where  is a radius-vector of electron and  is a vector from ion to electron. Let’s divide the velocity of electron into two parts:  is the perpendicular to the direction of magnetic field, i.e.  is the radius-vector from the center of the electron Larmor circle with radius  ( is the electron Larmor frequency) to the electron and along the magnetic field.

Obvious relations between vectors (see Figure on the left) are

 (2)

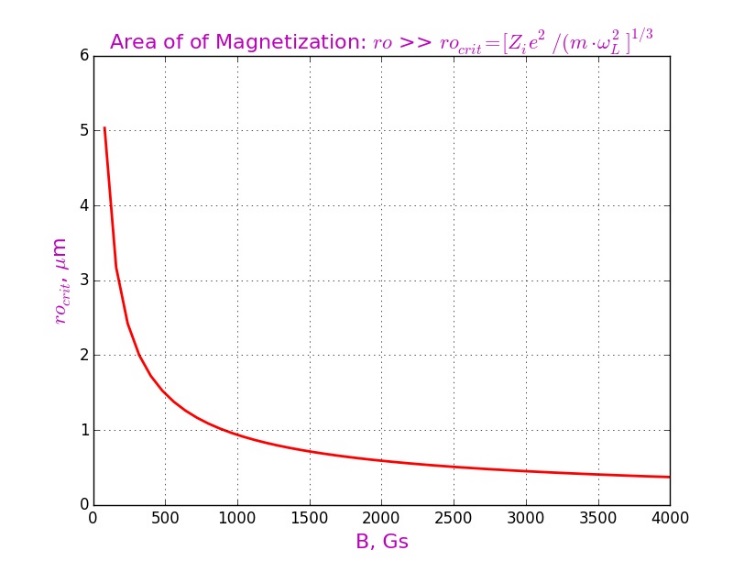
and allow rewriting equation (1):

 (3)

Equation (3b) allows finding the following condition for magnetization of electron motion: The first term in the right part of the equation must be much more than second one:

 (4)

where it was taken into account that the “reduced mass”  practically equals . Dependence of  on magnetic field is shown in the next Figure.

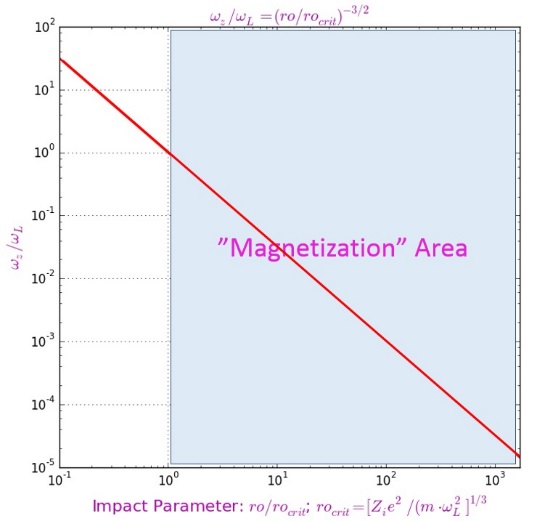
The displacement of the magnetized electron across the magnetic field as will be seen from the following is very small. It means that the distance  between ion and electron practically does not change during the collision, i.e. , where  is the impact parameter. Thus, the equation (3b) can be rewritten as follows:

 (5)

On the plane perpendicular to the magnetic field with the origin at the center of the Larmor circle, it is convenient to introduce a local coordinate system , so that  and instead of the equation (5) the following system is in place:

 (6)

where

 (7)

On the left Figure is shown the dependence of ratio  on the ratio .

System (6) is solved easily, using the substitution . Then the equation for  is as follows:

 (8a)

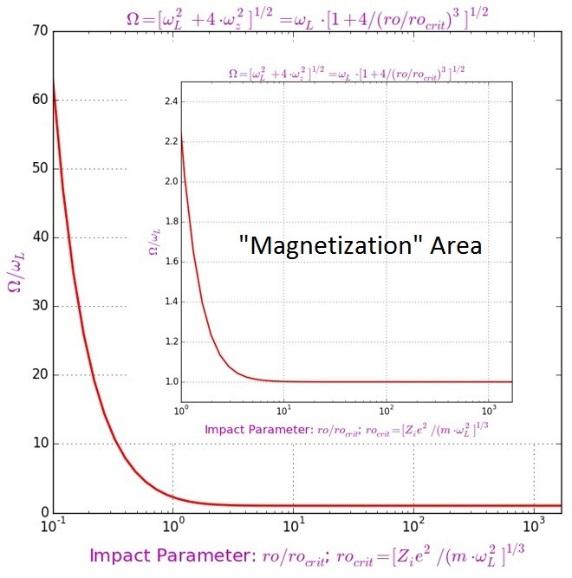
and has an obvious solution:

 (8b)

with

 (9)

Here .

Relative frequencies depend on ratio  only. On the left Figure shows that in the area of magnetization () the frequency  varies insignificantly and is close to the Larmor frequency. Relations (9) indicate a similar behavior of the frequencies .

Expressions (8) give the following solution of the equations (6):

 (10)

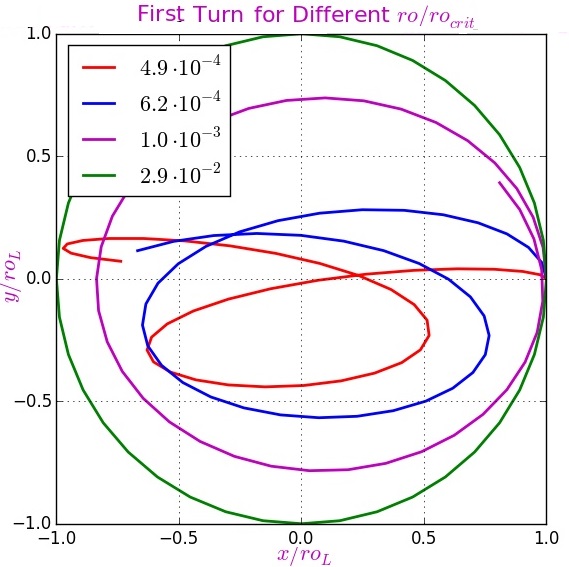
It is convenient to rewrite this solution in the dimensionless variables  and, without violating the generality of the examination, to use the following initial conditions:

. (11)

Then expressions (10) have a very simple form:

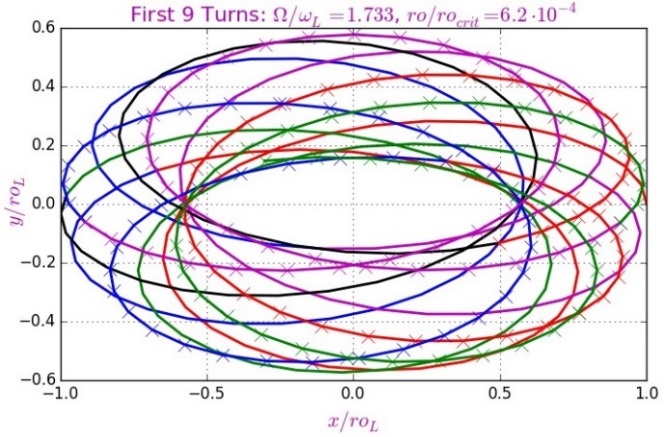
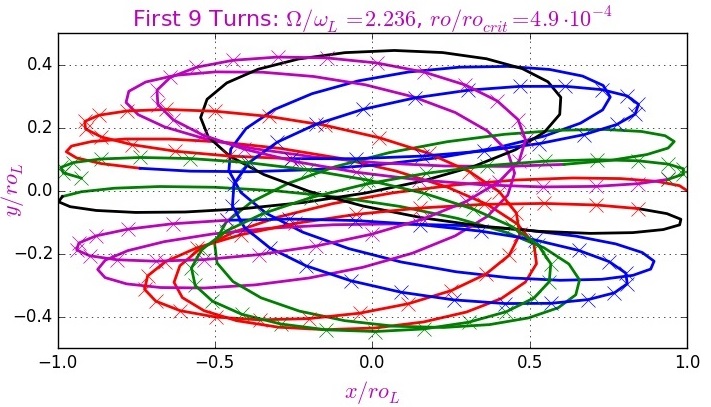
 (12)

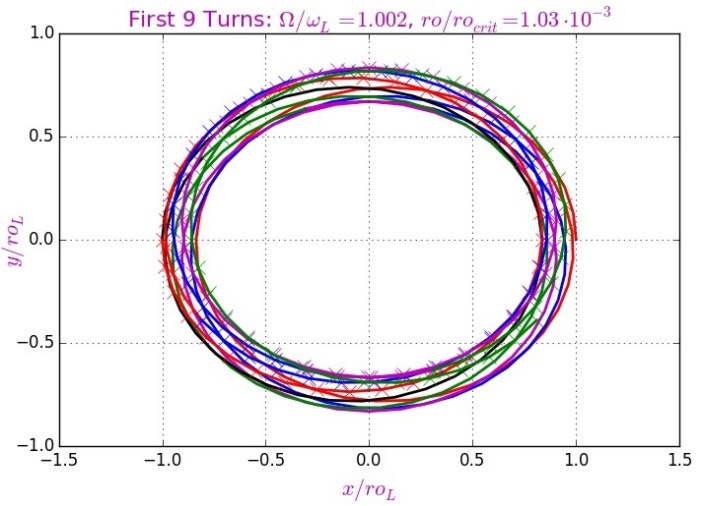
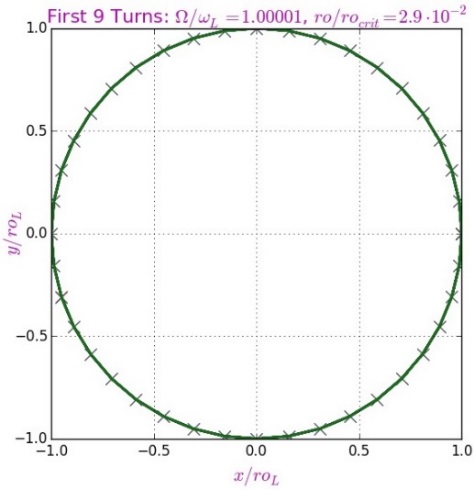
Relations (12) show very strong dependence of the trajectory of electron on the level of its magnetizing because all frequencies  depend on the value of ratio .

In accordance with the condition (4) the electron is magnetized  while in the opposite case the influence of the ion field will be significant.

The left Figure with first turn for the different value of  confirms that. It shows that the trajectory of a nonmagnetized electron significantly differs from Larmor circle. Nevertheless, this difference rapidly decreases with an increase in the impact parameter and at values still lower than the critical value practically disappears (green curve for ).

The next set of Figures demonstrates the first nine turns for different values of , i.e. out of the “magnetization” area. Each turn is shown in a different color: red, blue, magenta, green and black for turns 1 – 5 correspondingly and the same sequence of colors with sign “X” for turns 6 – 9.

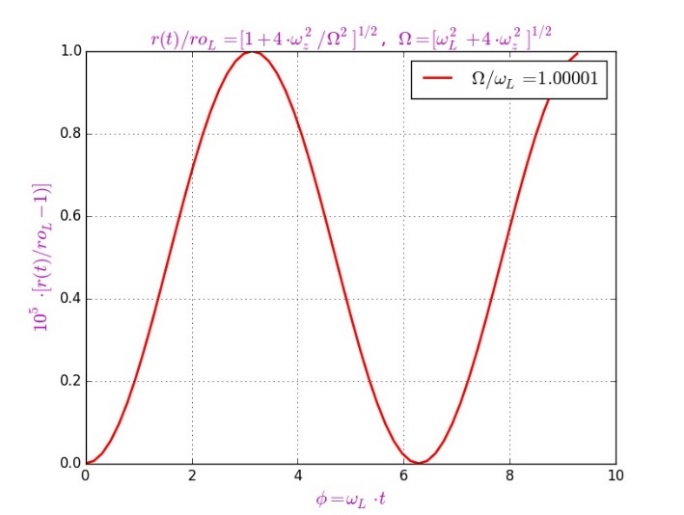
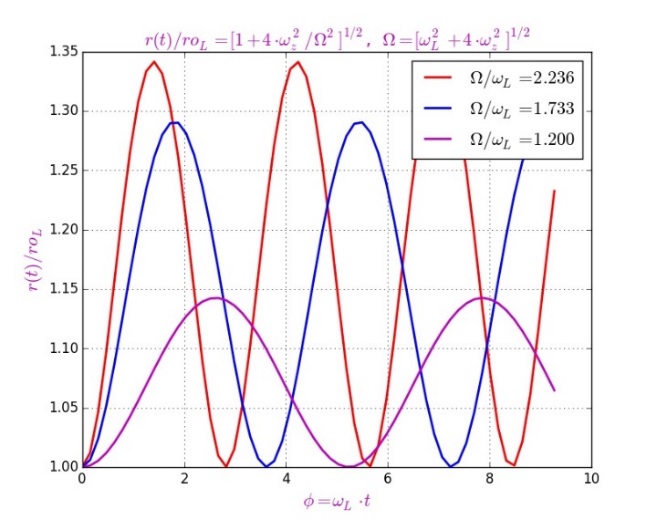


It can be seen that the radial size of trajectory  oscillates in time:

. (13)

This behavior is shown in the following Figures for the impact parameter values  used in the previous Figures.



All last these Figures confirm the conclusion made earlier that even with values of the impact parameter smaller than the critical one, the motion of the electron can be regarded as strongly magnetized.

**Conclusion: the region of magnetization of motion begins at the values of impact parameter much smaller than the critical value . Therefore, in calculating the parameter-dependent quantities, such as, for example, the friction force (acting on an ion moving in an electron medium), the critical value of the impact parameter is a good lower boundary.**