Low-lying States of ^{85}Rb

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In order to investigate the possibility to apply the concept of homology to nuclei in the Z≃38 region and consequently to shed more light on whether Z=38 constitutes a good closed shell or not, shell model calculations have been performed for the ^{85}Rb and ^{86}Sr nuclei. Homologous states in ^{86}Sr should arise from the weak coupling of the $2p_{1/2}$ proton with the low-lying states in ^{85}Rb. The experimental search of these states by measuring ^{88}Sr$(\vec{p},\alpha)^{85}$Rb and ^{89}Y$(\vec{p},\alpha)^{86}$Sr reactions will represent an interesting and challenging line of study.

In literature is reported a shell model study of ^{85}Rb [1], concerning essentially high spin states. On the contrary, our interest is devoted to low-lying levels that only can be parent states able to produce multiplets of homologous states at not too high excitation energies.

We performed shell model calculations using the computer code OXBASH [2] and the usual one- and two-body Hamiltonian

$$H = \sum_i \epsilon_i a_i^\dagger a_i + \sum_{ijkl} V_{ijkl} a_i^\dagger a_j^\dagger a_k a_l$$

For the two-body matrix elements V_{ijkl} we have used the GWBXB interaction which is an effective G-matrix interaction derived from the Paris nucleon-nucleon interaction.

To construct the model space the orbitals $1f_{5/2}, 2p_{3/2}, 2p_{1/2}$ and $1g_{9/2}$ for protons and $2p_{1/2}$ and $1g_{9/2}$ for neutrons are used. The single particle energies are slightly adjusted to reproduce the low-lying levels of ^{85}Rb. The core used in the calculations is ^{66}Ni (Z=28,N=38). The single particle energies and the occupation numbers for negative and positive parity states are shown in table 1.

Table 2 shows the comparison between theoretical and experimental [3] energy spectrum for the low-lying levels of ^{85}Rb. As it is possible to evince from the obtained results, the agreement is rather good. As signaled in the last column of table 2, the homology does not appear in the case of some of the low lying states of ^{85}Rb. In some cases, in fact, the large mixing of configurations resulting from the choice of single particle energies prevents the occurrence of the weak-coupling situation which originates the homology.

References

[1] R. Schwengner, G. Winter, J. Reif, H. Prade, L. Käubler, R. Wirowski, N. Nicolay, S. Albers, S. Esser, P. von Brentano, W. Andrejtscheff: Nucl. Phys. **A584** (1995) 159.
[2] B.A. Brown, A. Etchegoyen, W.D.M. Rae: MSU-NSCL (1985) Report No. 524.
[3] H. Sievers: NDS **62** (1991) 271.

π orbitals	S.P.E. (MeV)	O.N. (NPS)	O.N. (PPS)	ν orbitals	S.P.E. (MeV)	O.N. (NPS)	O.N. (PPS)
$1f_{5/2}$	-10.150	[4-6]	[4-6]	$2p_{1/2}$	-2.164	[2]	[1-2]
$2p_{3/2}$	-12.57	[2-4]	[2-4]	$1g_{9/2}$	0.664	[8]	[8-9]
$2p_{1/2}$	-9.61	[0-2]	[0-2]	$1g_{9/2}$	-6.466	[0]	[0-1]

Table 1: Single particle energies (S.P.E.) and occupation numbers (O.N.) (in square brackets) for negative (NPS) and positive (PPS) parity states of ^{85}Rb

Shell Model		NDS		
J^π	E_{exc} (MeV)	E_{exc} (MeV)	J^π	Parent state
$5/2^-$	0	0	$5/2^-$	yes
$3/2^-$	0.154	0.151	$3/2^-$	no
$1/2^-$	0.285	0.281	$1/2^-$	no
$9/2^+$	0.514	0.514	$9/2^+$	yes
$3/2^-$	0.861	0.732	$3/2^-$	no
$7/2^-$	0.778	0.869	$7/2^-$	yes
$1/2^-$	0.910	0.886	$1/2^-$	no
$5/2^-$	0.805	0.920	$(5/2^-)$	no
		0.920	$1/2^-,3/2^-$	no
$5/2^+$	1.087	0.951	$5/2^+$	yes

Table 2: Comparison between theoretical and experimental [3] energy spectrum for the low-lying levels of ^{85}Rb