various possibilities rapidly enough, computer experimentation becomes impractical.

International Collaboration

TERPSICHORE vividly demonstrates that an important program for supercomputer experimentation profits greatly from a collaboration between research scientists with complementary knowledge. The project was initiated at the Centre de Recherches en Physique des Plasmas (CRPP) of the Ecole Polytechnique Fédérale de Lausanne (EPFL) where specialists in MHD equilibria and stability were brought together for two years (1988-1989). The team included Dr. W. Anthony Cooper, a champion in vector analysis and the developer of the plasma and vacuum contributions in the variational form δW, Dr. Ulrich H. Schwenn from the Max-Planck Institut für Plasmaphysik (MP-IPP), Garching bei München, Germany, who wrote the equilibrium-stability interface, Dr. David V. Anderson from the Lawrence Livermore National Laboratory, USA, our specialist in vectorizing and parallelising the code, Dr. Ralf Gruber and Dr. Silvio Merazzi. The latter two scientists were mainly involved in the ASTRID aspects of the project, but they also contributed to the eigenvalue solver, the database management system, the command language and the graphics package.

The TERPSICHORE version for the Intel ipsc2 hypercube machine was prepared by Dr. Marc Gengler from the Computer Science Department of the EPFL. Dr. Guo Y. Fu is currently testing a new finite element approach and is adding terms to δW which which will enable us to compute in a realistic way how the unstable solution moves away from equilibrium. In addition, we were able to benefit from many important interactions with Dr. S.P. Hirshman of Oak Ridge National Laboratory, USA, and Drs. J. Nührenberg, C. Schwab and P. Merkel of the MP-IPP. An official cooperation between the CRPP and the Keldysh Institute, Moscow is being pursued to further mathematical understanding of some peculiarities of the ideal MHD spectrum, and to validate uniaxial 3-d equilibrium solutions.

The test phase of the project lasted approximately one year. During this period, results generated by TERPSICHORE were compared with available 2-d and 3-d results produced by existing programs. TERPSICHORE entered its production phase in May 1990 and owing to the efficiency of the program it was possible to produce relevant physics in a short time.

Many groups based in the USA, Japan, Australia, USSR and Europe have asked for copies of the code in order to interpret their experimental measurements, design new experiments or to identify new magnetic confinement configurations. We have proposed an international collaboration between the interested groups whose aim would be direct the further development of TERPSICHORE and its application. It is also proposed to organize special IAEA workshops to discuss results.

R. Gruber, *EPFL, Lausanne*

EUROGAM

New Dimensions to Studies of Nuclear Structure

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The combination of heavy ions and high resolution γ-ray multidetectors, comprising germanium elements surrounded by anti-Compton scintillator shields, has permitted this last decade a quantitative leap in the way we approach an understanding of the microscopic properties of the nucleus.

The product of the reaction of heavy ions is a compound nucleus with a very high angular momentum. A few particles then evaporate to give a low temperature, high angular momentum state that de-excites by radiating γ-rays (the so-called heavy ion fusion evaporation reaction).

The improved understanding applies not only to the individual excitations of nucleons but also to the collective behaviour of the nucleus. Perphaps the most spectacular discoveries are those providing evidence for very regular cascades of γ-ray emissions (some 15 to 20 transitions). This new type of γ-ray transition "band" was discovered at Daresbury Laboratory in the UK using ^{152}Dy nuclei. It was then more widely observed in the rare earth range (atomic number $A = 130$ to 150) as well as in the range $A = 190$. Microscopic calculations permit an interpretation based on a second stable minimum for the nuclear potential corresponding to a very deformed ("superdeformed") ellipsoidal nucleus with ratios of the major to minor axes approaching 1.6 for $A = 130$ and 190 and approaching 2 in the region of $A = 150$ (see *Europhysics News* **21** (1990) 86).

The structure of the superdeformed bands revealed unexpected features when compared with what had been established previously. There was found to be feeding below an angular momentum of 56 $\hbar$ with rapid saturation; and de-excitation at spins around 22 $\hbar$ within 1 to 3 transitions by a process which has not yet been revealed experimentally (because instruments are probably not sufficiently sensitive). The intensity of the superdeformed bands (between 1 and 2% relative to the total reaction channel) also has a similar magnitude for the cases examined, except around $A = 130$ where examples of stronger feeding have been observed. Microscopic calculations also show that the behaviour of the moments of inertia, whose values are always below those for rigid-body rotation (this has not yet been accounted for) is closely related to the occupation of "intruder" orbitals with high angular momenta.

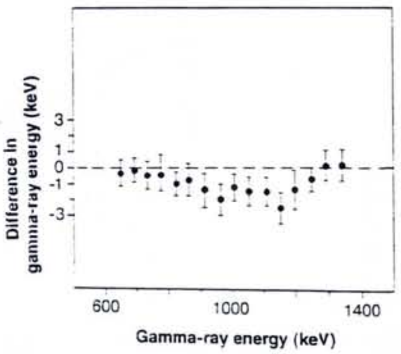

Fig. 1 — Differences in γ-ray energies in superdeformed bands between the yrast band in ^{152}Dy and the excited band in ^{151}Tb.

Excited superdeformed bands have been observed recently, also in the range of masses $A = 150$ and $A = 190$. Their intensities are even weaker (some fractions of a percent of the total intensity of the reaction channel) and they exhibit the same general characteristics as the yrast bands (bands corresponding to states with the lowest excitation energy for a given energy).

"Identical" bands

The most astonishing discovery in this area was made by a group from Strasbourg (T. Bryrski *et al., Phys. Rev. Lett.* **64** (1990) 1650). The analysis of data produced within the context of a French-UK collaboration revealed superdeformed bands whose γ-ray transition energies are the same to within one part in a thousand for the ^{152}Dy (yrast band) and ^{151}Tb (excited band) nuclei (see Fig. 1) whereas differences an order of magnitude larger were expected. Other examples of this phenomena involving the observation of "identical" bands in different nuclei have since been found in the rare earth region and the

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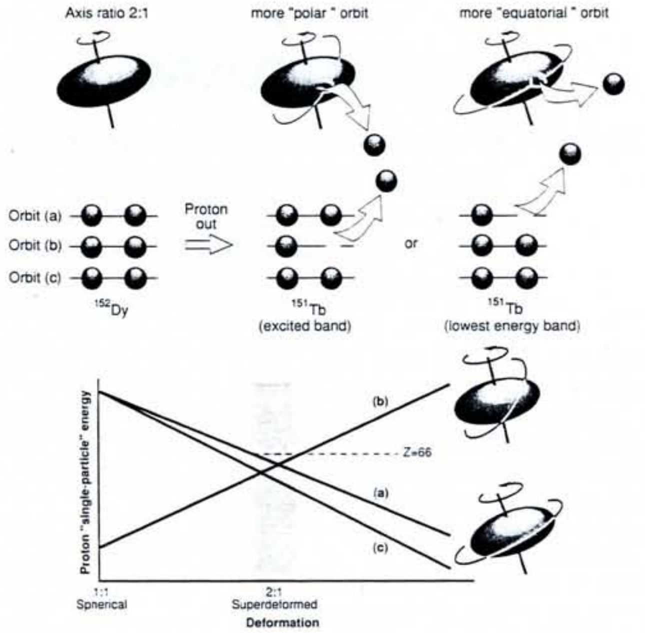

Fig. 2 — Schematic representations of, upper: the two proton orbitals in ^{152}Dy where removal of a proton gives the two superdeformed bands in ^{151}Tb; and lower: single-particle energies for these orbitals as a function of nuclear deformation (courtesy of SERC Daresbury Laboratory).

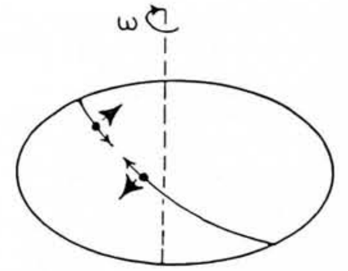

Fig. 3 — Schematic illustration showing the tendency for the Coriolis and centrifugal forces in a rotating nucleus to force apart paired nucleons moving in time-reversed orbits, thereby quenching the pairing correlations.

region of $A = 190$. It poses many entirely open questions relating to certain features of the mean nuclear field (the existence of new symmetries for example).

Octupole correlations

Recently, four superdeformed bands having 1.6, 2.1, 0.8 and 1.1% intensities were identified in ^{193}Hg at Daresbury by M.A. Riley *et al.* Crosstalk between two superdeformed bands has been demonstrated for the first time (see Fig. 2). The existence of such transitions (most probably E1 transitions) are interpreted as evidence for octupole shape correlations. At the same time, two superdeformed bands found at Strasbourg in ^{147}Gd (K. Zuber *et al., Phys. Lett.* **B254** (1991) 308) are interpreted together, with the existing data for ^{146}Gd and ^{148}Gd obtained by other authors, as the first experimental indication of octupole distortion (or at least octupole softness).

Superfluidity

In general terms, one must reconcile the extraordinary "rigidity" of the superdeformed structure to complex structures present at the first stable minimum of the nuclear potential. The study of this feature will also permit a totally new approach to clarify the properties of nuclei which have up to now been poorly investigated. For example, it was predicted many years ago by Motelson and Valatin that nuclear superfluidity owing to a short range, two-body residual "pairing" interaction between nucleons in time-reversed orbits should break down ("quench") at high rotational frequencies (see Fig. 3). Information on this pairing which may eventually lead to a test of the theory is only just now becoming available.

Certain other fundamental issues can also be probed (*e.g.* superdeformation at zero spin, hyperdeformation, "complete spectroscopy" to study rotational damping — the transition from discrete to chaotic nuclear regimes).

New Detectors

The 1980's generation of multidetector arrays based on national collaborations (TESSA in the UK, OSIRIS in Germany, Crystal Ball in France, 8π in Canada, NORDBALL in Scandinavia) and on several North American detectors (HERA at Berkeley, Spin Spectrometer at Oak Ridge, Multispectrometer at Argonne) permitted the observation of superdeformed bands on reducing the detection intensity limit to fractions of a percent. Understanding the new phenomena today calls for an ever larger decrease in the detection limit. This can only be achieved using a new generation of detector arrays. The very nature of the objective we visualize (a detection limit of 10^{-2} to 10^{-4}%) has entrained a worldwide grouping around two projects: GAMMASPHERE in the USA and EUROBALL in Europe. The latter collaboration has got underway with the EUROGAM detector which is essentially financed by France and the UK.

EUROGAM

EUROGAM is a new spectrometer for nuclear structure studies that is being built by a French-UK collaboration (see next page). Work started in 1989 and the first experiments could begin early next year with an array of 45 Compton suppressed Ge detectors. New types of composite Ge counters (see page 100) are being developed and their installation will eventually give a total of about 70 detectors modules thereby providing a high level of detectors efficiency in order to measure the multipolarity of γ-ray transitions of very low intensity.

EUROGAM was essentially conceived in order to resolve the problems raised by the nuclei's superdeformed state that Daresbury did so much to identify. This will be possible for the first time by exploiting coincidence numbers between detectors approaching five. This performance will enable not only a decrease in the intensity limit at which observations are possible but also a considerable improvement in selectivity. Nevertheless, EUROGAM will also permit many other types of investigations, notably in all those areas where an increased sensitivity is primordial. We can mention, for instance, studies of reaction mechanisms in particle γ-coincidences and, above all, the examination of highly unstable exotic nuclei. One might reasonably hope to extend our understanding to doubly magic nuclei with equal numbers of neutrons *(N)* and protons *(Z)*. The goal is to reach $N = Z = 50$ corresponding to ^{100}Sn for which closing of both major shells should lead to remarkable features.

Gentner-Kastler Prize

The 1991 Gentner-Kastler Prize awarded jointly by the French and German Physical Societies has been won by Professor Jörg Kotthaus of the Universität-Ludwig-Maximillian, München, Germany for contributions to semiconductor physics.

3rd EPAC Conference

In the last President's Report (*Europhysics News* **22** (1991) 47) we misquoted the annual report of the EPS Group on Accelerators by its Chairman, G. Plass, in saying that the next EPAC conference will merge with the International Conference on High Energy Accelerators organized by IUPAP. IUPAP in fact did not agree so the 3rd EPAC will take place in March 1992 in Berlin.