Plenary speakers

For completeness in the description of the conference, we enumerate the plenary speakers in the same order of intervention in the conference, and reproduce the abstract of the contribution they held.

Issachar Unna (Jerusalem): G. Racah: The Man and his Work

An introduction to the G. Racah Centennial Conference. Racah's life and his achievements will be presented. Special attention will be devoted to Racah's contributions to nuclear spectroscopy. Some results induced by and obtained with his methods by Igal Talmi and I. Unna will be presented.

Shmuel Elitzur (Jerusalem): Racah Algebra and 2D CFT

The Racah coefficients and their relations were initially formalized for the study of atomic spectra. In the late eighties theoretical interest in 2 dimensional Conformal Field Theories was intensified mainly in connection to string theory. It turned out that the Racah formalism was relevant in this field. The role of Racah's algebra in this context will be reviewed.

Gerardo Delgado Barrio (Madrid): Microscopic Superfluidity in Helium Clusters

Spectroscopic studies of simple molecules surrounded by He atoms show a drastic difference depending on the fermionic or bosonic character of the solvent atoms. A quantum chemistry-like approach has been recently developed in our group to deal with HeN -BC doped helium clusters, where the BC dopant is a conventional di-atomic molecule. The central idea is to consider the He atoms as "electrons" while the B and C atoms play the role of the nuclei in standard electronic structure calculations. The procedure provides spectral simulations and, hence, making feasible to do proper comparisons with current experiments. However, due to the big difference of masses of He and electrons, and also to the replacement of Coulomb potentials by molecular interactions, it is worthy to asses at what extent the approximations involved (decoupling of orbital angular momenta of the He atoms from the BC rotation and adiabaticity of the BC stretch versus de He motions) lead to accurate results. Here, we consider several diatomic molecules as dopants. The model provides the energy levels of the cluster and the intensities of the main lines of the spectrum at low temperatures.

Piet Van Isacker (Caen): Seniority in Quantum Many-Body Systems

In 1943 Racah introduced the seniority quantum number in the classification of electrons in an l^N configuration where it appears as a label additional to the total orbital angular

momentum L and the total spin S. About ten years after its introduction in atomic physics, seniority was adopted in nuclear physics for the jj-coupling classification of nucleons in a single-j shell. Seniority refers to the number of particles that are not in pairs coupled to angular momentum $J = 0$. In nuclear physics this concept has proven extremely useful, especially in semi-magic nuclei where only one type of nucleon (neutron or proton) is active and where seniority turns out to be conserved to a good approximation.

In this talk a review is given of the use of the seniority quantum number in many-body systems. The necessary and/or sufficient conditions for seniority conservation in a system of identical bosons or fermions (known since long) are briefly recalled. More recently, the possibility of partial seniority conservation has been pointed out when most states are mixed in seniority but some remain pure. An application of these ideas to the occurrence of nuclear isomers is presented. Seniority isomers are nuclear states characterized by electromagnetic decay hindered by selection rules related to the seniority quantum number. A simple analysis is presented of their possible formation with reference to the nickel isotopes $^{70-76}$Ni and the $N = 50$ isotones from molybdenum to cadmium. It is shown that the existence of seniority isomers is predominantly governed by the quadrupole pairing matrix element of the nucleon-nucleon interaction.

Francesco Iachello (Yale): Spectrum Generating Algebras and Superalgebras

Algebraic theory, that is, the mapping of all physical operators onto the elements of a Lie algebra $\mathfrak{g}$, will be briefly reviewed. Applications to spectroscopy of atomic nuclei (Interacting Boson Model with algebra $\mathfrak{g} \equiv U(6)$) and to the spectroscopy of molecules (Vibron Model with algebra $\mathfrak{g} \equiv U(4)$) will be presented. The dynamic symmetries of these models, corresponding to the breaking of the algebra $\mathfrak{g}$ into its subalgebras will be discussed.

In recent years, algebraic theory has been extended to describe mixed systems of bosons and fermions by mapping the operators onto the elements of a graded Lie algebra $\mathfrak{g}^*$. Applications to atomic nuclei (Interacting Boson-Fermion Model with algebra $\mathfrak{g}^* \equiv U(6/\Omega)$) will be presented. The dynamic supersymmetries of these models, corresponding to the breaking of $\mathfrak{g}^*$ into its graded (or not) subalgebras will be discussed and experimental examples presented. This is the only case known in Nature so far of supersymmetry.
Algebraic theory makes use of methods and techniques developed by Giulio Racah on the 1940's and summarized in his lecture notes at Princeton University "Group Theory and Spectroscopy".

Maurice Kibler (Lyon): Impact of G. Racah in Crystal Field Theory

The first part of this talk deals with the impact of the methods of Racah in crystal- and

ligand-field theories (two theories for explaining the electronic and magnetic properties of partly-filled shell ions in molecular, solid-state or biological environments). Emphasis is put on developments (during the period 1959-1995) for the calculation of (i) the energy levels for an ℓ^N ion embedded in an environment described by a point group G and (ii) the intensities of one- and two-photon transitions between the levels. The second part of the talk is devoted to some by-products as (i) the Wigner-Racah algebra of the group $SU(2)$ in a nonstandard basis $SU(2) \supset G^*$ (with $G \sim G^*/Z_2$), the Wigner-Racah algebra of a subgroup G^* of $SU(2)$, and (iii) the derivation of mutually unbiased bases in quantum information.

Luis Egido (Madrid): Recent developments in Nuclear Structure Physics

The availability of intense radioactive ion beams as well as the development of new instrumentation with increased efficiency and resolution (4π γ-ray spectrometer, recoil separators, particle detectors, etc.) led to a revival of the field of nuclear structure physics during the last decades. New phenomena and surprising nuclear properties have been discovered, such as neutron halos and skins, the disappearance of well-established and the nascency of new magic numbers far-off stability, new radioactive decay modes, etc., which enforced a modification and extension of our view of the atomic nucleus.