Test of Supersymmetry in IBM by High Resolution (p,d) Study of ^{196}Au.
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In the last two decades the introduction of dynamical symmetries in nuclear physics within the framework of the Interacting Boson Model (IBM)[1] has helped to establish a unified picture of the collective excitations of nuclei. With the use of supersymmetric dynamical symmetries a unified description of even-even and odd-A nuclei belonging to a common supermultiplet was obtained [1]. About a decade ago it was proposed that the incorporation of the neutron-proton degree of freedom would allow the extension of this concept to quartets of nuclei, comprising one even-even, two odd-A and one odd-odd nucleus, which can be described in a common framework [2]. This appealing and elegant possibility provides a test of the supersymmetry concept itself [3], as a prediction for the excited states in the odd-odd nucleus based upon those in the adjacent even-even and odd-A nuclei is obtained. However, in many cases the lack of detailed experimental information (especially for odd-odd nuclei) did not allow definite conclusions to be drawn.

In the Pt-Au region the nuclei can be described by the supersymmetry $U_\pi(6/4)\otimes \mathrm{U}_\nu(6/12)$. Depending on which representation of the product of subgroups is used, the positive-parity states of the even-even nucleus, the negative (positive) parity states arising from coupling a j=1/2,3/2,5/2 (j=3/2) odd neutron (proton) in the odd-mass nuclei are described. All members of the supermultiplet are described by the same expression with constant parameters:

$$E = A\sum_i N_{i\pi}(N_{i\pi}+7-2i) + B'\sum_i \sigma_i'(\sigma_i'+6-2i)$$
$$+ B\sum_i \sigma_i(\sigma_i+6-2i) + C[\tau_1(\tau_1+3)+\tau_2(\tau_2+1)]$$
$$+ DL(L+1) + EJ(J+1),$$

where $N_i, \sigma_i', \sigma_i, \tau_1, \tau_2, L, J$ are quantum numbers.

Since the initial work it was claimed that ^{196}Au would be the ideal candidate for such an approach and its level scheme has been predicted from a simultaneous fit of the three other nuclei belonging to the supermultiplet. These predictions were tested [3,4] using transfer reactions but still the experimental level scheme is very poorly known. In the work of [3] three major problems in the comparison between theory and experiment were found: experimentally only 20 levels were excited with l=1,3 while theory predicted the excitation of 22 levels below 570 keV; the excitation of the groundstate and 164 keV level was too high compared to the theoretical predictions. Therefore the parameters B and E were adapted in the work of [4]. However, all studies were performed with low resolution (7 and 12 keV respectively) and one could not rule out unobserved doublet structures. Using the Q3D magnetic spectrograph we have performed a high resolution (p,d) transfer experiment with 26 MeV protons on a 67 μg/cm^2 Au target.

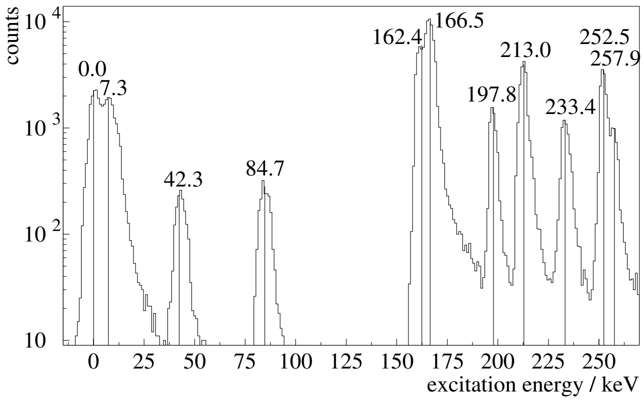

Fig. 1: Measured energy spectrum in the (p,d) experiment with 26 Mev protons on a 67 μg/cm^2 Au target. Three doublets near 3keV, 164keV and 255keV are seen for the first time. Especially the doublets in the region of the ground state and around 164keV are very interesting for the IBM point of view.

To calibrate the energies of the observed peaks a spectrum using a 115 μg/cm^2 target of 97% enriched ^{196}Pt was also recorded. Figure 1 shows the relevant part of the measured deuteron spectrum for the gold target at an angle of 25 degrees. The spectrometer was working with an excellent resolution of 4 keV (FWHM) in the region of interest. Inspection of the spectrum clearly shows that the groundstate is composed of a close lying doublet consisting out of two states separated by 7.3 keV, which are both strongly excited. A similar situation is at the highest peak in the spectrum around 164 keV. Both observations are in the line of the original supersymmetric prediction [3] and seem to explain most of the discrepancies observed in earlier studies. In the light of this, a more complete high resolution angular distribution is measured and will be evaluated soon. In addition a test for a (d,t) transfer experiment with polarized deuterons was made. It shows nice analyzing power. The Complete angular distribution will be taken in summer 1996 and will allow the unambigous assignment of most J-values for this reaction.

References

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