

PHYSICS AND ASTRONOMY

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Gunay Dadashzade

Azerbaijan State Pedagogical College

gunay_dadaszade@mail.ru

Electromagnetic Phenomena in Nature and Their Causes

Abstract

All physical phenomena that occur in nature are related to one or another mutual effects. Electric and magnetic phenomena are of particular importance in order to gain extensive knowledge about the structure of the world around us. Electric and magnetic forces can be transmitted over a certain distance like gravitational forces. While the source of the gravitational field is mass, the source of the electromagnetic field is electric charge.

The only reason for such a contradiction may be the discrepancy between the research methods used by science and the essence of the problem being studied. Historically, all research methods should be divided into methods before and after the advent of the computer era. It was the former that were at the disposal of researchers whose recommendations were used in the formation of the existing regulatory framework.

Keywords: *electromagnetic, charge, particles, framework, interaction*

Introduction

Electric charge is the property of electromagnetic creation between objects or particles. Electromagnetic interaction is the interaction between particles or objects that have an electric charge.

At the beginning of the 19th century, the English physicist Rutherford proposed the nuclear model of the atom. The atom consists of a positively charged nucleus and negatively charged electrons revolving around it. Later, it was determined that the nucleus of the atom is composed of protons and neutrons (Artemyev, Tikhodeev, & Shur 1965). The electric charges of the electron and proton are opposite in value. The nature that surrounds us is rich in electrical phenomena. We live in the earth's electric field. Various electrical processes also occur in living organisms.

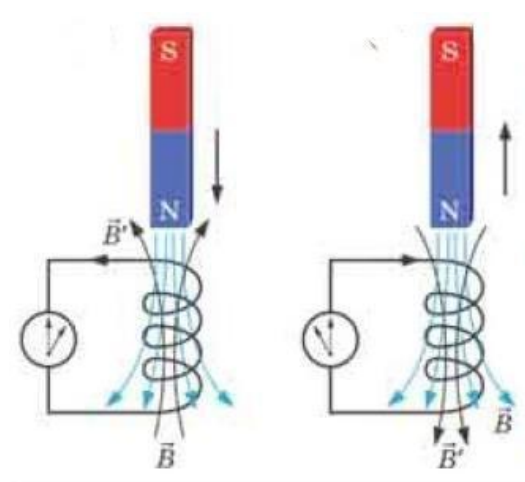


Figure 1. The induced current is caused by the change in the magnetic flux

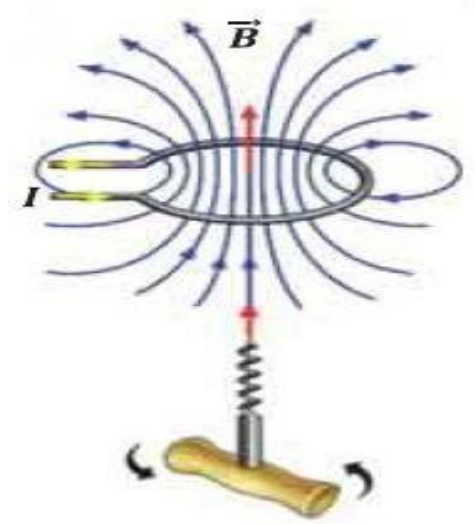


Figure 2. The direction of the induction of the magnetic field within the circular current

Research

The Earth is charged with a negative charge. The upper layers of the atmosphere have a positive electrical charge. The regular movement of charged particles is called an electric current. Electric current is magnetic. is the source of the magnetic field. The magnetic field is a type of matter created by electric charges in motion. It can be seen as a large magnet on the ground (Voldek & Popov, 2007). The connection between the changing electric field and the changing magnetic field creates the electromagnetic field. The propagation of the electromagnetic field in the form of waves in space was first experimentally confirmed by the German scientist Hers. I wonder if the electromagnetic field has a role in the development of the world from yesterday to today?

Electric current was already known to the Greeks 600 years before our era. At that time, people observed that amber attracts other materials by rubbing it on woolen cloth. In 1600, the English physicist GILBERT DE MAGNETE observed in his work that amber is attracted to other materials as well. In the 17th century, with electricity the engaged German scientist Offo Van created the first electrification machine, or rather, the generator. In the 18th century, the main work was done on the development of electric current and batteries to generate it. After the invention of the connection between magnetism and electric current at the beginning of the 19th century, a broad basis for the practical application of this physical quantity C. Maxwell's electromagnetic theory, as a generalization of the basic laws of electric and magnetic phenomena, foreshadowed new phenomena by explaining the results of the experiments that existed at the time (Petrov, 1974). It was later proven that the propagation speed of the free electromagnetic field in a vacuum is equal to the speed of light. It was only a few years after Hertz's discovery of electromagnetic waves. then it was already used to transmit information. In 1895, Popov invented a very primitive radio device. In the following years, the Italian inventor Marconi provided an electric bell ringing from a distance of 9 meters in 1896. The electromagnetic waves that caused the ringing of the bell were called radio waves. played an important role (Bespalov & Kotelenets, 2006).

If the induction vector is parallel to the surface – perpendicular to the surface normal – $\alpha = 90^\circ \rightarrow \cos 90^\circ = 0$, and the magnetic flux passing through the surface is equal to zero: $\varphi = 0$. Therefore, the induction vectors that do not cross the surface do not create a magnetic flux.

The phenomenon of electromagnetic induction discovered by the English scientist Michael Faraday (1791-1867) in 1831 showed that electric and magnetic fields interact.

You know that when a permanent magnet is inserted and removed from a coil connected to a galvanometer, an induced current is created in the contours (loops) of the coil. If the magnet is at rest or rotating inside the coil, no current is produced. Therefore, the induced current is caused by the change in the magnetic flux (Figure 1).

Generation of electric current in the circuit as a result of the change of the magnetic flux passing through the surface bounded by the conductive circuit is called the phenomenon of electromagnetic induction.

The direction of the induced current depends on the increase or decrease of the magnetic flux.

1. The magnetic flux increases ($\Delta\phi > 0$). This is possible if the magnet approaches the contour. As a result, the magnetic flux increases, the induction current generated in the loop creates its own magnetic field. That one the field repels the approaching magnet. Therefore, the induction vector of the external magnetic field that creates a current in the circuit and the induction vector of the magnetic field created by the induced current are opposite (Figure 1). In this case, the magnet and the contour repel each other like magnets of the same polarity. By knowing the direction of and applying the right-hand thread rule for circular currents, the direction of the induced current in the circuit is easily determined – the induced current is clockwise.

Right-handed screw rule for circular current: when the support of the coil is twisted in the direction of the circular current, the direction of the forward movement of the coil will indicate the direction of the induction of the magnetic field within the circular current (Figure 2).

When designing and operating intelligent relay protection and automation systems for power transformers supplying complex variable loads, it is necessary to analyze steady-state and transient processes occurring in transformers under normal and emergency conditions in order to make the right decision. For example, with the same instantaneous value of the current surge in the primary winding of the transformer, the protection system must clearly detect the difference between the short-circuit current and the magnetizing current when the transformer is turned on (Kopylov, 2009).

In the first case, the protection should operate instantly, and in the second case, it should not operate, or operate with a time delay. The use of classical mathematical methods for this purpose in many cases turns out to be very difficult due to nonlinear dependencies linking different physical quantities in the transformer, and the adoption of many assumptions or the use of graphical methods gives only approximate qualitative solutions (Lizunov & Lokhanin, 2004). A more effective method of analyzing processes is the method of numerically solving nonlinear differential equations of state in the integrated MathCAD computer mathematics package. To do this, it is necessary to compile a mathematical model of the transformer in the form of a system of nonlinear differential equations in the Cauchy form, which can be solved in the MathCAD package using the fourth-order Runge-Kutta method (Serebryakov & Shumeyko, 2005). The problem considered in this article is to compile a mathematical model of the transformer and study electromagnetic processes in the transformer on this model.

There is a contradiction between traditional scientific approaches to substantiating the required level of transformer insulation, summarized in the current regulatory framework (Serebryakov & Shumeyko, 2013), and operating experience (Serebryakov & Shumeyko, 2013), which consists in the impossibility of explaining the causes of damage to the longitudinal insulation of windings under the influence of internal overvoltages from the distribution network (Sapozhnikov, 1975).

Conclusion

The complexity of the mathematical description of the phenomenon under study forced us to look for rational (simplified) solutions (Ryudenberg, 1955).

The mathematical formulation of the technical problem is the most complex and important part of the work. It is not so much the chosen mathematical calculation methods that are important, but the chosen simplifications of the initial physical problem to be solved (Kostenko & Piotrovsky, 1972).

Any electrical equipment with high-voltage windings (EHVW) consists of at least windings, a magnetic circuit and insulation, which are placed in a housing. As a rule, at the stages of designing electrical equipment and studying the operating modes of electrical networks, all possible relationships between the specified structural components of EHVW are not taken into account.

It has been established for the first time that resonant overvoltages in parts of the winding are the main cause of turn-to-turn short circuits of transformer windings when exposed to internal overvoltages from the network.

Strengthening the longitudinal insulation of the winding will make it possible to increase the reliability of transformer operation.

Resonance of currents in complementary parts of the winding causes overvoltages to appear on these parts in the frequency range from 50 to 100,000 Hz. The frequency of the free component of network overvoltages determines the design of the winding part for which the overvoltages will be maximum.

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