on ω. In particular, the observed variations of the moment of inertia for ^{150}Gd are much larger than those seen in the neighbouring nuclei.

Intruder orbitals

In the presence of rotation, nuclear configurations can be labeled using the parity (π) and signature (r) quantum numbers. The latter symmetry is related to the invariance of the intrinsic nuclear Hamiltonian with respect to rotation by 180° about the axis of collective rotation. To distinguish between configurations belonging to the same (π,r) family, approximate quantum numbers must be introduced. Calculations based on the deformed shell model theory (see *e.g.* [2, 7] explain many of the observed properties of SD bands in terms of characteristic *intruder* orbitals originating from the high-N oscillator shells as they approach the Fermi surface at large deformation. For the nuclei of interest the intruder orbitals are the $N = 6$ proton states (originating from the $1i_{13/2}$ subshell) and the $N = 7$ neutron states (originating from the $1j_{15/2}$ subshell) — see Fig. 2. Because of their large intrinsic angular momenta these states are strongly influenced by the Coriolis force. The Lund group [7] has demonstrated that the observed variations in the moments of inertia in the SD bands shown in Fig. 5 can be attributed to the number of occupied high-N states. The different high-N occupation levels also account for the variation in deformation with particle number.

The intruder orbitals that become occupied in the SD bands lie at energies which are much above ($\approx$ 8-10 MeV) the Fermi surface for typical ground-state deformations. SD band spectroscopy therefore offers the unique possibility of probing relatively well-defined shell model configurations at extreme conditions. By extracting the positions of high-N levels at large deformations and extrapolating them back to normally deformed or spherical shapes we may in the future learn about the energy of high-j subshells that cannot be accessed otherwise.

Superfluidity

It is well known that the nuclear moments of inertia at low spins are much smaller than the corresponding rigid-body values. The reason is the short-range, two-body residual interaction that couples pairs of nucleons in time-reversed orbits. This interaction, known as *pairing*, leads to nuclear superfluidity characterized by the order parameter Δ, the pairing gap. At high spins, the Coriolis force tries to align the single particle angular momenta along the axis of nuclear rotation. It is therefore expected that nuclear superfluidity should break down at very high rotational frequencies. This phenomenon, known as the nuclear Meissner effect, was predicted in 1960 by Mottelson and Valatin. The near-rigid rotational pattern of SD bands suggests that the examination of SD states can give information about nuclear superfluidity under extreme conditions.

Owing to the very large $Z = 66$ and $N = 86$ single-particle gaps occurring at similar deformations (see Fig. 2) the SD configuration in the ^{152}Dy band can be understood in terms of a *doubly magic* structure. Superfluid-type correlations in this band are strongly quenched and are mainly dynamical (*i.e.* the pairing interaction cannot form a boson condensate) because the density of single particle states is very low. Conquently, the moment of inertia in ^{152}Dy is very close to the rigid-body limit and is almost independent of ω. This contrasts with the dramatic variation in the observed moment of inertia of ^{150}Gd (see Fig. 5) associated with the presence of quasiparticle excitations characteristic of the superfluid phase [2].

Perspectives

Without deprecating the unquestionable experimental success of γ-ray spectrometry, one has to stress that prediction of the presence and properties of high-spin SD states preceded the discovery of these states by almost a decade. The large amount of high-spin discrete spectroscopy data on SD states that has now been accumulated makes it possible, for the first time, to examine fine details of the underlying shell structure.

Recent experimental discoveries have greatly stimulated theoretical work on the nature of very elongated nuclear shapes. Although some questions concerning the structure of SD states have already been answered, many problems remain. One of the most puzzling is the mechanism by which the SD bands are populated. Why are special states so favoured among the many possible configurations that appear at excitation energies around 8 MeV (a typical neutron separation energy)? On the other hand, we know that as soon as the SD states are formed the relative in-band intensity remains almost constant. This result suggests that they hardly mix with the many close-lying levels because of their very distinct intrinsic structures.

Another interesting problem is the rapid depopulation of the SD bands (in none of the observed cases has the decay path from the SD band been established experimentally!). Calculations have given relatively detailed predictions of features of *excited* 1:2 states only, such as the higher lying rotational bands and the low and high frequency collective vibrations, all of which are expected to have very different properties as compared to the case for "normal" deformation.

Theory shows that very elongated structures should also exist in other regions of the periodic table, *e.g.* in $A \approx 80$ and $A \approx 190$ nuclei. It has also been suggested that even more elongated systems with 1:3 shapes ($\beta_2 \cong 1.1$!) arise. It will be interesting to see of these predictions prove to be as successful as those made in the 1970's.

Proposals for a new generation of spectrometer arrays are being discussed in the USA (GAMMASPHERE) and Europe (EUROBALL). These magnificent instruments will certainly be able to shed light on many basic aspects of the physics of superdeformation, and reveal new phenomena that will invite further study.

REFERENCES

[1] Cohen S., Plasil F. and Swiatecki W.J., *Ann. Phys. (N.Y.)* **82** (1974) 557.

[2] Nazarewicz W., Wyss R. and Johnson A., *Phys. Lett.* **B** (1989).

[3] Neergård K., Pashkevich V.V. and Frauendorf S., *Nucl. Phys.* **A262** (1976) 61; Andersson C.G. *et al.*, *Nucl. Phys.* **A268** (1976) 205.

[4] Schutz Y. *et al.*, *Phys. Rev. Lett.* **48** (1982) 1535; Nyakó B.M. *et al.*, *Phys. Rev. Lett.* **52** (1984) 507.

[5] Twin P.J. *et al.*, *Phys. Rev. Lett.* **57** (1986) 811.

[6] Bentley M.A. *et al.*, *Phys. Rev. Lett.* **59** (1987) 2141.

[7] Bengtsson T., Åberg S. and Ragnarsson I., *Phys. Lett.* **B208** (1988) 39.

Reactor Restarted

The ILL reactor was brought back into normal operation just before Easter after a 2½ month shut-down ordered by the French nuclear safety authorities following ILL's chance discovery that the reactor had been working since its commissioning in 1970 at about 10% above the authorised power limit.

The backlog of experiments will be whittled away by the year's end. Meanwhile, proposals for reassigning responsibility for reactor operation are being considered by the authorities, together with reports of safety studies. The reactor is modular in design and with component replacement, theoretically has a infinite life. Few components need early replacement in view of the higher than expected dose levels.