DESCRIPTION FOR THE GENERAL PUBLIC

The proposed project aims at conducting searches for physics phenomena from beyond the so-called Standard Model (SM) of elementary particles. SM is a physics theory that governs the subatomic world of fundamental constituents of the Universe and their interactions and has proved to describe most of the experimental results over the last 40 years. However, the current state of knowledge indicates that some processes from beyond the SM should occur at very high energies, although their expected rates are low and easy to miss in the overwhelming spectrum of phenomena that are currently experimentally accessible. The Higgs boson postulated by the Standard Model was discovered in 2012 by the ATLAS and CMS experiments. However, theories that go beyond the SM typically require an extended Higgs sector implying existence of additional scalar bosons. Within proposed project we plan to search for those additional Higgs bosons which can be electrically neutral or charged.

The proposed project will be carried out in the ATLAS experiment at the Large Hadron Collider (LHC) at CERN. The LHC is the largest experimental device ever constructed. It consists of a 27-km long underground tunnel which contains a ring of superconducting magnets with a number of accelerating structures. Its main goal is to accelerate proton beams to unprecedented energies of 6.5 TeV and to collide them in four designated points, instrumented with devices measuring basic properties of outgoing particles. Data collected by one of them, the ATLAS detector, will be used in this project. Until end of 2018, 150 fb^{-1} of data is expected to be collected by the ATLAS detector, giving a unique opportunity to search for processes occurring with very low probabilities.

Heavy fermions (*t*-quarks, *b*-quarks and τ leptons) are expected to be indicators of beyond-SM phenomena. In many models of non-SM physics the decay chains of New Physics particles contain one or more of them. Therefore, processes with such particles will be examined in detail. In particular, searches for a heavy neutral and a charged Higgs bosons will be performed with a pair of τ leptons or a *t*-quark and τ lepton in the final state, respectively. Another interesting New Physics process, to be examined in this project is the production of pairs of SM Higgs bosons decaying into two *W*-bosons and two τ leptons. Such events may suggest the existence of an exotic object, such as graviton, which would decay into Higgs boson pair and enhance the production rate over the very small rate predicted by SM.

The expected results of the proposed project depend on the actual properties of the Universe. Finding an evidence for an extended Higgs sector would make an outstanding discovery. On the other hand, excluding ever larger areas of parameter space available to BSM scenarios is of paramount importance. In either case, the boundaries of our knowledge are extended.