NUCLEAR PHYSICS

News from the frontline in the hunt for exotic nuclei

In Russia last summer 220 scientists attended an international symposium reviewing present and future research into exotic nuclei.

Nuclei, from the lightest to the super-heavyweights, were the subject of EXON 2004, the International Symposium on Exotic Nuclei held on 5-12 July 2004 in Peterhof, the former royal estate outside St Petersburg, Russia. The participants' main goals were to discuss the latest results and to develop the programme for further joint research in this area of nuclear physics.

Co-organized by the four scientific centres where exotic nuclei are studied — the Flerov Laboratory of Nuclear Reactions (FLNR) at the Joint Institute for Nuclear Research (Russia), RIKEN (Japan), GANIL (France) and GSI (Germany) — the symposium attracted 220 scientists from 23 countries. Eighty-six talks and more than 40 posters covered topics divided as follows: the synthesis of neutron-rich nuclei of light elements and the study of their properties; the synthesis of superheavy elements and the study of their properties; rare processes and decays; beams of radioactive nuclei (production and research programme); and experimental set-ups and future projects.

The first session covered the current experimental and theoretical situation in the investigation of the properties of neutron-rich nuclei. Here talks discussed the problems connected with precision measurements of nuclear masses in the vicinity of the neutron drip-line. The advent of relatively intense beams of exotic nuclei is now allowing the study of their interactions with other nuclei, and the first results of such investigations were presented in several talks. In the course of these studies of exotic nuclei new effects have been discovered, namely the appearance of new magic numbers (N = 16, N = 26), the co-existence in the same nucleus of two types of deformation, and an unusual order in nucleon shell filling. These effects were also the subject of a number of theoretical talks.

The latest achievements in the synthesis of superheavy elements were presented by various speakers, and other talks provided theoretical interpretations of the results obtained. Further scientific centres have now joined Dubna in implementing a programme for the production of superheavy elements, in particular at GANIL in France.
Investigations of the structure of transfermium elements (Z > 100) have also become an active area. This field of research involves such high-efficiency equipment as the gamma detectors EXOGAM, EUROBALL, AGATA and others. There were several reports on the results of such investigations, as well as a presentation on the possibility of investigating the characteristics of transuranium nuclei using laser spectroscopy.

The search for exotic states of nuclear matter – multi-neutron systems – has had some interesting results. Talks covered experimental attempts to observe such states, as well as peculiarities in the structure of light exotic nuclei.

One day of the symposium was devoted to large active accelerator complexes and new projects. The results and achievements were highlighted in a number of talks, covering for example the ALTO project at IPN Orsay, the KEK–JAERI joint radioactive nuclear-beam project (RNB), the Radiosotope Beam Factory at RIKEN (RIBF), the K = 130 cyclotron in Jyväskylä, TITAN at TRIUMF, and the first radioactive beams in Brazil. The new projects for accelerator complexes were presented on the last day of the symposium, covering NUSTAR at GSI, SPIRAL-2 at GANIL, radioisotope-beam-based research at RIKEN, and the FLNR cyclotrons at JINR.

Some interesting effects have been recently noticed in the characteristics of nuclear-reaction products and the decays of exotic nuclei while investigating fine structure. Multi-cluster decay has been discovered in the ternary fission of nuclei, and while some talks focused on that problem, others were devoted to the peculiarities of fine-structure effects in the decay of exotic nuclei.

The study of chemical properties of superheavy elements was the subject of a special session. Radiochemical groups from Germany, France and JINR have carried out a number of experiments using fast, selective methods. These include joint experiments on the chemical identification of superheavy elements and the study of their chemical properties, and several talks reported on the results.

One of the themes that aroused a great deal of interest among the participants was public relations. The talks “Russian–German Cooperation at GSI, an Example of Success and Friendship”, “Public Awareness of Nuclear Science in Europe” and “JINR: International Scientific Centre Bringing Nations Together” focused on this topic.

A round-table discussion summed up the work of the symposium. Participants agreed that wider collaboration should be established to open up new avenues of enquiry in the synthesis of superheavy elements and the study of their properties, and in investigations with beams of radioactive nuclei, and to develop new projects. They also want theoretical support for the investigations to be increased and for more young scientists to be attracted into the work.

EXON 2004 also offered an interesting cultural programme. There was the opportunity to see the cultural and historic attractions of St Petersburg and its vicinity, cruising on board a ship across Lake Ladoga to stop and admire the Island of Valaam. The next symposium will be held in Russia in two years’ time.

**Further reading**

See the conference website www.jinr.ru/exon2004/.

Yuri Penionzhkevich, JINR, co-chairman of EXON 2004.