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"LARGE HADRON COLLIDER" WITH DIFFERENT METHODS

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At first glance, Fans of spectacular spectacles, like a cloud mushroom over a nuclear test site or the bluish glow of Vavilov — Cherenkov in a reactor, have nothing to do here. All the most interesting things happen in tightly sealed pipes. And yet we can say without exaggeration that this is a place with the most extreme conditions on Earth. And in some ways, in the entire Solar System. For example, in 2021, the LHC managed to reach a record temperature of 5.5 trillion degrees (350 thousand times hotter than in the sun). And the density of the resulting substance was greater than that of a neutron star.

In its function, the collider is close to a microscope. And in some ways it even looks like a time machine. The smallest particles that make up the world cannot be seen or felt. Some of them even live for yoctoseconds (10 to the 24th power of a second) and are formed only under extreme conditions (such as existed, for example, at the birth of the Universe).

To simulate these conditions, scientists accelerate beams of elementary particles to near-light speeds and collide them. The matter of the macrocosm (molecules and physical bodies) disintegrates in such conditions, but the most interesting thing begins for the microcosm.

In the most general sense — to understand how everything works. Scientists use theoretical models to find explanations for natural phenomena, predict events and create new technologies. But in any model there are both white spots and contradictions.

Decades ago, physicists formulated the provisions of the Standard Model, in which all the main processes were subject to four forces: weak, strong, electromagnetic and gravitational. For example, without weak interaction there would be no thermonuclear reactions, the Sun would not shine and life would be impossible.

The equations of the Standard Model can be compared with a drawing of a huge tower. We look at it and imagine how the tower stands, how people live in it and how it behaves in different weather conditions. But this is just a theory. During construction, materials may behave differently. Due to a design error, such a building might never have been able to exist.

The standard model allows us to theoretically predict the properties of thousands of different processes in the world of elementary particles. And most often these predictions are confirmed by experiment. But sometimes the predictions differ from the data obtained. And sometimes you have to struggle for years to confirm a long-formulated hypothesis.

According to the Standard Model, all elementary particles are divided into fermions, which make up matter, and bosons, which provide interactions between fermions. Without bosons, neutrons, protons and electrons would simply fly around the universe without forming atoms.

Another important component of the theory is symmetry. It determines the behavior of particles and the action of forces that affect them. For example, electromagnetic and weak interactions due to symmetry act as manifestations of the same force — electroweak. But this beautiful idea in theory could only work if the particles had no mass.

It is believed that in the early universe, particles were massless, and symmetry was observed. But then the symmetry began to break spontaneously. Some particles behaved as massive, while others behaved as massless. One of the main mysteries of the Standard Model was connected with this process: why spontaneous symmetry breaking occurs.

Physicist Peter Higgs suggested that the mass of particles arises under the action of a special field. In the modern view, particles are not balls, but oscillating "pieces" (quanta) of the field. For example, electrons are vibrations of the electron field, and photons are electromagnetic. The Higgs boson is also a quantum. Some particles, passing through the Higgs field, "cling" to it and gain mass.

The Higgs boson was the last missing element in the Standard Model. If it had not been found, we would have had to look for other explanations of why the symmetry is broken. However, the Higgs mechanism itself is also not fully understood, and therefore the Standard Model itself is only a special case of a more general theory that has not yet been created.

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