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Searches for rare events, role of underground laboratories

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Understanding of nuclear processes occurring at low energies (< 1 MeV) and observed in laboratories is of great importance for modern particle physics, astrophysics and cosmology. Current experiments include studies of neutrino properties, stellar evolution, the search for non-baryonic dark matter, proton decay or neutrino-less double beta decay. The discovery of the non-zero mass of neutrinos and their oscillations is now well established, however, the absolute scale of their masses is still unknown. It is also unknown whether the neutrino is a Dirac or Majorana particle, that is, whether it is its own antiparticle. These fundamental problems can be resolved by studying the double beta decay. If the neutrinos were a Majorana particles, the neutrino-less double beta decay should occur. It is only possible if the neutrino and the antineutrino are identical particles and lepton number is not conserved. Another extremely exciting problem is the structure of the Universe. A number of astronomical observations indicate that stars in galaxies and galaxy clusters are immersed in a halo of non-luminous matter, having a mass at least one order of magnitude greater than that of visible matter. Although indirectly the existence of dark matter is quite well documented, its nature is still unknown. Theories extending the Standard Model suggest the possibility of direct registration of cold dark matter particles (collectively referred to as Weakly Interacting Massie Particles - WIMPs), through interactions with atomic nuclei.

The discovery of WIMPs, neutrino-less double beta decay or the proton decay would be of great importance for modern physics. However, searches for these processes are very difficult due to the fact that the expected signal is extremely weak. The active masses of the detectors currently in operation are on the order of several hundred kilograms, and essentially no detector has so far registered an indisputably positive signal. In the new generation of experiments being prepared, the active masses will be at the level of many tons. However, in order to significantly improve their sensitivities, at the same time as increasing the mass, the background of the detectors must be reduced. The background comes mainly from the decays of natural radioisotopes contained in the construction materials and from cosmic rays. To reduce the latter the detectors are located in deep underground laboratories. Shallower laboratories, on the other hand, are necessary for material testing, selection and related R&D studies. We plan to conduct such measurements in an underground laboratory in Książ. In the talk construction of the site, preliminary results of measurements characterizing the site (muon flux, radon concentration) and research plans will be discussed.

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