# Proton Superdeformed Bands below the Z=80 Gap in $^{191}$Au: More Evidence for Pseudo-spin Coupling

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Three superdeformed bands have been observed in $^{191}$Au using the EUROGAM II multidetector array. The yrast superdeformed band has been extended to very high rotational frequencies and two new excited bands have been found. These bands behave as signature partners and display characteristics which suggest they could be based on the [532]3/2 or [530]1/2 configurations, which become the $[\widetilde{431}]3/2,1/2$ doublet in the pseudo-spin formalism. It is important to note that band 3 has energies identical ($<\Delta E\gamma>$=1.5 keV) to those of band 1 in $^{192}$Hg within the observed range of frequencies.

The occurrence of the same transition energies (isospectral) in an even-even and an odd-mass nucleus requires an alignment that is exactly half-integer. For several cases in the mass ∼150 region the special proton orbital, [301]1/2, provides the half-integer alignment which comes about naturally [1] in a pseudospin scheme where the above orbital becomes $[\widetilde{200}]1/2$, implying an alignment of exactly one half, i.e. of the pseudo intrinsic spin. All the normal parity orbitals are either such pseudospin-singlets ( $\tilde{\Lambda} = 0$) or fall into pairs (pseudospin doublets) corresponding to a $\tilde{\Lambda} \neq 0$ with a small pseudo spin-orbit splitting. It was pointed out [2] that these pairs could also decouple the 1/2 $\hbar$ pseudo intrinsic spin, providing alignments of one half, but such behavior has so far not been observed.

For the pseudo-spin doublet, $[\widetilde{431}]1/2,3/2$, the Coriolis mixing should first decouple the pseudo intrinsic spin and produce two signature-degenerate bands, having alignments +1/2 and -1/2. The properties of bands 2 and 3 fit well those expected for the lower degenerate band with alignment +1/2. The HFB routhians for quasi-protons in a $^{190}$Pt core show that these two orbitals are the lowest quasi-particle excitations at low frequencies. However, both bands develop some signature splitting and the alignment of the lower one increases significantly beyond 1/2 at the higher frequencies. These features indicate deviations of the calculation from the simple decoupling of the pseudo-intrinsic spins; whereas, the data agree well with those expectations.

It is not really clear whether the calculations underestimate the effects of the pseudospin symmetry or whether the better agreement with the simple expectations is just an accident. However, that quantized alignments may be coming from pseudospin symmetry is an exciting possibility.

## References

[1] W. Nazarewicz et al., Phys. Rev.Lett. 64 1654 (1990).

[2] F.S. Stephens et al., Phys. Rev. Lett. 64 2623 (1990).