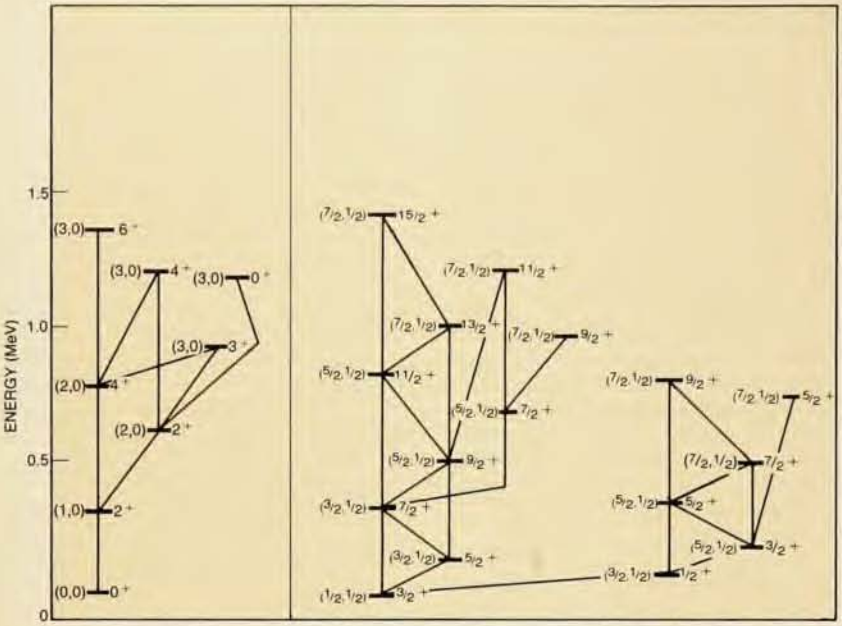

Predictions of supersymmetric structure in complex nuclei agree well with observed energy levels of the positive parity states of an even-*A* (Pt^{192}) nucleus (left) and an odd-*A* (Ir^{191}) nucleus. Iachello's group-theoretic model of the nucleus predicts each level to be one state with a particular set of quantum numbers—two of them are shown in parentheses, the third is the angular momentum. The model predicts energy levels in reasonable agreement with observation. The lines between levels denote observed electromagnetic transitions (E2 and M1).

sequently John Wood (Georgia Tech) extended the same approach to the positive parity states of gold-193, as he reported at the APS meeting in Washington in April.

Group-theory approach. In the interacting boson model, the one state of the S boson and the five states of the D boson determine the six-dimensional basis for the symmetry group SU(6). In 1975 Akito Arima (State University of New York at Stony Brook and University of Tokyo) together with Iachello showed[2] that in three cases the Hamiltonian for an even–even nucleus could be written in terms of the Casimir invariants of subgroups of SU(6). Such situations are called dynamical symmetries and result only because of special properties of the interparticle forces. The subgroups of SU(6) in this instance describe special cases where certain terms in the Hamiltonian dominate over others. Two of these correspond to the extreme cases of nuclear motion first treated by the Bohr and Mottelson model—the anharmonic vibrator and the axial rotor, both well known experimentally. The third of these dynamical symmetries was subsequently observed in heavy nuclei.

Following this success with even–even nuclei, Iachello attacked the problem of odd nuclei, which requires both bosonic and fermionic degrees of freedom. One of the dynamical symmetries in the boson case was the orthogonal group O(6). The boson states were classified according to the tensor representations of the group. To treat odd-*A* nuclei, Iachello used the group Spin (6), which maps onto O(6), and which includes both spinor representations (to classify fermions) and the O(6) tensor representations (to classify bosons). Joseph Ginocchio (Los Alamos) has developed[3] a similar model for odd-*A* nuclei, which uses the spinor representations associated with O(6). The angular momentum associated with the fundamental spinor representations of the group Spin (6) is $^3/_2$; so the simplest realization of fermion structure is for a fermion with angular momentum of $^3/_2$.

The group structure determines a set of quantum numbers that define the various states, as seen in the energy levels of the nucleus. At the suggestion of Wood and Charles Vieu (Orsay), Iachello looked for the spectra he had predicted among the odd-*A* nuclei in the platinum region. Indeed his labels worked both for the even-*A* platinum nucleus and the neighboring odd-*A* iridium nucleus.

Because of the dynamical symmetry, the Hamiltonian can be written as the sum of invariants with their coefficients adjusted to fit the experimental data. (The invariants are eigenvalues of the Casimir operators of the group, where a Casimir operator is one that, like J^2, commutes with all other operators.) The energy levels predicted by Iachello agree reasonably well with the observed spectra. The model also allows one to predict the allowed and forbidden electromagnetic transitions between the states. Wood reported that in the gold nucleus he studied all transitions expected from the model to be forbidden were at least strongly inhibited.

One problem with the structure adapted by Iachello is that it is not a true supersymmetry: It uses a group based on a Lie algebra—an algebra that is defined only in terms of ordinary commutators of the transformation generators. A more complex supersymmetry must be based on a graded Lie algebra which allows both commutation relations (satisfied by boson operators) and anticommutation relations (satisfied by single fermion operators). Iachello comments in his paper that one might investigate the embedding of Spin (6) into a graded Lie algebra; this has been done recently by Itzhak Bars and Baha Balantekin (Yale University).

Supersymmetry is only one of several active areas involving the interacting boson model. Some groups are trying to introduce more details into the model. Others are tempting to derive it from the shell model. Still others are studying[4] the relation between the interacting boson model and the collective model; debate continues on the relative merits of the two approaches. —BGL

References

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in brief

A satellite link between the Lawrence Livermore Laboratory and the Princeton Plasma Physics Laboratory will become operational the first of next year. The hookup will allow the two labs to transmit fusion data and information at the rate of 56 kilobits per second, initially, and ultimately at 1000 kilobits per second. The satellite link is the first phase of a plan to link all of the major magnetic fusion labs by satellite.

MIT plans to build a $5-million integrated-circuit fabrication facility at its Cambridge campus. The facility will serve a major role in MIT's effort to solve design and miniaturization problems associated with the development of very-large-scale integrated systems. □