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# PHYSICS BEYOND THE STANDARD MODEL: ACHIVEMENTS AND PROSPECTS

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The application of continuous and discrete groups to the theory of nuclei [1], elementary particles [2-4], in the theoretical physics of high energies leads to the need of systematization of knowledge and methods to obtain new information about phase transitions at high energies. Attempts to find a theory of the experiment on the scale of QCD led to the discovery of String Theory. The development of superstring theory as applied to cosmology led to the concept of the "Universe on brane". D-brane theory asserts that gravity and quantum mechanics are integral principles of the construction of the Universe. D-branes are used to solve three serious problems of the Big Bang: flatness problem; the problem of the horizon; the dark energy problem. The application of a complex approach in the study of new physics at high energies is an effective way of studying all four types of interaction within the framework of the theory of D-branes and superstrings, which are necessary for solving the current problems of modern theoretical and experimental physics.
**The purpose** of the work is to clarify the properties of physical objects such as vibrational modes of superstrings located between D-branes for purposeful search on modern accelerators in the form of Kaluza-Klein modes of gauge particles, microscopic black holes and other exotic particles. The study of black holes through the prism of the geometry of extra-dimensional space, superstring theory, and the holographic principle is an important component of understanding its nature. **Methodology** of the study is based on general research methods of analysis and synthesis, induction and deduction, mathematical and computer modeling of systems of particles and forces, use of group theory and the analogy method. Also, new theoretical models were proposed by Hawking in the aspect of treating particles near the event horizon, by Maldacena in the aspect of AdS/quantum field theory correspondence, by Witten in the aspect of the Thermal Phase Transition.
**Results** of considered material presents a theoretical model of a phase transition in the early stages of the evolution of the Universe, associated with a heterotic string model, identical to the phase transition of a black hole. We have shown the possibility of using symmetry groups to consider the Theory of Grand Unification. We presented nuclear theories constructed in accordance with various symmetry groups, as well as the matter content of models with extended gauge groups. String theory provides a large number of the observed features of the Universe. There are signs that string theory includes many of the qualitative features of the SM such as gauge groups and matter content [5]. These are ubiquitous features of D-brane realizations of gauge theories. Both gauge coupling unification and the matter content of the SM hint at the presence of a unified gauge group structure at high energies. Indeed, there is a natural sequence of E-group embeddings which give the SM gauge group and matter structure in an elegant manner [6-8].
Modern high energy physics is connected with experimental searches of new physics beyond the SM. Calculations of the production cross sections of rotating, non-rotating ADD microscopic BH using computer simulations and information on the searches for exotics at the LHC at 8 and 13 TeV were presented [9]. The studying of the properties of the new particles predicted by the theories of extra dimensions stimulated us to perform calculations at different parameters and energies within the RS model. Our calculations of *sigma* × ⊠⊠ of gravitons production show that the resonance peak shifts from 5 TeV to 7 TeV with increasing of energy at the colliders from 13 TeV to 14 TeV as well as the absence of peak at energy of 100 TeV at the center of mass energies [10].
In the framework of the space of extra dimensions, calculations of the energy of BH are presented and the proportionality of the energy to the number of degrees of freedom of the strings located between the branes, N, which has the meaning of the level of energy excitation of a soliton object of the D-brane type, is shown [11]. Since the entropy increases and this corresponds to an increase in the excitation level of the soliton state, the decay of BH would be accompanied by an energy release greater than the explosion of a hydrogen bomb [12].

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