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ELECTROMAGNETIC FIELD - THE HISTORY OF THE DISCOVERY AND PHYSICAL PROPERTIES

Electric and magnetic phenomena have been known to mankind since ancient times, because they saw lightning, and knew about magnets that attract certain metals. But until the 19th century, electricity and magnetism were considered separately from each other, and were accepted as unrelated phenomena.

Danish scientist Oersted established the connection between electrical and magnetic phenomena only in 1819. Later Ampere suggested that there are microscopic closed currents inside the permanent magnet, which create the magnetic field of the magnet interacting with the magnetic field of the current-carrying conductor.

In 1831, Faraday experimentally discovered the phenomenon of electromagnetic induction, that is, he was able to establish the fact of the appearance of an electromotive force in a conductor at the moment when a changing magnetic field acts on this conductor.

After 30 years, Maxwell created the theory of the electromagnetic field, according to which the electromagnetic field includes interconnected electric and magnetic fields. He also created the mathematical basis for electromagnetism, and described it in his famous equations. Maxwell's equations describe a huge range of phenomena, and directly the electromagnetic field. They are the basis of electrical and radio engineering and play a crucial role in the development of modern physics.

In 1887, Hertz confirmed Maxwell's theory of electromagnetic waves: his receiver detected the electromagnetic waves sent by the transmitter.

The electric field is created by electric charges, its lines of force begin on positive charges (conditionally flow from them), and end on negative charges (conditionally flow into them). Thus, electric charges are sources of an electric field. Another source of the electric field is the changing magnetic field. The force acting on an electric charge from the electric field is the part of the force acting on a given charge from the electromagnetic field.

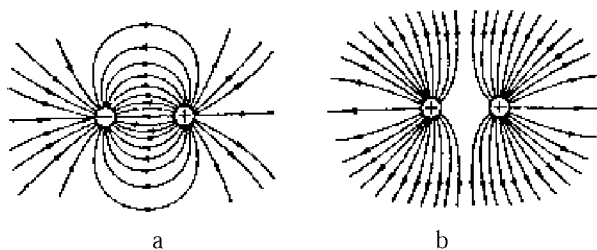


Figure 1 - The lines of field strength created by opposite charges (a) and like charges (b)

The magnetic field is created by moving electric charges (currents), or by time-varying electric fields, and acts only on moving electric charges.

Electromagnetic fields are usually subdivided into: weak, medium, strong and super-strong.

Weak and medium electromagnetic fields are widely used in scientific and applied purposes: in solid-state physics to study the energy spectra of electrons in metals, semiconductors and superconductors; to study ferro - and antiferromagnetism, to obtain ultra-low temperatures, in electron microscopes for focusing electron beams, etc.

To obtain strong electromagnetic fields, superconducting solenoids, water-cooled solenoids, pulse solenoids are used. The forces acting on conductors with current in strong fields can be very large (for example, in such fields mechanical stresses reach the ultimate strength of copper). The effect of the pressure of the electromagnetic field is taken into account when designing electromagnets and solenoids, it is used for stamping metal products.

Super-strong electromagnetic fields are obtained by the method of directed explosion. A copper pipe, inside which a strong pulsed magnetic field has been previously created, is radially compressed by the pressure of the explosion products. With a decrease in the radius R of the pipe, the magnitude of the magnetic field in it increases $\sim 1/R^2$. The disadvantages of this method include the short duration of the existence of an electromagnetic field (several microseconds), a small volume of an ultra-strong electromagnetic field and the destruction of the installation during an explosion.

The main source of electromagnetic waves is the antenna and high-frequency electro-motive force.

Sources of the electromagnetic field: FM radio broadcasting; VHF; personal computers; television stations; special-purpose radar stations; industrial installations; microwave ovens; radio relay stations; physical therapy.

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