NUCLEAR AND SUBNUCLEAR PHYSICS

Energetic particles in solar flares – multipoint observations from Sun to Lomnický Štít
supervisor: prof. Ing. Karel Kudela, DrSc.
consultant: RNDr. Radoslav Bučík, PhD
(https://radoslavbucik.wordpress.com)
study form: full time
Annotation: Particle acceleration is ubiquitous in the Universe. Sun is the only astrophysical object where energetic particles from solar flares and their sources can be jointly observed. The acceleration mechanism in solar flares, tremendously enhancing rare elements like 3He and ultra-heavy nuclei (like 197Au, 207Pb), has been puzzling for almost 50 years. Magnetic reconnection is the energy source of particle acceleration in solar flares as indicated by hard X-ray imaging of energetic electrons. By investigating of energetic ions we can probe how the magnetic energy is transformed during reconnection. Such study provides a unique view on diverse processes operating in solar flares and presumably in flares on other stars in the Universe. The goal of this project is to advance our understanding the acceleration of energetic ions in solar flares and their injection into the interplanetary space. This requires a systematic and detailed analysis of the sources of these particles with high-resolution measurements that have only been available in recent years.

Measurement of top quark production differential cross-section in ATLAS experiment
supervisor: doc. RNDr. Jozef Urbán, CSc.
consultant: RNDr. Roman Lysák, Ph.D.
study form: full time
Annotation: Top kvark is the heaviest elementary particle. It is assumed to play a special role in many models beyond the Standard Model, the currently accepted theory of elementary particles. The large number of top quarks produced in ATLAS experiment gives the possibility to test the Standard Model in such regions and with such precision which has not been done before. At the same time, it also allows to look for a "new" physics beyond the Standard Model. This work involves the study of top quark pair production and the measurement of differential cross-section as a function of top quark kinematic variables. It is expected to use the simulated and real data of the ATLAS experiment.

Study of top quark decays at LHC energies
supervisor: doc. RNDr. Jozef Urbán, CSc.
consultant: RNDr. Pavol Striženec, CSc.
Annotation: The student should become familiar with the physics of the decays and properties of top quarks produced in the proton-proton collisions at LHC energies, to study the results of previous experiments at the Tevatron and their interpretation, as well as results obtained on LHC experiments so far. To learn the subdetectors and trigger system of the ATLAS experiment. By means of the standard ATLAS program packages to learn how to estimate the ATLAS detector response, efficiency of the processing chain, to suggest and test the event selection criteria. Handle the work in the distributed computing environment Grid on user level. Compare the results of physics analysis with the results of models and other experiments.

Cosmic rays distribution and movement in Heliosphere and Earth's magnetosphere study

supervisor: prof. RNDr. Stanislav Vokál, DrSc.
consultant: RNDr. Pavol Bobik, PhD.
study form: full time

Annotation: The thesis is focused on the study of the distribution and movement of charged particles in Heliosphere and Earth's magnetosphere. Voyagers flight and measurement of missions as IBEX have brought in recent years many new facts that change our view of the Heliosphere and the cosmic rays in it. The PhD study will focus on methods and models of movement of CR particles in Heliosphere and magnetosphere to interpret the results of the AMS-02, PAMELA measurements in Earth's magnetosphere and Voyager 1 and 2 missions in the outer Heliosphere. The development of models of cosmic rays distributions in the Heliosphere will be based on the Fokker-Planck equation solution by stochastic calculus and numerical methods Crank Nicholson/ADI and analytical method AI. For the motion of particles in the geomagnetic field, the study will focus on the internal model (IGRF) and external models (series of Tsyganen models) of the geomagnetic field and numerical models for calculating the trajectory of charged particles in the combined magnetic field of these models.

Secondary charged particles and nuclear fragments in collisions of high energy atomic nuclei

supervisor: prof. RNDr. Stanislav Vokál, DrSc.
consultant: RNDr. Janka Vrláková, PhD.
study form: full time

Annotation: Study of the secondary charged particles production and nuclear fragments, their yields, multiplicities, correlations and angular spectra obtained by the same standard emulsion method using different primary nuclei (A=1-208), energies (E=1-200 GeV) and impact parameters of colliding nuclei – analysis of experimental data samples of EMU01 and Dubna emulsion collaborations. The comparison with proton-proton interactions. Search for fluctuations of particles production using the scaled factorial moments method, and other methods. Model calculations using modified FRITIOF and Dubna cascade models, or other theoretical approaches. Comparison of the experimental results with theoretical predictions.