Direct Evidence for the Existence of Supersymmetry in Odd-Odd Nuclei ◇

A. Metz, G. Graw, R. Hertenberger, Y. Eisermann, J. Jolie [a], N. Warr [a], C. Günther [b], and J. Gröger [b]

[a] Physics Department, University, CH-1700 Fribourg, Switzerland

[b] Institut für Strahlen und Kernphysik, D-53115 Bonn, Germany

The extended supersymmetry of the IBM deals with boson-fermion and proton neutron degrees of freedom allowing the description of a quartet of nuclei using the same algebraic form of the Hamiltonian [1]. Such a quartet is characterised by the quantum number N related to the number of proton (π) and neutron (ν) bosons (N_B) and fermions (N_F) by the relation $N = \sum_{\mu=\nu,\pi}(N_B^\mu + N_F^\mu)$. The $U_\nu(6/12) \times U_\pi(6/4)$ supersymmetry can be applied in the Au- and Ir-region where the supermultiplet ^{194}Pt-^{195}Pt-^{195}Au-^{196}Au is discussed as the best example of the supersymmetry [2,1]. The respective Hamiltonian in the O(6)-limit has 6 parameters and is derived in the form: $H = A\ C_2(U^{B+F}_{\nu+\pi}(6))\ +B'\ C_2(\overline{O}^{B+F}_{\nu+\pi}(6))\ +B\ C_2(O^{B+F}_{\nu+\pi}(6))\ +C\ C_2(O^{B+F}_{\nu+\pi}(5))\ +D\ C_2(O^{B+F}_{\nu+\pi}(3))\ +E\ C_2(Spin(3))$. Besides the analytic expression for the excitation energies of four nuclei, the supersymmetric scheme provides also analytic results for the wavefunctions of the states. Those do not depend on the parameters of the Hamiltonian and can be tested, for instance, via single particle transfer reaction amplitudes.

Following this concept, we tested the supersymmetry by comparison to the obtained transfer strengths of the negative parity states in ^{196}Au of a polarised $(\vec{d},t)$ transfer experiment. The analysis of this experiment, complemented by (p,d) and polarised $(\vec{d},\alpha)$ measurements, provided a sufficient basis for the test in respect to a complete level scheme up to an energy of app. $700 keV$ and the corresponding spin assignments of the states. Especially for negative parity states the experiments leaded to a, in part tentative, spin assignment of 104 states up to $1300 keV$, from which only the ground state was known with spin and parity before [3].

Fig 1. shows the achieved correlation of theory and experiment for the two nuclei ^{195}Au and ^{196}Au of the supermultiplet in the energy range of 0 to $1 MeV$. The correlations of the nuclei ^{194}Pt-^{195}Pt, completing the supermultiplet, are shown in contribution [4]. The correlations between theory and experiment for the odd-neutron nucleus ^{195}Pt and the odd-odd nucleus ^{196}Au are proven by the detailed level-by-level comparisons of experimentally obtained and theoretiocally calculated transfer strengths, using a semi-microscopically derived transfer operator which is newly included in the supersymmetry. The achieved results prove that the extended supersymmetry accounts for all excited states in ^{196}Au in the discussed energy region. All spin assignments provided by the $(\vec{d},t)$ and $(\vec{d},\alpha)$ transfer experiments consistently fit in supersymmetric level scheme and, additionally, it was possible to fix the partly tentative spin assignments of the $(\vec{d},t)$ analysis.

In view of the extreme complexity of heavy transitional odd-odd nuclei, the few parameters needed to describe almost one hundred states in four different nuclei simoultaneously and the agreement of the wavefunction sensitive observables that form the transfer strengths, we can only conclude that supersymmetry exists in atomic nuclei!

References

[1] P. Van Isacker, J. Jolie, K. Heyde, A. Franck, Phys. Rev. Lett. **54** (1985) p.653
[2] J. Jolie *et al.*, Phys. Rev. **C43** (1991) R16
[3] A. Metz *et al.*, to be published
[4] A. Metz *et al.*, this report p.24

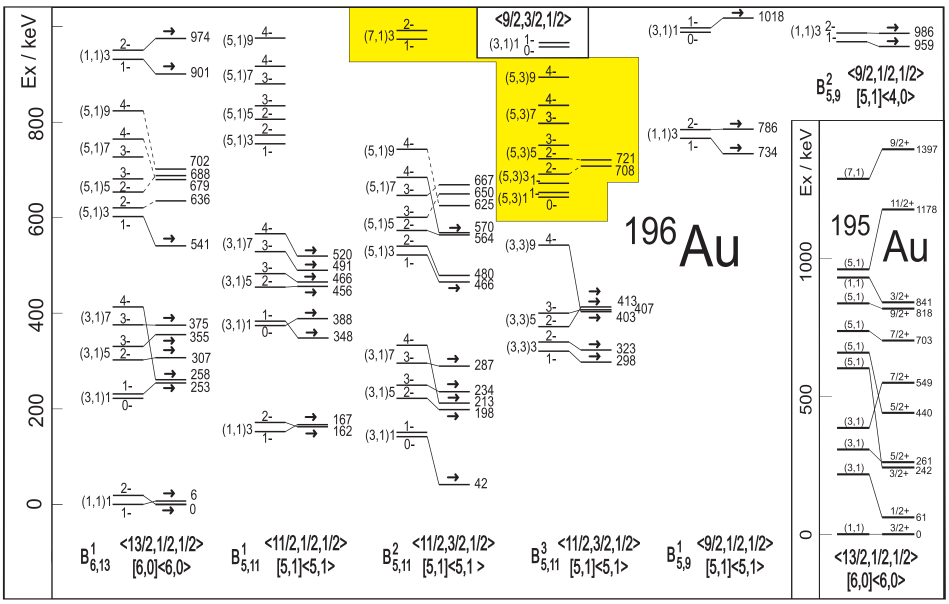

Fig. 1: Supersymmetric level scheme of the odd-odd nucleus ^{196}Au and the odd-proton nucleus ^{195}Au. Below each band the quantum numbers $[N_1, N_2] < \sigma_1, \sigma_2 > < \sigma_1, \sigma_2, \sigma_3 >$ are printed. On the left of each predicted level the quantum numbers $(\tau_1, \tau_2)L$ are positioned while J stays on top. To the left of the experimental states their obtained excitation energies are listed. The arrow on top of an experimental level marks the states well reproduced by the semi-microscopic transfer operator.

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