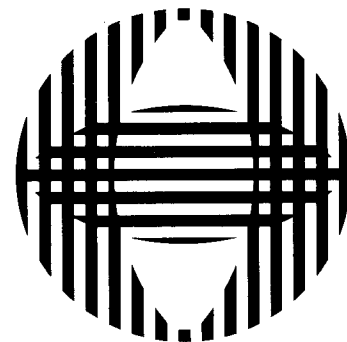


Nuclear extremes



The logo of the International Conference on Extreme States in Nuclear Systems (ESINS). It is an artist's view of the penetration of a relativistic heavy ion through nuclear matter.

An International Conference on Extreme States in Nuclear Systems (ESINS) was held in Dresden from 4–9 February, with three hundred participants from twenty countries. The Conference was organized by the Central Institute for Nuclear Research, Rossendorf, and Dresden Technical University to review present knowledge about nuclear systems under extreme conditions.

The programme — a mixture of speculative ideas as well as established knowledge — covered the following topics: compression of nuclear matter in heavy ion collisions, creation of nuclear compounds in reactions at relativistic energies, dynamics of complex nuclear states in deep inelastic heavy ion reactions, nuclear behaviour at very high spin, present status of creating superheavy nuclei and quantum electrodynamics of strong fields, formation of pion condensate and corresponding astrophysical topics, multi-quark systems and quasinuclear nucleon-antinucleon states.

Heavy ions at relativistic energies

Highlights were the recent Berkeley and Dubna experiments with relativistic heavy ions. Using the JINR 2 m propane bubble chamber, inelastic interactions of carbon nuclei up to energies of 40 GeV with tantalum and carbon nuclei have been studied. Events with sequential collisions of the projectile-like fragments in the forward direction indicate that the projectile retains its individuality during the whole process, an observation which was not expected.

The underlying dynamics of this process (for example, the role of quark substructure in nuclei) is not yet clear. Semi-inclusive and exclusive measurements, such as are

planned with the 4π plastic ball detector now under construction by the Berkeley / Darmstadt / Marburg collaboration, could uncover the mechanism of these nucleus-nucleus collisions.

Shock waves

New three-dimensional fluid dynamical calculations further strengthen confidence in the concept of shock wave creation in nucleus-nucleus collisions. The peak in the angular distribution at the Mach angle for nearly central collisions of neon on uranium has been qualitatively confirmed by recent experiments of the Frankfurt group by selecting out high multiplicity events.

For intermediate impact parameters, shock wave dynamics predicts that two nuclear residues will be kicked apart in definite azimuthal

directions. Experimentally, this has been seen in the Berkeley coincidence measurements. This looks like the start of the study of highly compressed nuclear matter.

Nuclear collectivity

Several contributions demonstrated that great progress has been made in the investigation of nuclear structure and dynamics, and new facets of 'nuclear collectivity' are now under study.

The idea of the pion condensate required the analysis of correlated

Discussion between S.T. Belyaev of the Kurchatov Institute Moscow (at the microphone) and R. Bock of Darmstadt (right) after a talk on heavy ion reactions leading to extreme states in nuclear systems. Seated is P. Radvanyi of Saclay.

(Photo Akademie der Wissenschaften der DDR)



particle-hole states with different pion quantum numbers. Particle-hole interaction modes become critical when momentum transfers are greater than twice the pion mass. Such excitations can be investigated in proton scattering reactions on nuclei. It is to be hoped that the energy resolution required to do these experiments well will become available in the near future. No experimental evidence of pion condensate in actual nuclei has yet been found.

Nuclear rotations are now studied close to the spin region, where rotationally induced fission sets in. Refined gamma-gamma coincidence techniques make it possible to find band intersections away from the Yrast level by selecting transitions with nearly equal energies. Most of these intersections can be well understood from the results of the rotating quasiparticle model. Very interesting information is expected to come from these studies of the rotational fission process.

Extreme states in heavy ion collisions

Recent experiments at Darmstadt, using accelerated uranium-238 ions on a uranium-238 target, gave a lower limit for the time it takes for the two nuclei to break up (3 to 4×10^{-21} s) in a sequential decay (even for the heaviest intermediate systems with atomic numbers greater than 110). This short time, which is characteristic of deep inelastic heavy ion collisions, manifests itself in a rapid balancing of the

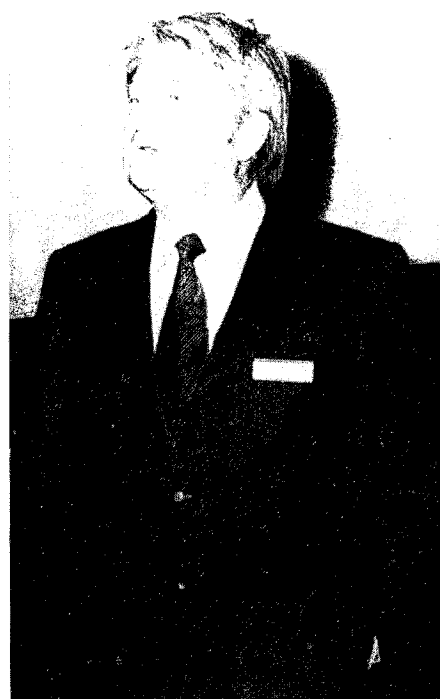
charge between the fragments. How is the charge transported through the neck of the double nuclear system as the fission develops? One possible explanation is the excitation of the isovector giant dipole mode, representing a longitudinal vibration of the system.

Some extreme nuclear states have already lost their speculative character and entered into the realm of known phenomena. Now heavy ion physics has a lot of other new challenging problems to solve. As the field develops, close connections between high energy particle physicists and low energy nuclear physicists are very important and the ESINS Conference did a lot to strengthen these contacts.

The help of L. Münchow, one of the local organizers of the Conference, in preparing this report is much appreciated.

Arkadi Migdal (Moscow) speaking about phase transitions in neutron matter and dynamics of nuclear stars.

(Photo Akademie der Wissenschaften der DDR)



LOS ALAMOS New linac structure works

One of the projects in the Accelerator Technology Division at Los Alamos is the design of the Fusion Materials Irradiation Test Facility (FMIT) which is to be built at Hanford. The concept, which originated at Brookhaven, is to accelerate a current of 100 mA of deuterons to 35 MeV and strip them to yield a high flux of 14 MeV neutrons. Such a flux will be encountered in fusion reactors and can thus be used to investigate material properties for the reactors.

An idea that Los Alamos decided to try for FMIT emerged from thinking about a similar project in the USSR (from I.M. Kapchinski of ITEP and I. Teplekov of Serpukhov). It tries to respond, in one structure at the input end of the linac, to the needs of the preliminary acceleration, beam focusing and beam bunching. Conventional structures require separate systems for all three functions. The idea is particularly attractive for the first stage of a linac where bunching needs to be achieved to give the beam the right form to pass through a subsequent conventional structure and where magnetic fields have to be relatively high to achieve beam focusing (which is velocity dependent).

The new structure goes under the name of radiofrequency quadrupole, RFQ. It has four poles running the length of a vacuum tube which is fed with r.f. power. The poles are scalloped so that the tips near the beam are spaced further and further apart as the beam moves along the tube. The scalloping achieves electric fields which produce acceleration and bunching. Alternate pole tips are negative and positive to produce