8 DEPARTMENT OF NUCLEAR THEORY

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Overview

The Department of Nuclear Theory consists of 18 physicists and 3 graduate students working on different aspects of low energy, high energy, plasma and nonlinear physics and, recently, also on a general problem of quantization of particle dynamics. In addition to this activity, close collaboration with SMC, LEAR and ALICE Collaborations at CERN must be also emphasized.

This year was particularly fruitful for our Department because of the success of our colleague, Dr. Robert Smolanczuk (at present Fullbright Fellow at LBL, Berkeley). In a series of papers he demonstrated a new possibility of obtaining superheavy elements hinting at the existence of the "island of stability" for some combinations of charges and atomic numbers. His ideas were behind the experiment done at Berkeley claiming the discovery of two new elements with A=116 and 118. If confirmed, this could be a dawn of a new approach to the physics of superheavy nuclei. The weight of this discovery is such that the name of our colleague was mentioned in international journals and papers of very broad dissemination, radio and TV included. He was also rewarded by "J.M.Nitschke Technical Excellence Award" (USA) for this achievement.

Other studies were perhaps not so spectacular but still they brought us in total (including collaborations with experimental groups, mostly from the Department of High Energy Physics) 38 regular papers (plus over 14 already accepted for publication). The specific topics worthy of special emphasis are:

- Studies of structure and decay of heaviest nuclei have been continued. Much attention was given to rotational properties of deformed superheavy nuclei. An intensive study of cross sections for the synthesis of heaviest nuclei via various reaction channels has been performed.
- Studies of strange nuclear matter have been continued focusing this time on the proper description of the pion spectra from the strangeness exchange reactions measured recently at BNL.
- The work on contour gauges has been completed. It was shown how to define local charges which obey a local charge algebra. In particular, the appearance of singular topological terms has been clearly demonstrated.
- From the analysis of data coming from the Pamir carbon emulsion chamber measuring developments of the Extensive Air Showers (EAS) of cosmic rays, the inelasticity of hadron-carbon reaction has been deduced. This adds to a very few such direct estimations of this very important quantity existing so far. Using another results from EAS it was demonstrated that their development is of the so called Lévy flights type (i.e., it resembles superdiffusion).
- In a series of papers the new method of defining topology of the space-time using a quantum probe particle has been proposed.
- The plasma group investigated spherical soliton collisions in a strongly magnetized plasma. The result resembled forward exchange scattering of a neutron on a proton with the exchange of a π meson. Thus the name "soliton" invented a third of a century ago so as to stress quantal nature, gains new meaning.

Other topics covered include studies on nonleptonic decays of K mesons, deep inelastic scatterings, studies of nonlinearities in the solar plasma, solitons in an Abrikosov Iattice studies of nuclear quasibound states of antiprotons and η-mesons.

Collaborations with several universities have been maintained. These include the Polish Academy of Sciences, Universities of Warsaw, Kielce, Łódź, Muenchen, Liege, Siegen, Helsinki, Matsumoto, Berkeley, Brussels, St. Petersburg, Tbilisi, Regensburg, Lipsk, London, Warwick and the Institutes: CERN, GSI, LBL and JINR.