Realistic Shell-model Calculations for ^{114}Sn

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Along with the experimental work of Ref. [1], where ^{114}Sn has been studied via the ^{116}Sn(p,t)^{114}Sn reaction, we have given a shell-model description of this nucleus. We have assumed that ^{100}Sn is a closed core and let the 14 valence neutrons occupy the five single-particle (s.p.) orbits in the 50-82 shell. As residual interaction between the valence neutrons we have employed a realistic effective interaction derived from the Bonn-A nucleon-nucleon potential, which we have already used in a previous study of the light tin isotopes with A$\leq$106. This interaction, however, turns out to be not completely adequate when moving away from closed shells. We have found out that a substantial improvement is obtained by weakening the $J^\pi = 0^+$ matrix elements.

J^π	E(MeV)	J^π	E(MeV)
0^+	0.0	6^+	3.54
2^+	1.75	0^+	3.66
0^+	1.82	4^+	3.70
4^+	2.22	2^+	3.71
3^+	2.42	1^+	3.71
0^+	2.52	3^+	3.73
2^+	2.58	5^+	3.78
4^+	2.75	6^+	3.84
1^+	2.78	4^+	3.86
2^+	2.81	2^+	3.89
3^+	2.84	0^+	3.96
2^+	2.90	3^+	3.97
0^+	2.98	8^+	3.99
3^+	3.04	10^+	4.00
4^+	3.16	4^+	4.07
5^+	3.19	1^+	4.13
2^+	3.21	5^+	4.23
6^+	3.22	4^+	4.24
4^+	3.24	3^+	4.33
3^+	3.29	3^+	4.42
2^+	3.29	4^+	4.42
2^+	3.39	1^+	4.43
1^+	3.42	0^+	4.44
2^+	3.47	6^+	4.47
4^+	3.53	1^+	4.49

Table 1: Calculated excitation energy for positive-parity levels in ^{114}Sn up to 4.5 MeV.

As regards the s.p. energies, our adopted values are (in MeV): $\epsilon_{g7/2} = 0.0$, $\epsilon_{d5/2} = 0.35$, $\epsilon_{s1/2} = 2.15$, $\epsilon_{d3/2} = 2.50$, and $\epsilon_{h11/2} = 3.60$. They have been determined from an analysis of the low-energy spectra of the isotopes ^{113}Sn and ^{115}Sn.

Within the chosen model space the size of the energy matrices to be set up and diagonalized is very large and we have found it convenient to resort to a truncation method. To start with, we have carried out calculations within the framework of the broken-pair approximation including up to two broken pairs. In Tables 1 and 2 we report the excitation energies for positive- and negative-parity states, respectively. We include at most 10 levels for each angular momentum and parity up to 4.5 MeV excitation energy. The calculated spectrum can be compared with the experimental one of Ref. [1], where the levels adopted so far are also reported. This comparison shows that the overall agreement between the calculated and experimental low-energy spectra is rather satisfactory.

We are currently refining our calculations employing a better approximation scheme, the chain-calculation method, which we have already used in the previous study of ^{120}Sn [2]. A detailed comparison between theory and experiment will be made upon completion of these calculations.

J^π	E(MeV)	J^π	E(MeV)
5^-	2.75	6^-	3.42
7^-	3.03	4^-	3.44
3^-	3.09	7^-	3.44
6^-	3.04	4^-	3.49
8^-	3.10	9^-	3.49
6^-	3.12	5^-	3.73
5^-	3.13	8^-	3.75
4^-	3.28	6^-	3.77
5^-	3.29	3^-	4.41
7^-	3.34	4^-	4.47
3^-	3.40		

Table 2: Calculated excitation energy for negative-parity levels in ^{114}Sn up to 4.5 MeV.

References

[1] P. Guazzoni *et al.*, this report, p.10
[2] P. Guazzoni Phys. Rev. **C60** (1999) 54603