Shell Model Description of the Level Structure of ^{120}Sn

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The shell model study of ^{120}Sn has been performed within the framework of the Chain Calculation Method (CCM) including states with seniority v up to 4, with considerable reduction of the size of the matrices to be diagonalized. As residual interaction between the valence neutrons, we have used a realistic effective interaction derived from the Paris nucleon-nucleon potential [1] and the s.p. energies relative to the ^{100}Sn core have been derived from the experimental spectrum of ^{131}Sn assuming that the five levels observed below 2.5 MeV excitation energy are single-neutron hole states. They are (in MeV): $\epsilon_{g_{7/2}} = 0.0$, $\epsilon_{d_{5/2}} = 0.591$, $\epsilon_{d_{3/2}} = 2.382$, $\epsilon_{s_{1/2}} = 2.141$, and $\epsilon_{h_{11/2}} = 2.988$.

In the figure the spectrum of ^{120}Sn, established in a high resolution ^{122}Sn(p,t)^{120}Sn reaction measurement is compared with the calculated one. In the theoretical spectrum we include all the levels up to 3.0 MeV while in the higher-energy region only states having the same angular momenta and parities as those of the observed ones are reported.

In the energy interval 2.7–3.2 MeV the theoretical level density is smaller than the observed one, due to the lack of configurations with $v > 4$, which are likely to produce a downshift of most of the high-lying states. This is indicated by the fact that, except the 1^+ state, all the states up to about 2.7 MeV have dominant $v = 0$ or 2 components while above this energy there is in general a strong seniority mixing. Thus, rather large discrepancies are to be expected in the higher-energy region.

The experimental low-energy spectrum is well reproduced by the theory. In fact, up to 2.3 MeV a one-to-one correspondence between the six lowest calculated and experimental levels can be unambiguously established. A discrepancy of about 200 keV occurs only for the two 2^+ states, the calculated excitation energies of the other four states differing by less than 80 keV from the experimental ones.

Four of the next five excited levels in the observed spectrum, $J^\pi = 2^+$ (twice), 4^+, and 7^-, can be identified with calculated states located in the energy interval 2.4-2.7 MeV, the agreement between theory and experiment being comparable with that obtained for the lower-energy region. Our results, therefore, confirm the spin-parity assignments made in the present work for the states at 2.42, 2.47, and 2.48 MeV, which had not received until now a firm assignment [2]. Concerning the 3_1^- state at 2.40 MeV, the calculated energy is about 500 keV higher than the experimental one. This is not surprising since configurations outside of our model space are likely to be important for this state. Besides the four above states, other eight states are predicted by the theory in the energy range 2.4–2.7 MeV. In particular, the 5^- state can be associated to the 5^- level at 2.80 MeV, while the 6^+ and 8^+ states can each be identified with the higher spin member of the $J^\pi = 2^+ + 6^+$ and $J^\pi = 1^- + 8^+$ unresolved doublets at 2.69 and 2.84 MeV, respectively. Four states with $J^\pi = 1^+$, 4^-, and 6^- (twice) are predicted at 2.50, 2.56, 2.54, and 2.60 MeV, respectively. However these unnatural parity states are not excited in a one-step (p,t) reaction.

References

[1] F. Andreozzi *et al.*, Phys. Rev. **C54** (1996) 1636

[2] K. Kitao *et al.*, pre-publication of the adopted level scheme of ^{120}Sn, Information extracted from the ENSDF data base revision of 28-Jan-1999, using the NNDC Online Data Service.