

STRUCTURE OF THE VIBRATIONAL NUCLEUS $^{131}_{53}\text{I}^{78}$

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In this paper we wish to discuss some of the details of our results on the study of the decay of ^{131}Te isomers to levels of ^{131}I . This nucleus is a particularly attractive one to study because of the relative ease of preparation (n, γ), the sizeable Q_β (2.2 MeV), the presence of $3/2^+$ and $11/2^-$ β -decay parents which can populate a wide range of ^{131}I states, a rather well studied stable core, ^{130}Te , and because the odd-mass I isotopes have been studied by both Coulomb excitation [1] and ($^3\text{He}, d$) reactions [2].

We show in fig. 1 the low-lying positive parity states of ^{131}I alongside the states of the ^{130}Te core and the states predicted in the limit of weak coupling of a proton to the ^{130}Te core and the coupling of the three proton cluster ($\pi g_{7/2}$) $_5^3$ to the ^{128}Sn core. We have made a tentative numerical identification of all 10 states resulting from the $\pi g_{7/2}$ \otimes 2^+ $_1$ and $\pi d_{5/2}$ \otimes 2^+ $_1$ configurations. We have also identified 15 additional states (out of 29 possible) that may result from the coupling of the ($\pi g_{5/2}$) $_5^3$ to the ^{128}Sn core and the coupling of the $\pi g_{7/2}$ and $\pi d_{5/2}$ states to the 2^+ $_2$ and 4^+ $_1$ ^{130}Te states. Of special importance are the $15/2^+$ and $13/2^+$ states observed near 1500 keV.

We show in fig. 2 the negative parity levels observed in ^{131}I along with the negative parity states in the ^{130}Te core and the ^{131}I negative parity states predicted in the limit of weak coupling. The measured g factor [3] for the

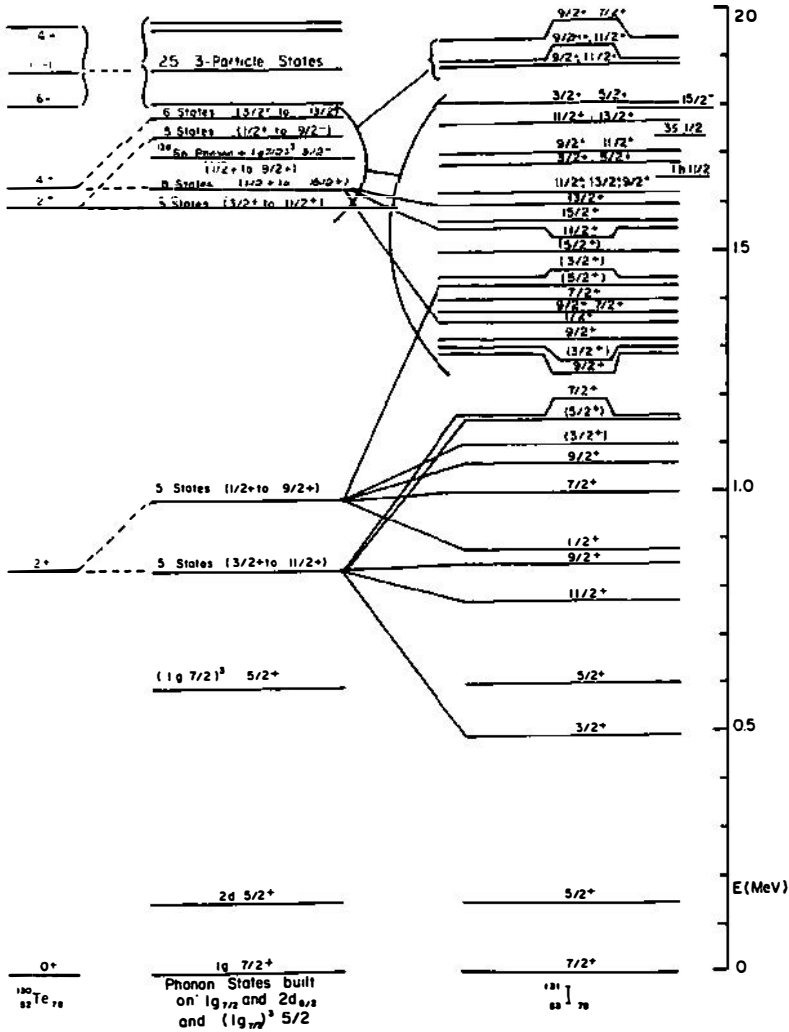


Fig. 1

$15/2^-$ isomer is in accord with the values calculated for $[\pi g_{7/2}(\nu h_{11/2} \nu d_{3/2})^5]_{15/2^-}$ or $[\pi g_{7/2}(\nu h_{11/2} \nu d_{3/2})^4]_{15/2^-}$ configurations and no others, i.e., only these two have even the correct sign.

The clearly observed structural differences [4]

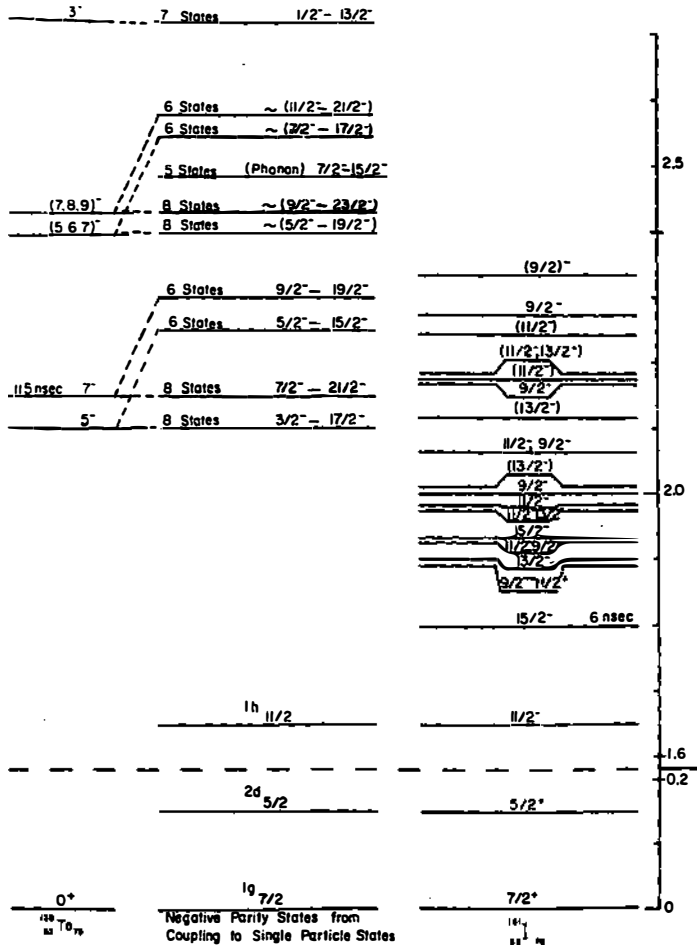


Fig. 2

between the simpler, better understood ^{51}Sb nuclei and the ^{53}I nuclei could not be accounted for by the differences in the respective Sn and Te cores as seen in the failure of the intermediate coupling [5] or quasiparticle

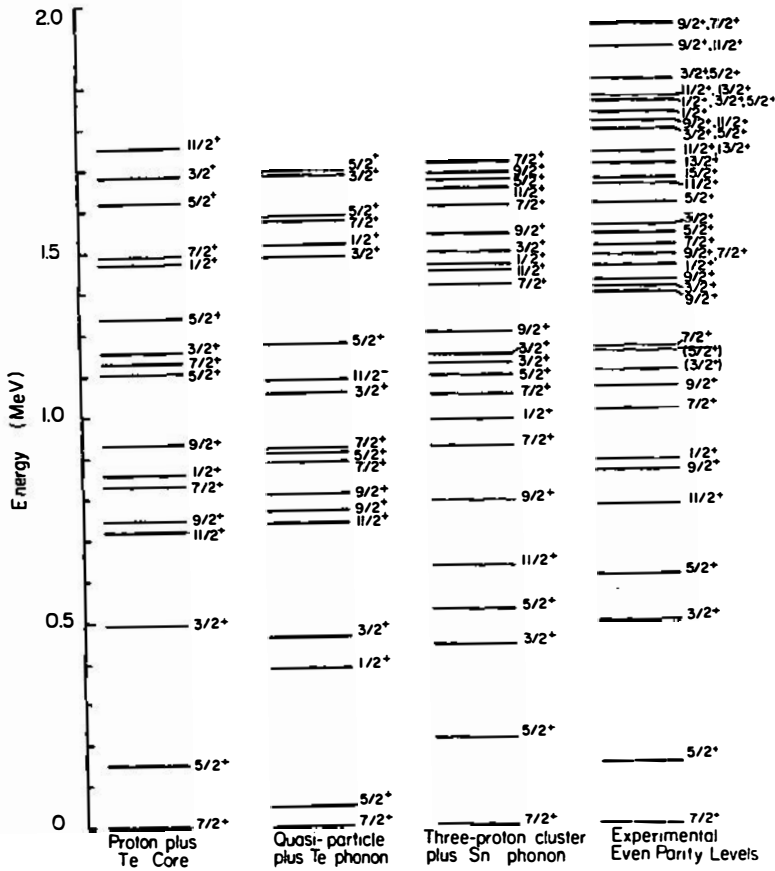


Fig. 3

plus phonon calculations [6] shown in fig. 3.

The clearest example of these inadequacies are the $5/2^+$ states. The three lowest $5/2^+$ states in ^{131}I are strongly populated in β decay and strongly populated in the $^3\text{He}, d$ reaction. This behavior is in contrast to the strong population in the Sb nuclides of only the lowest $5/2^+$ level (the $\pi d_{5/2}$) in the above two processes. Newer

approaches using a 3-proton cluster $|7,8,9|$ have proven more successful but introduce much more 3 particle clustering into many level configurations than is warranted by the experimental data.

We argue that only the $(g_{7/2})^3_{5/2+}$ configuration is important below 2 MeV. We note the strong calculated $(g_{7/2})^3_{11/2+}$ contribution to the lowest $11/2^+$ state in contrast to the strong, experimentally observed Coulomb excitation strength to that state in ^{129}I . We also note the presence of the $13/2^+$ and $15/2^+$ levels near each other and near the position of the 4_1^+ level in the ^{130}Te core. As there is no $(g_{7/2})^3_{13/2+}$ state, any substantial $(\pi g_{7/2})^3_{15/2+}$ contribution to the configuration of the $15/2^+$ state would lower it away from the $13/2^+$ state. The $15/2^+$ state calculated for ^{129}I by Vanden Berghe $|10|$ is in fact predicted at 800 keV. Furthermore, on the $N = 82$ shell, only the $(\pi g_{7/2})^3_{5/2+}$ state is observed at low energy $|11|$.

From our data we suggest that an adequate description of ^{131}I levels must include protons coupled to the vibrational Te core, protons coupled to the $\nu\nu$ negative parity states, and must limit important three particle contributions to the $5/2^+$ levels.

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