LOW-SPIN LEVELS IN ^{101}Pd OBSERVED IN THE $^{103}Rh(p,3n)$ REACTION

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In the last few years, considerable interest has developed in describing nuclei outside the traditional regions of deformation by means of the rotational model. Especially interesting have been those nuclei which appear to exhibit only a very moderate deformation; for in those cases, nuclear angular velocities are required to be very large (even for low-spin states) and consequently Coriolis effects (rotation alignment and decoupling) dominate the nuclear structure. A very striking example of this is the observed yrast structure in $^{101-105}Pd$ from the work of the Purdue group[1-4]. The well-known rotation-aligned structure (decoupled bands) is evident for $h_{11/2}$, $d_{5/2}$, and $g_{7/2}$ to varying degrees and is particularly pronounced in ^{101}Pd. A recent Coriolis band-mixing calculation by H.A. Smith and F.A. Rickey[5] has been successful in explaining the observed band structure (the so-called "favored states") as predominantly rotation-aligned excitations. In addition, the calculation predicts many other so-called "unfavored states" which are also observed in $^{103,105}Pd$. Both the rotational and weak-coupling models can reproduce the high-spin (favored) states in the Pd nuclei. The explanation of the low-spin (unfavored) states, however constitutes a stringent test of any model, and the rotational model has done reasonably well in this regard for $^{103,105}Pd$. In ^{101}Pd, no states other than the $h_{11/2}$, $g_{7/2}$, and $d_{5/2}$ favored states have so far been observed. The rotational model actually predicts the existence of a dramatic band structure for the unfavored states in ^{101}Pd. For each of the $d_{5/2}$ and $g_{7/2}$ rotation-aligned bands a rotation-anti-aligned counterpart is predicted with the appropriate low-spin sequence: $|j-R|$, $|j-R-2|$, etc. A similar prediction is obtained for the negative-parity ($h_{11/2}$) states.

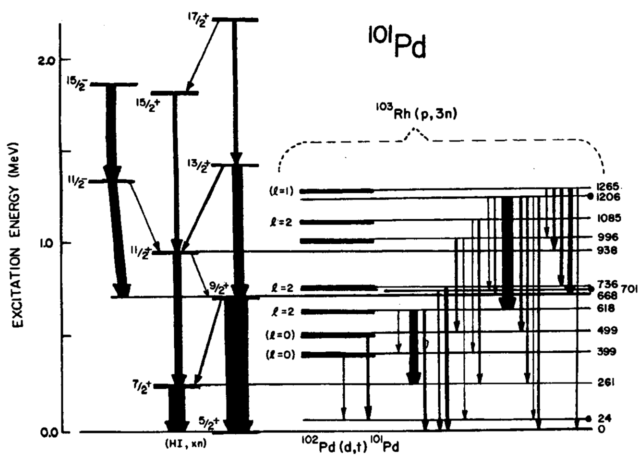

Figure 1. Tentative ^{101}Pd level scheme from $^{103}Rh(p3n)$ Reaction

The present measurements were undertaken to investigate the low-spin level structure of ^{101}Pd in order to test the very specific predictions of the rotational model. In order to populate preferentially lower-spin states in ^{101}Pd, we utilized the $^{103}Rh(p,3n)$ reaction. A 0.1-mil rhodium foil was bombarded at the Naval Research Laboratory Cyclotron Facility with 25, 30, and 35 MeV protons. In-beam prompt and inter-beam-burst gamma-ray spectra were obtained at all three energies, along with angular distributions at 45, 57 and 90 degrees for E_p = 30 MeV. New gamma rays from the $^{103}Rn(pxn)$ reactions were assigned to ^{101}Pd if their excitation functions followed those of known ^{101}Pd transitions. In this experiment, 79 gamma transitions were assigned to ^{101}Pd, and 68 of these are transitions observed for the first time. Using gamma-ray energy sum criteria, along with the known level structure from (HI,xn) studies and some guidance from unpublished (d,t) data of R. Anderson and F. Rickey[6], we have constructed a preliminary level scheme shown in Figure 1. Since we have not yet confirmed our assignments with gamma-gamma coincidence data, our proposed additions to the known level structure of ^{101}Pd must be regarded as tentative. We have applied our energy sum criteria rather conservatively and have restricted our presentation to the new level structure below 1300 keV. It would be unwise to extend the proposed level scheme much further in excitation on energy sum arguments alone.

The known yrast levels and their populating and depopulating gamma transitions seen in this experiment are grouped to the left in the figure, while the newly-observed gamma transitions and new levels proposed in this study are shown to the right. The levels seen in the (d,t) reaction study[6] are highlighted in the center of the figure. It must be emphasized that only about 75% of the total observed gamm-ray intensity is represented in this figure; many gamma rays have no unique placement on an energy basis alone.

The gamma ray spectra reveal that we still populate the three favored bands in ^{101}Pd rather strongly, although we do not bring in as much angular momentum to the compound system as is brought in with the heavy ions[2]. It should also be remarked that the angular distributions for known dipole and known quadrupole gamma rays were essentially indistinguishable. This presumably suggests that the degree of alignment with incoming protons at this energy is considerably diminished compared to that attained with the heavy ions.

There are a small number of new, very intense gamma transitions that are of interest. Two of these transitions fit uniquely (on an energy basis) as is shown in Figure 1 and are suggestive of the intra-band cascade in the $g_{7/2}$ anti-aligned band ($7/2^+$, $3/2^+$, $1/2^+$...). The remainder of this group of intense transitions cannot be accommodated into the level scheme shown and are not depicted in the figure. This may be the result of another, rather exclusive intra-band cascade, perhaps the $d_{5/2}$ anti-aligned band. More definite treatment of these gamma rays must await the analysis of some γ-γ coincidence data, recently acquired at the Naval Research Laboratory.

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