Ageing friends at a congenial meeting

Alex Comfort

Aging: An Exploration. By David Barash.
University of Washington Press: 1983. Pp.240. $14.95, £12.75.

POPULAR books on ageing are rather like conferences on a recondite area of research — they tend to be parades of familiar faces. One greets the quotations and examples like old friends and looks out for those who should be there. Professor Barash's book is an entertaining reworking of Visscher, Ernest and other — largely prescientific — writers on age. Unfortunately, while the literary background is colourful and some of the social comment is acute, the corpus of modern gerontological research has largely passed Barash by: he is still going on about Orgel's error hypothesis and Bidder on growth, and about the Vilcabambans and Abkhasians, when the focus of potential application has shifted to the hypothalamus, to immunology and to other areas largely ignored here.

The book is well-written, amusing and accurate in terms of the gerontology of, say, 1960 (though Barash regrettably attributes Frederick the Great's classic exhortation in battle — "Sons of bitches! D'you want to live forever?" to an American sergeant). But it fails altogether to project ageing research as the going concern which it is: there is little or nothing about research prospects, and a good deal too much about the history of quackery. This is partly because the earlier gerontologists made their point and entered the nature of ageing in the agenda of their colleagues — in neurotransmitter studies, for example — but it makes the book a little dated, and unlikely to inspire younger researchers to take up the subject and secure clinically applicable results. □

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Dynamics of dizzy nuclei

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Fast Nuclear Rotation.
By Zdzislaw Szymański.
Oxford University Press: 1983. Pp.250. £35, $39.

IN ATOMIC and solid-state physics much can be learned about the internal dynamics of a system by the application of external electric and magnetic fields. The nucleus, however, is a strongly bound object and, in the laboratory, it is not possible to create fields that are sufficiently strong to perturb its internal structure. One extremely fruitful alternative is to set the nucleus spinning and see how its structure responds to the resulting inertial forces. Our knowledge of nuclear structure has greatly increased over the past ten years or more through the application of this idea, and in *Fast Nuclear Rotation* Szymański has set out to document the relevant theoretical and experimental advances.

For a rotating system one can generalize the concept of a quantum mechanical ground state by talking of the configuration which has the lowest energy for a given value of the angular momentum. Equivalently the set of states defined in this way may be thought of as having the largest possible spins for given excitation energies, and are referred to as the "yrast" states of the system. ("Yrast", as Szymański explains, is the superlative of the Swedish "yr", meaning dizzy.)

For sufficiently rapid rotations the entire nuclear shape will be modified and may undergo violent convulsions in an attempt to minimize its energy while accommodating large amounts of angular momentum. It is finally unable to find any equilibrium configuration and will be torn apart by the enormous centrifugal forces present. The book takes us up the entire yrast line from the low-spin region to this ultimate demise into fission fragments. Along this path many fascinating changes in internal structure take place, and it is the observation of these nuclear "glitches" (e.g. sudden changes in the moment of inertia) and their interpretation in terms of the underlying nucleon motions which is the aim of the field of nuclear high-spin states.

As is described in the book, the most usual way of producing a rapidly rotating nucleus is by the so-called fusion–evaporation mechanism in which two nuclei are caused to collide at energies high enough to overcome their mutual Coulomb repulsion. The fused system produced in this way has a high angular momentum and a large excitation energy. Indeed for any given spin, the energy of the compound nucleus will be significantly higher than the corresponding yrast energy and the system may be thought of as being hot. Just like a hot classical liquid, the droplet of hot nuclear matter cools by "evaporation", i.e. by rapid emission of neutrons, protons and alpha particles which carry away large amounts of energy but little angular momentum. (In addition to producing high-spin states the evaporation process may also be used to produce exotic β-unstable isotopes.) On reaching a lower temperature the nucleus can no longer emit particles and the subsequent energy and spin losses must take place via series of γ-decays into and through the yrast states or down the many other "side-bands", i.e. sequences of higher energy rotational states. It is the experimental observation of the ensuing γ-cascades which is the key to the elucidation of nuclear structure at high spins. The sophistication of experimental devices and techniques has grown enormously in recent years, allowing one to resolve individual γ-decays from states with spins in excess of forty units of angular momentum. Indeed many significant advances have been made since the manuscript of *Fast Nuclear Rotation* was completed, though this is a reflection of the vitality of the subject rather than too serious a criticism of Szymański's treatment in the book.

Many of the phenomena associated with nuclear rotations can be thought of in a semiclassical way. Indeed the very phrase "nuclear rotations" implies that it is possible to think of the nuclei in question as deformed objects rotating with some classical angular velocity, which is in turn related to the frequency of the emitted γ-rays. Although typical rotations may seem rather fast ($\sim 10^{20}$ revolutions per second) they correspond to velocities of the nuclear surface significantly less than those of the individual nucleons through the nuclear interior. It is, therefore, meaningful to think of a particle moving in an average field generated by all the others, and of this field rotating in space. This notion leads to the cranked shell model for high-spin states and Szymański discusses many successes of this model in detail. For example the phenomenon of backbending (a decrease in rotational velocity accompanying an increase in angular momentum) is explained in terms of the effect of the Coriolis force on the individual nucleons. In the nuclear ground state nucleons tend to be coupled in pairs, with zero total angular momentum, while the Coriolis force tends to align their individual angular momenta with the axis of rotation. This increases the total spin of the system even though its collective rotational velocity may drop as a given pair is broken up. The interplay between such collective and single-particle effects is central to this area of study and is well brought out in the book.

In order to understand the relevance of high-spin phenomena it is of course essential to have a certain knowledge of more conventional nuclear-structure physics. Szymański admits that some of the important theoretical ingredients have been treated rather briefly in his Chapter 1. Although this is mitigated to some extent by copious references, the uninitiated will find the book tough going. For those with a reasonable working knowledge of nuclear structure, however, it will be essential reading. □

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