объединенный
институт
ядерных
исследований
дубна

E4-85-264

V.P.Gerdt, N.A.Kostov, P.P.Raychev,*
R.P.Roussev*

CALCULATION OF THE MATRIX ELEMENTS OF THE HAMILTONIAN OF THE INTERACTING VECTOR BOSON MODEL USING COMPUTER ALGEBRA.

Matrix Elements of the Hamiltonian - Analytical Results

Submitted to "Journal of Computational Physics"

* Institute for Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences, Sofia, Bulgaria

1985

LIST OF RESULTS

1. Following the "pseudospin" structure (see the table of ref. /1/) of the terms of the IVBM Hamiltonian, here we give the results of their direct action on the BM-states in the case $\lambda+\mu-L$ - even and the corresponding matrix elements (PIFs) Notations (see (2.3.6) of ref. /2/)

$$|i,j,k,\ell\rangle \equiv |\ell_1+i,\ \ell_2+j,\ \tau+k,\ \alpha+\ell\rangle$$

$$\ell_1 = L-\mu+2\alpha;\quad \ell_2=\mu-2\alpha;\quad \tau=\frac{1}{2}(\lambda+\mu-L-2\alpha);$$

$$2T=\ell_1+2\tau;\quad L=\ell_1+\ell_2 .$$

1. $A^L(p,n)\,A^L(p,n)$; $\quad (t,t_0)=(2,2)$

$$A^0(p,n)\,A^0(p,n)\,|0,0,0,0\rangle = 0;\quad C_s^{(k)}(0)=0$$

$$A^1(p,n)\,A^1(p,n)\,|0,0,0,0\rangle = -\frac{1}{2}\ell_2(\ell_2-1)\,|2,-2,1,0\rangle - 2\alpha(\ell_2+\alpha)\,|0,0,2,-1\rangle;$$

$$C_0^{(2)}(1) = -\frac{1}{2}\ell_2(\ell_2-1);\quad C_{-1}^{(2)}(1) = -2\alpha(\ell_2+\alpha);$$

$$A^2(p,n)\,A^2(p,n)\,|0,0,0,0\rangle = -A^1(p,n)\,A^1(p,n)\,|0,0,0,0\rangle$$

$$C_0^{(2)}(2) = -C_0^{(2)}(1);\quad C_{-1}^{(2)}(2) = -C_{-1}^{(2)}(1);$$

2. $A^L(n,p)\,A^L(n,p)$; $\quad (t,t_0)=(2,-2)$

$$A^0(n,p)\,A^0(n,p)\,|0,0,0,0\rangle = \frac{2}{3}T^2_{-1}\,|0,0,0,0\rangle$$

$$C_0^{(0)}=\frac{2}{3};$$

$$A^1(n,p)\,A^1(n,p)\,|0,0,0,0\rangle = -2\tau(\tau-1)\,|0,0,-2,1\rangle + \ell_2(\ell_2-1)n_1^3 z\,|-2,-2,0,0\rangle$$

$$+2\tau(\ell_1+2\ell_2+4\alpha+2)\,n_1 z\,|-2,0,-1,0\rangle + \{4\alpha(\ell_1+2\ell_2+2\alpha) - 2\tau(\ell_2+2\alpha+1) +$$

$$+\frac{1}{2}\ell_1(\ell_1-1)-\frac{1}{2}\ell_2(\ell_2-1)\}n_1^2\,|-2,0,0,0\rangle-2r(L+2a+1)\,|-2,2,-1,0\rangle\,+$$

$$+2a(\ell_1+4\ell_2+4a)\,n_1^3 z\,|-4,0,1,-1\rangle+2a(3\ell_1+4\ell_2+4a)\,n_1 z\,|-4,2,0,-1\rangle-$$

$$-6a(\ell_1+2\ell_2+2a)\,n_1^2\,|-4,2,1,-1\rangle-2a(\ell_2+a)\,n_1^4\,|-4,0,2,-1\rangle-$$

$$-2a(L+a)|-4,4,0,-1\rangle-\frac{1}{2}\ell_2(\ell_2-1)\,n_1^4\,|-2,-2,1,0\rangle\,;$$

$$C_0^{(2)}(1)=-\frac{2\ell_2(\ell_2-1)}{(2T+4)(2T+3)(2T+2)(2T+1)}\;;\quad C_{-1}^{(2)}(1)=-\frac{8a(\ell_2+a)}{(2T+4)(2T+3)(2T+2)(2T+1)};$$

$$C_0^{(1)}(1)=\frac{2\cdot 2^{1/2}\,\ell_2(\ell_2-1)}{(2T+2)(2T+1)2T}+\frac{4\cdot 2^{1/2}(r+1)(2T+3)}{2T}\,C_0^{(2)}(1);$$

$$C_{-1}^{(1)}(1)=\frac{2\cdot 2^{1/2}\,a(\ell_1+4\ell_2+a)}{(2T+2)(2T+1)T}+\frac{4\cdot 2^{1/2}(r+2)(2T+3)}{2T}\,C_{-1}^{(2)}(1)$$

$$C_1^{(0)}(1)=\frac{6r(r+1)(2T+2)(2T+1)}{T(2T-1)}\,C_0^{(2)}(1)-\frac{6r(2T+1)}{2^{1/2}(2T-1)}\,C_0^{(1)}(1);$$

$$C_0^{(0)}(1)=\frac{1}{T(2T-1)}\{4a(\ell_1+2\ell_2+2a)-2r(\ell_2+2a+1)+\frac{1}{2}\ell_1(\ell_1-1)-\frac{1}{2}\ell_2(\ell_2-1)\}-$$

$$-\frac{3(2r+1)(2T+1)}{T(2T-1)}[(r+1)(2T+2)\,C_0^{(2)}(1)-\frac{2T}{\sqrt{2}}\,C_0^{(1)}(1)]+$$

$$+\frac{3(r+1)(2T+1)}{T(2T-1)}[\,2(r+2)(2T+2)\,C_{-1}^{(2)}(1)-\frac{2T}{\sqrt{2}}\,C_{-1}^{(1)}(1)];$$

$$C_{-1}^{(0)}(1)=-\frac{3a(\ell_1+2\ell_2+2a)}{T(2T-1)}-\frac{3(2r+3)(2T+1)}{(2T-1)}[\,\frac{2(r+2)(T+1)}{T}\,C_{-1}^{(2)}(1)-\frac{1}{\sqrt{2}}\,C_{-1}^{(1)}(1)];$$

$$C_1^{(-1)}(1)=\frac{2(r-1)}{2T-2}[4\cdot 2^{1/2}(r+1)\,r(2T+1)\,C_0^{(2)}(1)-3r\cdot 2T\,C_0^{(1)}(1)-2^{1/2}(2T-1)\,C_1^{(0)}(1)];$$

$$C_0^{(-1)}(1)=\frac{2\cdot 2^{1/2}\,r(\ell_1+2\ell_2+4a+2)}{2T-2}+\frac{r}{2T-2}[4\cdot 2^{1/2}(r+1)(2T+1)(2r+1)\,C_0^{(2)}(1)$$

$$-3(2r+1)\,2T\,C_0^{(1)}(1)+2\sqrt{2}(2T-1)\,C_0^{(1)}(1)]-\frac{2r(r+1)}{2T-1}\times$$

$$\times[\,4\cdot 2^{1/2}(r+2)(2T+1)\,C_{-1}^{(2)}(1)-6T\,C_{-1}^{(1)}(1)]$$

$$C_{-1}^{(-1)}(1)=\frac{2\cdot 2^{1/2}\,a(3\ell_1+4\ell_2+4a)}{2T-2}+\frac{r+1}{2T-2}[\,4\cdot 2^{1/2}(r+2)(2r+3)(2T+1)\,C_{-1}^{(2)}(1)$$

$$-6(2r+3)\,T\,C_{-1}^{(1)}(1)+2\cdot 2^{1/2}(2T-1)\,C_{-1}^{(0)}(1)];$$

$$C_2^{(-2)}(1)=-4r(r+1)(r-1)(r-2)\,C_0^{(2)}(1)+4\cdot 2^{-1/2}r(r-1)(r-2)\,C_0^{(1)}(1)$$

$$+2(r-2)(r-1)\,C_1^{(0)}(1)-2\cdot 2^{-1/2}(r-2)\,C_1^{(-1)}(1);$$

$$C_1^{(-2)}(1)=-2r(r-1)+4r(r+1)(r-1)(2r-1)\,C_0^{(2)}(1)-4r(r+1)(r-1)(r+2)\,C_{-1}^{(2)}(1)$$

$$-4\cdot 2^{-1/2}r(r-1)(2r-1)\,C_0^{(1)}(1)+4\cdot 2^{-1/2}r(r+1)(r-1)\,C_{-1}^{(1)}(1)-(r-1)(2r-3)\,C_1^{(0)}(1)$$

$$+2r(r-1)\,C_0^{(0)}(1)+2^{-1/2}(2r-3)\,C_1^{(-1)}(1)-2\cdot 2^{-1/2}\,C_0^{(-1)}(1);$$

$$C_0^{(-2)}(1)=-2r(L+2a+1)-r(r+1)(2r+1)(2r-1)\,C_0^{(2)}(1)+4r(r+1)(r+2)(2r+1)\,C_{-1}^{(2)}(1)$$

$$+2^{-1/2}r(2r+1)(2r-1)\,C_0^{(1)}(1)-4\cdot 2^{-1/2}r(r+1)(2r+1)\,C_{-1}^{(1)}(1)-r(2r-1)\,C_0^{(0)}(1)+$$

$$+2r(r+1)\,C_{-1}^{(0)}(1)+2\cdot 2^{-1/2}r\,C_{-1}^{(-1)}(1)+2^{-1/2}(2r-1)\,C_0^{(-1)}(1);$$

$$C_{-1}^{(-2)}(1)=-2a(L+a)-(r+1)(r+2)(2r+1)(2r+3)\,C_{-1}^{(2)}(1)+$$

$$+2^{-1/2}(r+1)(2r+1)(2r+3)\,C_{-1}^{(1)}(1)-(r+1)(2r+1)\,C_{-1}^{(0)}(1)+2^{-1/2}(2r+1)\,C_{-1}^{(-1)}(1);$$

$$A^2(np)\,A^2(np)\,|0,0,0,0\rangle=(2A^{\circ}(n,p)\,A^{\circ}(n,p)-A^1(n,p)\,A^1(n,p)))\,|0,0,0,0\rangle$$

$$C_s^{(k)}(2)=2\,C_s^{(k)}(0)-C_s^{(k)}(1);$$

3. $A^L(p,n)\,A^L(p,p)$ – a mixture of $(t,t_0)=(2,1)$ and $(t,t_0)=(1,1)$

$A^\circ(p,n)\,A^\circ(p,p)\,|\,0,0,0,0> = 0;\qquad C_s^{(k)}(0)=0$

$A^1(p,n)\,A^1(p,p)\,|\,0,0,0,0> = -a(\ell_1+2\ell_2+2a)\,z\,|-1,0,1,-1>$

$+\,2a(\ell_2+a)\,n_1\,|-1,0,2,-1> + \frac{1}{2}\,\ell_2(\ell_2-1)\,n_1\,|\,1,-2,1,0>;$

$C_0^{(2)}(1)=\frac{2^{1/2}\ell_2(\ell_2-1)}{2(2T+4)};\quad C_{-1}^{(2)}(1)=-\frac{2\cdot 2^{1/2}\,a(\ell_2+a)}{2T+4};\quad C_0^{(1)}(1)=\frac{\ell_2(\ell_2-1)(r+1)}{2T+4}$

$C_{-1}^{(1)}(1)=a[\,\ell_1+2\ell_2+2a-\frac{4(r+2)(\ell_2+a)}{2T+4}\,]$

$A^2(p,n)\,A^2(p,p)\,|\,0,0,0,0> = -A^1(p,n)\,A^1(p,p)\,|\,0,0,0,0>$

$C_s^{(k)}(2)=-C_s^{(k)}(1)$

4. $A^L(n,n)\,A^L(p,n)$ – a mixture of $(t,t_0)=(2,1)$ and $(t,t_0)=(1,1)$

$A^\circ(n,n)\,A^\circ(p,n)\,|\,0,0,0,0> = 0$

$C_s^{(k)}(0)=0$

$A^1(n,n)\,A^1(p,n)\,|0,0,0,0> = -\frac{1}{2}\ell_2(\ell_2-1)\,n_1\,|1,-2,1,0> + \frac{1}{2}\ell_2(\ell_2-1)\,z\,|1,-2,0,0>$

$-2a(\ell_2+a)\,n_1\,|-1,0,2,-1> + 2a\,(\ell_2+a|\,z|-1,0,1,-1>;$

$C_0^{(2)}(1)=-\frac{2^{1/2}\ell_2(\ell_2-1)}{2(2T+4)};\quad C_{-1}^{(2)}(1)=-\frac{2^{1/2}\cdot 2a(\ell_2+a)}{2T+4};$

$C_0^{(1)}(1)=-\ell_2(\ell_2-1)[\,\frac{r+1}{2T+4}-\frac{1}{2}\,];\quad C_{-1}^{(1)}(1)=-2a(\ell_2+a)[\,\frac{2(r+2)}{2T+4}-1\,];$

$A^2(n,n)\,A^2(p,n)\,|\,0,0,0,0> = -A^1(n,n)\,A^1(p,n)\,|\,0,0,0,0>$

$C_s^{(k)}(2)=-C_s^{(k)}(1)$

5. $A^L(n,p)\,A^L(n,n)$ – a mixture of $(t,t_0)=(2,-1)$ and $(t,t_0)=(1,-1)$

$A^\circ(n,p)\,A^\circ(n,n)\,|\,0,0,0,0> = \frac{1}{2}(A^1(n,p)\,A^1(n,p)+A^2(n,p)\,A^2(n,p))\,|0,0,0,0>$

$C_s^{(k)}(0)=\frac{1}{2}(C_s^{(k)}(1)+C_s^{(k)}(2))$

$A^1(n,p)\,A^1(n,n)\,|\,0,0,0,0> = -r(\ell_2+a)\,z\,|-1,0,-1,0> + \{2ra-4a^2-4a\ell_2$

$-a\ell_1+\frac{1}{2}\ell_2^2+\frac{1}{2}\ell_1\ell_2+r\ell_2-\frac{1}{2}\ell_2\}\,n_1\,|-1,0,0,0> - a(\ell_1+2\ell_2+2a)\,z\,|-3,2,0,-1>$

$-a(\ell_1+6\ell_2+6a)\,n_1^2 z\,|-3,0,1,-1> - \ell_2(\ell_2-1)\,n_1^2 z\,|-1,-2,0,0,> +$

$+\,2a(\ell_1+3\ell_2+3a)\,n_1\,|-3,2,1,-1> + 2a(\ell_2+a)\,n_1^3\,|-3,0,2,-1> +$

$+\,\frac{1}{2}\ell_2(\ell_2-1)\,n_1^3\,|-1,-2,1,0>;$

$C_0^{(2)}(1)=\frac{2^{1/2}\ell_2(\ell_2-1)}{(2T+4)(2T+3)(2T+2)};\quad C_{-1}^{(2)}(1)=\frac{4\cdot 2^{1/2}a(\ell_2+a)}{(2T+4)(2T+3)(2T+2)};$

$C_0^{(1)}(1)=-\frac{2\ell_2(\ell_2-1)}{(2T+2)(2T+1)}[\,1-\frac{3(r+1)}{2T+4}\,];$

$C_{-1}^{(1)}(1)=-\frac{2a}{(2T+2)(2T+1)}[\,\ell_1+6\ell_2+6a-\frac{12(\ell_2+a)(r+2)}{2T+4}\,];$

$C_1^{(0)}(1)=\frac{4\cdot 2^{1/2}r\ell_2(\ell_2-1)(\ell_1-r)}{(2T+3)(2T+2)(2T)};$

$C_0^{(0)}(1)=\frac{2^{1/2}}{2T}[\,2ra-4a^2-4a\ell_2-a\ell_1+\frac{1}{2}\ell_2^2+\frac{1}{2}\ell_1\ell_2+r\ell_2-\frac{1}{2}\ell_2\,]-$

$-\frac{3(r+1)(2T+2)}{2T}[\,(2r+1)C_0^{(2)}(1)-2(r+2)\,C_{-1}^{(2)}(1)\,]+$

$+\frac{2^{1/2}(2T+1)}{2T}[\,(2r+1)\,C_1^{(1)}(1)-2(r+1)\,C_{-1}^{(1)}(1)\,];$

$$C_{-1}^{(0)}(1) = \frac{2\cdot 2^{1/2} a}{2T}\left[\ell_1+3\ell_2+3a+\frac{6(r+2)(2r+3)(\ell_2+a)}{(2T+3)(2T+2)} - \frac{(\ell_1+6\ell_2+6a)(2r+3)}{2T+2}\right];$$

$$C_1^{(-1)}(1) = -2(r-1)\left[2r(r+1)C_0^{(2)}(1) - 2^{1/2} r C_0^{(1)}(1) - C_1^{(0)}(1)\right];$$

$$C_0^{(-1)}(1) = -r(\ell_2+a) + r\left[2^{-1/2}(r+1)(2r+1)C_0^{(2)}(1) - 4\cdot 2^{-1/2}(r+2)(r+1)C_{-1}^{(2)}(1)\right]$$

$$+ r\left[-(2r+1)C_0^{(1)}(1) + 2(r+1)C_{-1}^{(1)}(1) - 2\cdot 2^{-1/2} C_0^{(0)}(1)\right];$$

$$C_{-1}^{(-1)}(1) = -a(\ell_1+2\ell_2+2a) + (r+1)\left[2\cdot 2^{-1/2}(r+2)C_{-1}^{(2)}(1) - (2r+3)C_{-1}^{(1)}(1) + 2\cdot 2^{-1/2} C_{-1}^{(0)}(1)\right]$$

$$A^2(n,p)\,A^2(n,n)\,|0,0,0,0\rangle = \ell_2(\ell_2-1)\,n_1^2 z\,|-1,-2,0,0\rangle + \{4a^2+4a\ell_2+\tfrac{2}{3}ra+\tfrac{1}{3}r\ell_2$$

$$+\tfrac{1}{2}\ell_2+\tfrac{7}{3}a\ell_1-\tfrac{1}{2}\ell_2^2+\tfrac{1}{6}\ell_1\ell_2\}\,n_1\,|-1,0,0,0\rangle - \tfrac{1}{2}\ell_2(\ell_2-1)\,n_1^3\,|-1,-2,1,0\rangle$$

$$-\tfrac{r}{3}(\ell_2+2a)\,z\,|-1,0,-1,0\rangle + a(\ell_1+2\ell_2+2a)\,z\,|-3,2,0,-1\rangle +$$

$$+a(\ell_1+6\ell_2+6a)\,n_1^2 z\,|-3,0,1,-1\rangle - 2a(\ell_1+3\ell_2+3a)\,n_1\,|-3,2,1,-1\rangle -$$

$$-2a(\ell_2+a)\,n_1^3\,|-3,0,2,-1\rangle;$$

$$C_0^{(2)}(2) = -C_0^{(2)}(1);\quad C_{-1}^{(2)}(2) = -C_{-1}^{(2)}(1);\quad C_0^{(1)}(2) = -C_0^{(1)}(1);\quad C_{-1}^{(1)}(2) = -C_{-1}^{(1)}(1);$$

$$C_1^{(0)}(2) = -C_1^{(0)}(1);\quad C_0^{(0)}(2) = \frac{2^{1/2}}{2T}\left[4a^2+4a\ell_2+\tfrac{1}{3}r\ell_2+\tfrac{1}{2}\ell_2+\tfrac{7}{3}a\ell_1-\right.$$

$$\left.-\tfrac{1}{2}\ell_2^2+\tfrac{1}{6}\ell_1\ell_2\right] - \frac{3(r+1)(2T+2)}{2T}\left[(2r+1)C_0^{(2)}(2) - 2(r+2)C_{-1}^{(2)}(2)\right] +$$

$$+\frac{2^{1/2}(2T+1)}{2T}\left[(2r+1)C_0^{(1)}(2) - 2(r+1)C_{-1}^{(1)}(r)\right];$$

$$C_{-1}^{(0)}(2) = -C_{-1}^{(0)}(1);\quad C_1^{(-1)}(2) = -C_1^{(-1)}(1);\quad C_0^{(-1)}(2) = -\frac{r}{3}(\ell_2+a) +$$

$$+r\left[2\cdot 2^{-1/2}(r+1)(2r+1)C_0^{(2)}(2) - 4\cdot 2^{-1/2}(r+2)(r+1)C_{-1}^{(2)}(2) - (2r+1)C_0^{(1)}(2) +\right.$$

$$\left.+2(r+1)C_{-1}^{(1)}(2) - 2\cdot 2^{-1/2} C_0^{(0)}(2)\right];$$

$$C_{-1}^{(-1)}(2) = -C_{-1}^{(-1)}(1).$$

6. $A^L(p,p)\,A^L(n,p)$ – a mixture $(t,t_0)=(2,-1)$ and $(t,t_0)=(1,-1)$

$$A^\circ(p,p)\,A^\circ(n,p)\,|0,0,0,0\rangle = \frac{1}{2}\left(A^1(p,p)\,A^1(n,p) + A^2(p,p)\,A^2(n,p)\right)|0,0,0,0\rangle$$

$$C_s^{(k)}(0) = \frac{1}{2}\left(C_s^{(k)}(1) + C_s^{(k)}(2)\right)$$

$$A^1(p,p)\,A^1(n,p)\,|0,0,0,0\rangle = \tfrac{1}{2}\ell_2(\ell_2-1)\,n_1^2 z\,|-1,-2,0,0\rangle + \{4a\ell_2+3a\ell_1+4a^2 -$$

$$-2ra - r\ell_2 + \tfrac{1}{2}\ell_1\ell_2 + \tfrac{1}{2}\ell_1^2 - \tfrac{1}{2}\ell_1 - 2r\}\,n_1\,|-1,0,0,0\rangle + r(L+2a+2)\,z\,|-1,0,-1,0\rangle$$

$$-\tfrac{1}{2}\ell_2(\ell_2-1)\,n_1^2\,|-1,-2,1,0\rangle + 2a(L+a)\,z\,|-3,2,0,-1\rangle + 2a(\ell_1+3\ell_2+3a)\,n_1^2 z\,|-3,0,1,-1\rangle$$

$$-2a(2\ell_1+3\ell_2+3a)\,n_1\,|-3,2,1,-1\rangle - 2a(\ell_2+a)\,n_1^3\,|-3,0,2,-1\rangle;$$

$$C_0^{(2)}(1) = -\frac{2^{1/2}\,\ell_2(\ell_2-1)}{(2T+4)(2T+3)(2T+2)};\qquad C_{-1}^{(2)}(1) = \frac{-4\cdot 2^{1/2}\,a(\ell_2+a)}{(2T+4)(2T+3)(2T+2)}$$

$$C_0^{(1)}(1) = -\frac{\ell_2(\ell_2-1)}{(2T+2)(2T+1)}\left[\frac{6(r+1)}{2T+4}-1\right];$$

$$C_{-1}^{(1)}(1) = -\frac{4a}{(2T+2)(2T+1)}\left[\frac{6(\ell_2+a)(r+2)}{2T+4} - \ell_1 - 3\ell_2 - 3a\right];$$

$$C_1^{(0)}(1) = -\frac{2\cdot 2^{1/2}\,r\ell_2(\ell_2-1)(\ell_1-r)}{(2T+3)(2T+2)(2T)};\quad C_0^{(0)}(1) = \frac{2^{1/2}}{2T}\left[4a\ell_2+3a\ell_1+4a^2-2ra-r\ell_2+\right.$$

$$\left.+\tfrac{1}{2}\ell_1\ell_2 + \tfrac{1}{2}\ell_2^2 - \tfrac{1}{2}\ell_2 - 2r\right] - \frac{3(r+1)(2T+2)}{2T}\left[(2r+1)C_0^{(2)}(1) - 2(r+2)C_{-1}^{(2)}(1)\right] +$$

$$+\frac{2^{1/2}(2T+1)}{2T}\left[(2r+1)C_0^{(1)}(1) - 2(r+1)C_{-1}^{(1)}(1)\right]$$

$$C_{-1}^{(0)}(1) = \frac{-2\cdot 2^{1/2} a}{2T}\left[2\ell_1+3\ell_2+3a+\frac{6(r+2)(2r+3)(\ell_2+a)}{(2T+3)(2T+2)} - \frac{2(2r+3)(\ell_1+3\ell_2+3a)}{2T+2}\right];$$

$$C_1^{(-1)}(1) = -2(r-1)\left[2r(r+1)C_0^{(2)}(1) - 2^{1/2} r C_0^{(1)}(1) - C_1^{(0)}(1)\right];$$

$$C_0^{(-1)}(1)=\tau(L+2\alpha+2)+\tau[2\cdot 2^{-1/2}(\tau+1)(2\tau+1)C_0^{(2)}(1)-4\cdot 2^{-1/2}(\tau+2)(\tau+1)C_{-1}^{(2)}(1)-$$

$$-(2\tau+1)C_0^{(1)}(1)+2(\tau+1)C_{-1}^{(1)}(1)-2\cdot 2^{-1/2}C_0^{(0)}(1)];$$

$$C_{-1}^{(-1)}(1)=2\alpha(L+\alpha)+(\tau+1)[2\cdot 2^{-1/2}(\tau+2)(2\tau+3)C_1^{(2)}(1)-(2\tau+3)C_{-1}^{(1)}(1)+$$

$$+2\cdot 2^{-1/2}C_{-1}^{(0)}(1)];$$

$$A^2(p,p)\,A^2(n,p)\,|0,0,0,0>=-\frac{\tau}{3}(14\alpha+7L+8\tau+2)\,z\,|-1,0,-1,0>+$$

$$+\{\frac{8}{3}\tau^2+\frac{14}{3}\tau\alpha+\frac{7}{3}\tau\ell_2+\frac{8}{3}\tau\ell_1-4\alpha^2-4\alpha\ell_2-\frac{5}{3}\alpha\ell_1+\frac{2}{3}\tau+\frac{1}{6}\ell_1\ell_2+\frac{1}{6}\ell_1^2-\frac{1}{6}\ell_1\}\times$$

$$\times n_1|-1,0,0,0>+\frac{1}{2}\ell_2(\ell_2-1)n_1^3|-1,-2,1,0>+2\alpha(2\ell_1+3\ell_2+3\alpha)n_1|-3,2,1,-1>-$$

$$-2\alpha(L+\alpha)z|-3,2,0,-1>+2\alpha(\ell_2+\alpha)n_1^3|-3,0,2,-1>$$

$$-2\alpha(\ell_1+3\ell_2+3\alpha)n_1^2z|-3,0,1,-1>-\frac{1}{2}\ell_2(\ell_2-1)n_1^2z|-1,-2,0,0>$$

$$C_0^{(2)}(2)=-C_0^{(2)}(1);\quad C_{-1}^{(2)}(2)=-C_{-1}^{(2)}(1);\quad C_0^{(1)}(2)=-C_0^{(1)}(1);$$

$$C_{-1}^{(1)}(2)=-C_{-1}^{(1)}(1);\quad C_1^{(0)}(2)=-C_1^{(0)}(1);$$

$$C_0^{(0)}(2)=\frac{2^{1/2}}{2T}\{\frac{8}{3}\tau^2+\frac{14}{3}\tau\alpha+\frac{7}{3}\tau\ell_2+\frac{8}{3}\tau\ell_1-4\alpha^2-4\alpha\ell_2-\frac{5}{3}\alpha\ell_1+\frac{2}{3}\tau+$$

$$+\frac{1}{6}\ell_1\ell_2+\frac{1}{6}\ell_1^2-\frac{1}{6}\ell_1\}$$

$$\frac{-3(\tau+1)(2T+2)}{2T}[(2\tau+1)C_0^{(2)}(2)-2(\tau+2)C_{-1}^{(2)}(2)]+\frac{2^{1/2}(2T+1)}{2T}[(2\tau+1)C_0^{(1)}(2)-$$

$$-2(\tau+1)C_{-1}^{(1)}(2)]$$

$$C_{-1}^{(0)}(2)=-C_{-1}^{(0)}(1);\quad C_1^{(-1)}(2)=-C_1^{(-1)}(1);$$

$$C_0^{(-1)}(2)=-\frac{\tau}{3}(14\alpha+7L+8\tau+2)+\tau[2\cdot 2^{-1/2}(\tau+1)(2\tau+1)C_0^{(2)}(2)-$$

$$-4\cdot 2^{-1/2}(\tau+2)(\tau+1)C_{-1}^{(2)}(2)-(2\tau+1)C_0^{(1)}(2)+2(\tau+1)C_{-1}^{(1)}(2)-2\cdot 2^{-1/2}C_0^{(0)}(2)];$$

$$C_{-1}^{(-1)}(2)=-C_{-1}^{(-1)}(1);$$

2. Following the "pseudospin" structure (see the Table of ref.[1]) of the terms of the IIVBM Hamiltonian, here we give the results of their direct action on the BM-basis in the case $\lambda+\mu-L$ -odd and the corresponding matrix elements (PIFs). Notations (see (2.3.6) of ref.[2])

$$|i,j,k,\ell>=|\ell_1+i,\ell_2+j,\tau+k,\alpha+\ell>;$$

$$\ell_1=L-\mu+2\alpha;\ \ell_2=\mu-2\alpha-1;\ \tau=\frac{1}{2}(\lambda+\mu-L-2\alpha-1);\ 2T=\ell_1+2\tau;\ L=\ell_1+\ell_2;$$

1. $A^L(p,n)\,A^L(p,n)$; $\quad(t,t_0)=(2,2)$

$$A^\circ(p,n)\,A^\circ(p,n)\,z\,|0,0,0,0>=0;\quad C_{s(0)}^{(k)}=0;$$

$$A^1(p,n)\,A^1(p,n)\,z\,|0,0,0,0>=-\frac{1}{2}\ell_2(\ell_2-1)\,z\,|2,-2,1,0>-2\alpha(\ell_2+\alpha+1)\,z\,|0,0,2,-1>;$$

$$C_0^{(2)}(1)=-\frac{1}{2}\ell_2(\ell_2-1);\quad C_{-1}^{(2)}(1)=-2\alpha(\ell_2+\alpha+1);$$

$$A^2(p,n)\,A^2(p,n)\,z\,|0,0,0,0>=-A^1(p,n)\,A^1(p,n)\,z\,|0,0,0,0>;$$

$$C_0^{(2)}(2)=-C_0^{(2)}(1);\quad C_{-1}^{(2)}(2)=-C_{-1}^{(2)}(1);$$

2. $A^L(n,p)\,A^L(n,p)$; $\quad(t,t_0)=(2,-2)$;

$$A^\circ(n,p)\,A^\circ(n,p)\,z\,|0,0,0,0>=\frac{2}{3}T_{-1}^2\,z\,|0,0,0,0>;\quad C_0^{(0)}(0)=\frac{2}{3}$$

$$A^1(n,p)\,A^1(n,p)\,z\,|0,0,0,0>=-2\tau(\ell_1+2\ell_2+4\alpha+5)\,n_1\,|0,0,-1,1>+$$

$$+[4\alpha(\ell_1+2\ell_2+2\alpha+3)-2\tau(\ell_2+2\alpha+2)+\frac{1}{2}\ell_1(\ell_1-1)-\frac{1}{2}\ell_2(\ell_2-1)+3\ell_1+$$

$$+4\ell_2+4]n_1^2z\,|-2,0,0,0>+$$

$$+[-2\alpha(\ell_1+4\ell_2+4\alpha+5)-\ell_1+\ell_2(\ell_2-3)-2]n_1^3\,|-2,0,1,0>+$$

$$+[2\tau(\ell_1+2\ell_2+4\alpha+4)-2\alpha(3\ell_1+4\ell_2+4\alpha+5)-2(L+1)]n_1\,|-2,2,0,0>-$$

$$-2\tau(L+2\alpha+2)z\,|-2,2,-1,0>-2\alpha n_1^4z\,|-4,0,2,-1>-$$

$$-6\alpha(\ell_1+2\ell_2+2\alpha+2)\,n_1^2\,z\,|-4,2,1,-1>-2\alpha(L+\alpha+1)\,z\,|-4,4,0,-1>+$$

$$+2a(\ell_1+4\ell_2+4a+4)n_1^3\,|-4,2,2,-1\rangle + 2a(3\ell_1+4\ell_2+4a+4)n_1\,|-4,4,1,-1\rangle -$$

$$-2r(r-1)z\,|0,0,-2,1\rangle - \frac{1}{2}\ell_2(\ell_2-1)n_1^4 z\,|-2,-2,1,0\rangle - \ell_2(\ell_2-1)n_1^3\,|0,-2,0,1\rangle;$$

$$C_0^{(2)}(1) = -\frac{2\ell_2(\ell_2-1)}{(2T+5)(2T+4)(2T+3)(2T+2)}; \quad C_{-1}^{(2)}(1) = -\frac{8a}{(2T+5)(2T+4)(2T+3)(2T+2)};$$

$$C_1^{(1)}(1) = -\frac{2\cdot 2^{1/2}\ell_2(\ell_2-1)}{(2T+3)(2T+2)(2T+1)} - \frac{4\cdot 2^{1/2}(r+1)(2T+4)}{2T+1}C_0^{(2)}(1);$$

$$C_0^{(1)}(1) = \frac{2\cdot 2^{1/2}\{-2a(\ell_1+4\ell_2+4a+5)-\ell_1+\ell_2(\ell_2-3)-2\}}{(2T+3)(2T+2)(2T+1)} +$$

$$+\frac{2\cdot 2^{1/2}(2T+4)}{2T+1}[(2r+3)C_0^{(2)}(1) - 2(r+2)C_{-1}^{(2)}(1)]$$

$$C_{-1}^{(1)}(1) = \frac{4\cdot 2^{1/2}a(\ell_1+4\ell_2+4a+4)}{(2T+3)(2T+2)(2T+1)} + \frac{2\cdot 2^{1/2}(2r+3)(2T+4)}{2T+1}C_{-1}^{(2)}(1);$$

$$C_1^{(0)}(1) = \frac{6r(2T+2)}{2T}\left[\frac{2(r+1)(2T+3)}{2T+1}C_0^{(2)}(1) + \frac{2T+2}{2^{1/2}}C_1^{(1)}(1)\right];$$

$$C_0^{(0)}(1) = \frac{2}{(2T+1)(2T)}[4a(\ell_1+2\ell_2+2a+3) - 2r(\ell_2+2a+2) + \frac{1}{2}\ell_1(\ell_1-1) -$$

$$-\frac{1}{2}\ell_2(\ell_2-1) + 3\ell_1 + 4\ell_2 + 4] -$$

$$-\frac{6(r+1)(2T+3)(2T+2)}{(2T+1)(2T)}[(2r+3)C_0^{(2)}(1) - 2(r+2)C_{-1}^{(2)}(1)] + \frac{6(r+1)(2T+2)}{2^{1/2}(2T)}C_0^{(1)}(1);$$

$$C_{-1}^{(0)}(1) = -\frac{12a(\ell_1+2\ell_2+2a+2)}{(2T+1)(2T)} - \frac{6(r+2)(2T+2)}{(2T)}\left[\frac{2(2r+5)(2T+3)}{2T+1}C_{-1}^{(2)}(1) -\right.$$

$$\left.-\frac{1}{2^{1/2}}C_{-1}^{(1)}(1)\right]$$

$$C_2^{(-1)}(1) = \frac{2r(r-1)}{2T-1}[4\cdot 2^{1/2}(r+1)(2T+2)C_0^{(2)}(1) + 3(2T+1)C_1^{(1)}(1)] -$$

$$-\frac{2\cdot 2^{1/2}(r-1)(2T)}{2T-1}C_1^{(0)}(1)$$

$$C_1^{(-1)}(1) = \frac{-2\cdot 2^{1/2}r(\ell_1+2\ell_2+4a+5)}{2T-1} - \frac{8\cdot 2^{1/2}r(r+1)(2T+2)}{2T-1}[(2r+1)C_0^{(2)}(1) - (r+2)C_{-1}^{(2)}(1)]$$

$$-\frac{3r(2T+1)}{2T-1}[(2r-1)C_1^{(1)}(1) - 2(r+1)C_0^{(1)}(1)] + \frac{2^{1/2}2T}{2T-1}[(2r-1)C_1^{(0)}(1) - 2rC_0^{(0)}(1)];$$

$$C_0^{(-1)}(1) = \frac{2^{1/2}}{2T-1}[2r(\ell_1+2\ell_2+4a+4) - 2a(3\ell_1+4\ell_2+4a+5) - 2(L+1)] +$$

$$+\frac{2\cdot 2^{1/2}(r+1)(2r+3)(2T+2)}{2T-1}[(2r+1)C_0^{(2)}(1) - 4(r+2)C_{-1}^{(2)}(1)] -$$

$$-\frac{3(r+1)(2T+1)}{2T-1}[(2r+1)C_0^{(1)}(1) - 2(r+2)C_{-1}^{(1)}(1)] +$$

$$+\frac{2^{1/2}2T}{2T-1}[(2r+1)C_0^{(0)}(1) - 2(r+1)C_{-1}^{(0)}(1)];$$

$$C_{-1}^{(-1)}(1) = \frac{2\cdot 2^{1/2}(3\ell_1+4\ell_2+4a+4)}{2T-1} + \frac{2^{1/2}(2r+3)}{2T-1}[2(r+2)(2r+5)(2T+2)C_{-1}^{(2)}(1) -$$

$$-3\cdot 2^{-1/2}(r+2)(2T+1)C_{-1}^{(1)}(1) + 2TC_{-1}^{(0)}(1)];$$

$$C_2^{(-2)}(1) = -4r(r+1)(r-1)(r-2)C_0^{(2)}(1) - 4\cdot 2^{-1/2}r(r-1)(r-2)C_1^{(1)}(1) +$$

$$+2(r-1)(r-2)C_1^{(0)}(1) + 2\cdot 2^{-1/2}(r-2)C_2^{(-1)}(1);$$

$$C_1^{(-2)}(1) = -2r(r-1) + 4r(r+1)(r-1)[(2r+1)C_0^{(2)}(1) - \frac{1}{2^{1/2}}C_0^{(1)}(1)] -$$

$$-4r(r+1)(r-1)(r+2)C_{-1}^{(2)}(1) + (r-1)(2r-1)[2\cdot 2^{-1/2}rC_1^{(1)}(1) - C_1^{(0)}(1)] +$$

$$+2(r-1)[rC_0^{(0)}(1) + 2^{-1/2}C_1^{(-1)}(1)];$$

$$C_0^{(-2)}(1) = -2r(L+2a+2) - r(r+1)(2r+3)[(2r+1)C_0^{(2)}(1) - 4(r+2)C_{-1}^{(2)}(1)] +$$

$$+2\cdot 2^{-1/2}r(r+1)[(2r+1)C_0^{(1)}(1) - 2(r+2)C_{-1}^{(1)}(1)] - r[(2r+1)C_0^{(0)}(1) -$$

$$- 2(r+1)\, C^{(0)}_{-1}(1) - 2\cdot 2^{-1/2} C^{(-1)}_{0}(1)];$$

$$C^{(-2)}_{-1}(1) = -2a(L+a+1) - (r+1)(r+2)(2r+3)[(2r+5)\, C^{(2)}_{-1}(1) - 2\cdot 2^{-1/2} C^{(1)}_{-1}(1)] -$$

$$-(r+1)[(2r+3)\, C^{(0)}_{-1}(1) - 2\cdot 2^{-1/2} C^{(-1)}_{-1}(1)];$$

$$A^2(n,p)\, A^2(n,p)\, z\,|0,0,0,0> = (2A^\circ(n,p)\, A^\circ(n,p) - A^1(n,p)\, A^1(n,p))\, z\,|0,0,0,0>$$

$$C^{(k)}_s(2) = 2C^{(k)}_s(0) - C^{(k)}_s(1)$$

3. $A^L(p,n)\, A^L(p,p)$ – a mixture of $(t,t_0) = (2,1)$ and $(t,t_0) = (2,-1)$

$$A^\circ(p,n)\, A^\circ(p,p)\, z\,|0,0,0,0> = 0$$

$$C^{(k)}_s(0) = 0$$

$$A^1(p,n)\, A^1(p,p)\, z\,|0,0,0,0> = [a(\ell_1 + 2\ell_2 + 2a - 3) - \ell_2 - \frac{1}{2}\ell_1 - 1]\,|1,0,1,0> -$$

$$-a(\ell_1 + 2\ell_2 + 2a - 2)\,|-1,2,2,-1> + 2a(\ell_2 + a - 1)\, n_1 z\,|-1,0,2,-1> +$$

$$+\frac{1}{2}\ell_2(\ell_2 - 1)\, n_1 z\,|1,-2,1,0>;$$

$$C^{(2)}_0(1) = \frac{2^{1/2}\ell_2(\ell_2-1)}{2(2T+5)};\quad C^{(2)}_{-1}(1) = \frac{2\cdot 2^{1/2} a(\ell_2 + a - 1)}{2T+5};\quad C^{(1)}_1(1) = -\frac{\ell_2(\ell_2-1)(r+1)}{2T+5};$$

$$C^{(1)}_0(1) = a(\ell_1 + 2\ell_2 + 2a - 3) - \ell_2 - \frac{1}{2}\ell_1 - 1 + 2^{-1/2}(2r+3)\, C^{(2)}_0(1) - 2^{-1/2}\, 2(r+2)\, C^{(2)}_{-1}(1);$$

$$C^{(1)}_{-1}(1) = -a(\ell_1 + 2\ell_2 + 2a - 2) + 2^{-1/2}(2r+5)\, C^{(1)}_{-1}(1);$$

$$A^2(p,n)\, A^2(p,p)\, z\,|0,0,0,0> = -A^1(p,n)\, A^1(p,p)\, z\,|0,0,0,0>;$$

$$C^{(k)}_s(2) = -C^{(k)}_s(1);$$

4. $A^L(n,n)\, A^L(p,n)$ – a mixture of $(t,t_0) = (2,1)$ and $(t,t_0) = (2,-1)$

$$A^\circ(n,n)\, A^\circ(p,n)\, z\,|0,0,0,0> = 0; \qquad C^{(k)}_s(0) = 0;$$

$$A^1(n,n)\, A^1(p,n)\, z\,|0,0,0,0> = -\frac{1}{2}\ell_2(\ell_2-1)\, n_1 z\,|1,-2,1,0> - 2a(\ell_2+a+1)\, n_1 z\,|-1,0,2,-1>$$

$$-[2a(\ell_2+a) - \frac{1}{2}\ell_2(\ell_2+1)]\,|1,0,1,0> - \frac{1}{2}\ell_2(\ell_2-1)\,|3,-2,0,1> + 2a(\ell_2+a+1)\,|-1,2,2,-1>$$

$$C^{(2)}_0(1) = -\frac{2^{1/2}\ell_2(\ell_2-1)}{2(2T+5)};\quad C^{(2)}_{-1} = -\frac{2\cdot 2^{1/2} a(\ell_2+a+1)}{2T+5};\quad C^{(1)}_1(1) = -\frac{\ell_2(\ell_2-1)(\ell_1+3)}{2(2T+5)};$$

$$C^{(1)}_0(1) = -2a(\ell_2+a) + \frac{1}{2}\ell_2(\ell_2+1) + 2^{-1/2}(2r+3)\, C^{(2)}_0(1) - 2^{-1/2}(r+2)\, C^{(2)}_{-1}(1);$$

$$C^{(1)}_{-1}(1) = \frac{2a\ell_1(\ell_2+a+1)}{2T+5}$$

$$A^2(n,n)\, A^2(p,n)\, z\,|0,0,0,0> = -A^1(n,n)\, A^1(p,n)\, z\,|0,0,0,0>;$$

$$C^{(k)}_s(2) = -C^{(k)}_s(1);$$

5. $A^L(p,n)\, A^L(n,n)$ – a mixture of $(t,t_0) = (2,-1)$ and $(t,t_0) = (1,-1)$

$$A^\circ(n,p)\, A^\circ(n,n)\, z\,|0,0,0,0> = \frac{1}{2}(A^1(n,p)\, A^1(n,n) + A^2(n,p)\, A^2(n,n))\, z\,|0,0,0,0$$

$$C^{(k)}_s(0) = \frac{1}{2}(C^{(k)}_s(1) + C^{(k)}_s(2))$$

$$A^1(n,p)\, A^1(n,n)\, z\,|0,0,0,0> = \{-r(\ell_2+a+1) + a(\ell_1+2\ell_2+2a+1) +$$

$$+\frac{1}{2}\ell_2 + \frac{1}{2}\ell_1 + \frac{1}{2}\}\,|-1,2,0,0> + \{-4a\ell_2 + 2ra - 4a^2 - a\ell_1 + \frac{1}{2}\ell_2^2 + \frac{1}{2}\ell_1\ell_2 + r\ell_2 -$$

$$-2\ell_2 + r - 5a - \frac{1}{2}\ell_1 - \frac{3}{2}\}\, n_1 z\,|-1,0,0,0> + r(\ell_2+a+1)\,|1,0,-1,1>$$

$$-a(\ell_1 + 2\ell_2 + 2a + 2)\,|-3,4,1,-1> + \{-\ell_2(\ell_2-1) + a(\ell_1 + 6\ell_2 + 6a) + 7a + \ell_2 + 2\ell_1 + 1\}$$

$$\times n_1^2\,(-1,0,1,0> - a(\ell_1 + 6\ell_2 + 6a + 6)\, n_1^2\,|-3,2,2,-1> + \ell_2(\ell_2-1)\, n_1^2\,|1,-2,0,1> +$$

$$+2a(\ell_1 + 3\ell_2 + 3a + 3)\, n_1 z\,|-3,2,1,-1> + 2a(\ell_2+a+1)\, n_1^3 z\,|-3,0,2,-1>$$

$$+\frac{1}{2}\ell_2(\ell_2-1)\, n_1^3 z\,|-1,-2,1,0>;$$

$$C_0^{(2)}(1) = \frac{2^{1/2}\,\ell_2(\ell_2-1)}{(2T+5)(2T+4)(2T+3)}; \qquad C_{-1}^{(2)}(1) = \frac{2\cdot 2^{1/2}\,a(\ell_2+a+1)}{(2T+5)(2T+4)(2T+3)};$$

$$C_1^{(1)}(1) = \frac{2\ell_2(\ell_2-1)}{(2T+3)(2T+2)} - \frac{6(\tau+1)(2T+4)}{2^{1/2}(2T+2)}C_0^{(2)}(1);$$

$$C_0^{(1)}(1) = \frac{2}{(2T+3)(2T+2)}[-\ell_2(\ell_2-1)+a(\ell_1+6\ell_2+6a)+7a+\ell_2+2\ell_1+1]$$

$$+\frac{3(2T+4)}{2^{1/2}(2T+2)}[(2\tau+3)C_0^{(2)}(1)-2(\tau+2)C_{-1}^{(2)}(1)];$$

$$C_{-1}^{(1)}(1) = -\frac{2a(\ell_1+6\ell_2+6a+6)}{(2T+3)(2T+2)}+\frac{(2\tau+3)(2T+4)}{2^{1/2}(2T+2)}C_{-1}^{(2)}(1);$$

$$C_1^{(0)}(1) = \frac{2\tau(2T+2)}{2T+1}[3(\tau+1)(2T+3)C_0^{(2)}(1)+2^{1/2}C_1^{(1)}(1)];$$

$$C_0^{(0)}(1) = \frac{2^{1/2}}{2T+1}[2\tau a-4a^2-4a\ell_2-a\ell_1+\frac{1}{2}\ell_2^2+\frac{1}{2}\ell_1\ell_2+\tau\ell_2-2\ell_2+\tau-5a-\frac{1}{2}\ell_1-\frac{3}{2}]-$$

$$-\frac{3(\tau+1)(2T+3)}{2T+1}[(2\tau+3)C_0^{(2)}(1)-2(\tau+2)C_{-1}^{(2)}(1)]+\frac{2\cdot 2^{1/2}(\tau+1)(2T+2)}{2T+1}C_0^{(1)}(1);$$

$$C_{-1}^{(0)}(1) = \frac{2\cdot 2^{1/2}a(\ell_1+3\ell_2+3a+3)}{2T+1}-\frac{(\tau+2)}{2T+1}[3(2\tau+5)(2T+3)C_{-1}^{(2)}(1)-\frac{2\cdot 2^{1/2}(2T+2)}{2T+1}C_{-1}^{(1)}(1)];$$

$$C_2^{(-1)}(1) = \frac{4\tau(\tau+1)(\tau-1)}{2^{1/2}}C_0^{(2)}(1)+2\tau(\tau-1)C_1^{(1)}(1)-2\cdot 2^{-1/2}(\tau-1)C_1^{(0)}(1);$$

$$C_1^{(-1)}(1) = -\tau(\ell_2+a+1)-4\cdot 2^{-1/2}\tau(\tau+1)[(2\tau+1)C_0^{(2)}(1)-(\tau+2)C_{-1}^{(2)}(1)]-\tau[(2\tau-1)C_1^{(1)}(1)-$$

$$-2(\tau+1)C_0^{(1)}(1)]+2^{-1/2}(2\tau-1)C_1^{(0)}(1)-2\cdot 2^{-1/2}\tau C_0^{(0)}(1);$$

$$C_0^{(-1)}(1) = -\tau(\ell_2+a+1)+a(\ell_1+2\ell_2+2a+1)+\frac{1}{2}\ell_2+\frac{1}{2}\ell_1+\frac{1}{2}+$$

$$+2^{-1/2}(\tau+1)(2\tau+3)[(2\tau+1)C_0^{(2)}(1)-4(\tau+2)C_{-1}^{(2)}(1)]-$$

$$-(\tau+1)[(2\tau+1)C_0^{(1)}(1)-2(\tau+2)C_{-1}^{(1)}(1)]+2^{-1/2}(2\tau+1)C_0^{(0)}(1)-2^{-1/2}\cdot 2(\tau+1)C_{-1}^{(0)}(1);$$

$$C_{-1}^{(-1)}(1) = -a(\ell_1+2\ell_2+2a+1)+(\tau+2)(2\tau+3)[2^{-1/2}(2\tau+5)C_{-1}^{(2)}(1)-C_{-1}^{(1)}(1)]+$$

$$+2^{-1/2}(2\tau+3)C_{-1}^{(0)}(1);$$

$$A^2(np)\,A^2(n,n)\,z\,|0,0,0,0\rangle = \{\ell_2(\ell_2-1)-a(\ell_1+6\ell_2+6a)-7a-\ell_2-\frac{1}{2}\ell_1-1\}\times$$

$$\times n_1^2|-1,0,1,0\rangle+\{4a^2+4a\ell+\frac{2}{3}\tau a+\frac{1}{3}\tau\ell_2+\frac{7}{3}a\ell_1-\frac{1}{2}\ell_2^2+\frac{1}{6}\ell_1\ell_2+\frac{1}{3}\tau+\frac{19}{3}a+$$

$$+\frac{8}{3}\ell_2+\frac{7}{6}\ell_1+\frac{13}{6}\}n_1 z|-1,0,0,0\rangle-$$

$$-\{\tau/3(\ell_2+2a+1)+a(\ell_1+2\ell_2+2a+10/3)+\tau/6\,\ell_2+\frac{1}{2}\ell_1+7/6\}|-1,2,0,0\rangle-$$

$$-\ell_2(\ell_2-1)n_1^2\,|1,-2,0,1\rangle-\frac{1}{2}\ell_2(\ell_2-1)n_1^3 z\,|-1,-2,1,0\rangle+\tau/3(\ell_2+2a+1)|1,0,-1,1\rangle+$$

$$+a(\ell_1+2\ell_2+2a+2)|-3,4,1,-1\rangle+a(\ell_1+6\ell_2+6a+6)n_1^2|-3,2,2,-1\rangle-$$

$$-2a(\ell_1+3\ell_2+3a+3)n_1 z|-3,2,1,-1\rangle-2a(\ell_2+a+1)n^3 z|-3,0,2,-1\rangle;$$

$$C_{-1}^{(2)}(2) = -C_0^{(2)}(1); \quad C_{-1}^{(2)}(2) = -C_{-1}^{(2)}(1); \quad C_1^{(1)}(2) = -C_1^{(1)}(1);$$

$$C_0^{(1)}(2) = \frac{2}{(2T+3)(2T+2)}[\ell_2(\ell_2-1)-a(\ell_1+6\ell_2+6a)-7a-\ell_2-\frac{1}{2}\ell_1-1]+$$

$$+\frac{3(2T+4)}{2^{1/2}(2T+2)}[(2\tau+3)C_0^{(2)}(2)-2(\tau+2)C_{-1}^{(2)}(2)];$$

$$C_{-1}^{(1)}(2) = -C_{-1}^{(1)}(1); \qquad C_1^{(0)}(2) = -C_1^{(0)}(1);$$

$$C_0^{(0)}(2) = \frac{2^{1/2}}{2T+1}[4a^2+4a\ell_2+\frac{2}{3}\tau a+\frac{1}{3}\tau\ell_2+\frac{7}{3}a\ell_1-\frac{1}{2}\ell_2^2+\frac{1}{6}\ell_1\ell_2+\frac{1}{3}\tau+$$

$$+\frac{19}{3}a+\frac{8}{3}\ell_2+\frac{7}{6}\ell_1+\frac{13}{6}]-\frac{3(\tau+1)(2T+3)}{2T+1}[(2\tau+3)C_0^{(2)}(2)-2(\tau+2)C_{-1}^{(2)}(2)]+$$

$$+\frac{2\cdot 2^{1/2}(\tau+1)(2T+2)}{2T+1}C_0^{(1)}(2);$$

$$C^{(0)}_{-1}(2) = -C^{(0)}_{-1}(1); \qquad C^{(-1)}_{2}(2) = -C^{(-1)}_{2}(1);$$

$$C^{(-1)}_{1}(2) = \tau/3(\ell_2+2a+1) - 4\cdot 2^{-1/2}\tau(\tau+1)[(2\tau+1)C^{(2)}_{0}(2) - (\tau+2)C^{(2)}_{-1}(2)] -$$

$$-\tau[(2\tau-1)C^{(1)}_{1}(2) - 2(\tau+1)C^{(1)}_{0}(2)] + 2^{-1/2}(2\tau-1)C^{(0)}_{1}(2) - 2^{-1/2}2\tau C^{(0)}_{0}(2);$$

$$C^{(-1)}_{0}(2) = -\tau/3(\ell_2+2a+1) + a(\ell_1+2\ell_2+2a+\frac{10}{3}) + \frac{5}{6}\ell_2 + \frac{1}{2}\ell_1 + \frac{7}{6} +$$

$$+ 2^{-1/2}(\tau+1)(2\tau+3)[(2\tau+1)C^{(2)}_{0}(2) - 4(\tau+2)C^{(2)}_{-1}(2)] -$$

$$-(\tau+1)[(2\tau+1)C^{(1)}_{0}(2) - 2(\tau+2)C^{(1)}_{-1}(2)] + 2^{-1/2}(2\tau+1)C^{(0)}_{0}(2) - 2^{-1/2}(\tau+1)C^{(0)}_{-1}(2);$$

$$C^{(-1)}_{-1}(2) = -C^{(-1)}_{-1}(1);$$

6. $A^L(p,p)A^L(n,p)$ – a mixture $(t,t_0)=(2,-1)$ and $(t,t_0)=(1,-1)$

$$A^{\circ}(p,p)A^{\circ}(n,p)\,z\,|0,0,0,0\rangle = \frac{1}{2}(A^1(p,p)A^1(n,p) + A^2(p,p)A^2(n,p))\,z\,|0,0,0,0\rangle$$

$$C^{(k)}_{s}(0) = \frac{1}{2}(C^{(k)}_{s}(1) + C^{(k)}_{s}(2));$$

$$A^1(p,p)A^1(n,p)\,z\,|0,0,0,0\rangle = [4a\ell_2 + 3a\ell_1 + 4a^2 - 2\tau a - \tau\ell_2 + \frac{1}{2}\ell_1\ell_2 +$$

$$+\frac{1}{2}\ell_1^2 + 6a - 3\tau + \frac{5}{2}\ell_2 + 2\ell_1 + \frac{5}{2}]n_1 z\,|-1,0,0,0\rangle - \frac{1}{2}\ell_2(\ell_2-1)n_1^3 z\,|-1,-2,1,0\rangle -$$

$$-\frac{1}{2}\ell_2(\ell_2-1)n_1^2\,|1,-2,0,1\rangle - 2a(2\ell_1+3\ell_2+3a+3)n_1 z\,|-3,2,1,-1\rangle$$

$$-2a(\ell_2+a+1)n_1^3 z\,|-3,0,2,-1\rangle + [\frac{1}{2}\ell_2(\ell_2-1) - 2a(\ell_1+3\ell_2+3a) - 8a -$$

$$-2\ell_2 - \ell_1 - 2]n_1^2\,|1,-2,0,1\rangle + [\tau(L+2a+2) - 2a(L+a) + \tau - 3a - \frac{1}{2}L - \frac{1}{2}]\times$$

$$\times|-1,2,0,0\rangle - \tau(L+2a+4)\,|1,0,-1,1\rangle + a(2L+2a+1)\,|-3,4,0,-1\rangle +$$

$$+2a(\ell_1+3\ell_2+3a+3)n_1^2\,|-3,2,2,-1\rangle;$$

$$C^{(2)}_{0}(1) = -\frac{2^{1/2}\ell_2(\ell_2+1)}{(2T+5)(2T+4)(2T+3)}; \quad C^{(2)}_{-1}(1) = \frac{-2\cdot 2^{1/2}a(\ell_2+a+1)}{(2T+5)(2T+4)(2T+3)};$$

$$C^{(1)}_{1}(1) = -\frac{\ell_2(\ell_2-1)}{(2T+3)(2T+2)} - \frac{6(\tau+1)(2\tau+4)}{2^{1/2}(2T+2)}C^{(2)}_{0}(1);$$

$$C^{(1)}_{0}(1) = \frac{2}{(2T+3)(2T+2)}[\frac{1}{2}\ell_2(\ell_2-1) - 2a(\ell_1+3\ell_2+3a) - 8a - 2\ell_2 - \ell_1 - 2] +$$

$$+\frac{6(2T+4)}{2^{1/2}(2T+2)}[(2\tau+3)C^{(2)}_{0}(1) - (\tau+2)C^{(2)}_{-1}(1)];$$

$$C^{(1)}_{-1}(1) = \frac{4a(\ell_1+3\ell_2+3a+2)}{(2T+3)(2T+2)} + \frac{(2\tau+3)(2T+4)}{2^{1/2}(2T+2)}C^{(2)}_{-1}(1);$$

$$C^{(0)}_{1}(1) = \frac{6\tau(\tau+1)(2T+3)}{2T+1}C^{(2)}_{0}(1) + \frac{2\cdot 2^{1/2}\tau(2T+2)}{2T+1}C^{(1)}_{1}(1);$$

$$C^{(0)}_{0}(1) = \frac{2^{1/2}}{2T+1}[4a\ell_2 + 3a\ell_1 + 4a^2 - 2\tau a - \tau\ell_2 + \frac{1}{2}\ell_1\ell_2 + \frac{1}{2}\ell_1^2 + 6a - 3\tau +$$

$$+\frac{5}{2}\ell_2 + 2\ell_1 + \frac{5}{2}] - \frac{3(\tau+1)(2T+3)}{2T+1}[(2\tau+3)C^{(2)}_{0}(1) - 2(\tau+2)C^{(2)}_{-1}(1)] +$$

$$+\frac{2\cdot 2^{1/2}(\tau+1)(2T+2)}{2T+1}C^{(1)}_{0}(1);$$

$$C^{(0)}_{-1}(1) = -\frac{2\cdot 2^{1/2}a(2\ell_1+2\ell_2+3a+3)}{2T+1} - \frac{(\tau+2)}{2T+2}[3(2\tau+5)(2T+3)C^{(2)}_{-1}(1) -$$

$$-2\cdot 2^{1/2}(2T+2)C^{(1)}_{-1}(1)];$$

$$C^{(-1)}_{2}(1) = \frac{4\tau(\tau+1)(\tau-1)}{2^{1/2}}C^{(2)}_{0}(1) + 2\tau(\tau-1)C^{(-1)}_{1}(1) - 2\cdot 2^{-1/2}(\tau-1)C^{(0)}_{1}(1);$$

$$C^{(-1)}_{1}(1) = -\tau(L+2a+4) - 4\cdot 2^{-1/2}\tau(\tau+1)[(2\tau+1)C^{(2)}_{0}(1) - (\tau+2)C^{(2)}_{-1}(1)] -$$

$$-\tau[(2\tau-1)C^{(1)}_{1}(1) - 2(\tau+1)C^{(1)}_{0}(1)] + (2\tau-1)2^{-1/2}C^{(0)}_{1}(1) - 2\cdot 2^{-1/2}\tau C^{(0)}_{0}(1);$$

$$C^{(-1)}_{0}(1) = \tau(L+2a+2) - 2a(L+a) + \tau - 3a - \frac{1}{2}L - \frac{1}{2} + 2^{-1/2}(\tau+1)(2\tau+3)\times$$

$$\times[(2r+1)C_0^{(2)}(1)-4(r+2)C_{-1}^{(2)}(1)]-(r+1)[(2r+1)C_0^{(1)}(1)-2(r+2)C_{-1}^{(1)}(1)]+$$

$$+2^{-1/2}(2r+1)C_0^{(0)}(1)-2\cdot 2^{-1/2}(r+1)C_{-1}^{(0)}(1);$$

$$C_{-1}^{(-1)}(1)=a(2L+2a+1)+(r+2)(2r+3)[2^{-1/2}(2r+5)C_{-1}^{(2)}(1)-C_{-1}^{(1)}(1)]+$$

$$+2^{-1/2}(2r+3)C_{-1}^{(0)}(1);$$

$$A^2(p,p)A^2(n,p)z\,|\,0,0,0,0> = \frac{1}{2}\ell_2(\ell_2-1)n_1^3 z\,|-1,-2,1,0>+$$

$$+[\frac{8}{3}r^2+\frac{14}{3}ra+\frac{17}{3}r\ell_2+\frac{8}{3}r\ell_1-4a^2-4a\ell_2-\frac{5}{3}a\ell_1+\frac{1}{6}\ell_1\ell_2+\frac{1}{6}\ell_1^2+\frac{17}{3}r-$$

$$-\frac{17}{3}a-\frac{11}{6}\ell_2-\frac{2}{3}\ell_1-\frac{11}{6}]n_1 z\,|-1,0,0,0>+2a(2\ell_1+3\ell_2+3a+3)n_1 z\,|-3,2,1,-1>+$$

$$+2a(\ell_2+a+1)n_1^3 z\,|-3,0,2,-1>$$

$$+r/3(14a+7L+8r+16)\,|1,0,-1,1>+[-\frac{r}{3}(14a+7L+8r+2)+2a(L+a)-5r+$$

$$+\frac{5}{3}a-\frac{1}{6}L-\frac{1}{6}]|-1,2,0,0>+[2a(\ell_1+3\ell_2+3a)-\frac{1}{2}\ell_2(\ell_2-1)-4r+8a+$$

$$+2\ell_2+\ell_1+2]n_1^2|-1,0,1,0>+\frac{1}{2}\ell_2(\ell_2-1)n_1^2\,|1,-2,0,1>-$$

$$-a(2L+2a+1)\,|-3,4,1,-1>-2a(\ell_1+3\ell_2+3a+2)n_1^2(-3,2,2,-1>;$$

$$C_0^{(2)}(2)=-C_0^{(2)}(1);\quad C_{-1}^{(2)}(2)=-C_{-1}^{(2)}(1);\quad C_1^{(1)}(2)=-C_1^{(1)}(1);$$

$$C_0^{(1)}(2)=\frac{2}{(2T+3)(2T+2)}[2a(\ell_1+3\ell_2+3a)-\frac{1}{2}\ell_2(\ell_2-1)-4r+8a+2\ell_2+\ell_1+2]+$$

$$+\frac{6(2T+4)}{2^{1/2}(2T+2)}[(2r+3)C_0^{(2)}(2)-(r+2)C_{-1}^{(2)}(2)];$$

$$C_{-1}^{(1)}(2)=-C_{-1}^{(1)}(1);\qquad C_1^{(0)}(2)=-C_1^{(0)}(1);$$

$$C_0^{(0)}(2)=\frac{2^{1/2}}{2T+1}[\frac{8}{3}r^2+\frac{14}{3}ra+\frac{17}{3}r\ell_2+\frac{8}{3}r\ell_1-4a^2-4a\ell_2-\frac{5}{3}a\ell_1+\frac{1}{6}\ell_1\ell_2+$$

$$+\frac{1}{6}\ell_1^2+\frac{17}{3}r-\frac{17}{3}a-\frac{11}{6}\ell_2-\frac{2}{3}\ell_1-\frac{11}{6}]-\frac{3(r+1)(2T+3)}{2T+1}[(2r+3)C_0^{(2)}(2)-$$

$$-2(r+2)C_{-1}^{(2)}(2)]+\frac{2\cdot 2^{1/2}(r+1)(2T+2)}{2T+1}C_0^{(1)}(1);$$

$$C_{-1}^{(0)}(2)=-C_{-1}^{(0)}(1);\qquad C_2^{(-1)}(2)=-C_2^{(-1)}(1);$$

$$C_1^{(-1)}(2)=r/3(14a+7L+8r+16)-\frac{4r(r+1)}{2^{1/2}}[(2r+1)C_0^{(2)}(2)-(r+2)C_{-1}^{(2)}(2)]-$$

$$-r[(2r-1)C_1^{(1)}(2)-2(r+1)C_0^{(1)}(2)]+\frac{2r-1}{2^{1/2}}C_{-1}^{(0)}(2)-\frac{2r}{2^{1/2}}C_0^{(0)}(2);$$

$$C_0^{(-1)}(2)=r/3(14a+7L+8r+2)+2a(L+a)-5r+\frac{5}{3}a-\frac{1}{6}L-\frac{1}{6}+$$

$$+\frac{(r+1)(2r+3)}{2^{1/2}}[(2r+1)C_0^{(2)}(2)-4(r+2)C_{-1}^{(2)}(2)]-(r+1)[(2r+1)C_0^{(1)}(2)-$$

$$-2(r+2)C_{-1}^{(1)}(2)]+\frac{2(r+1)}{2^{1/2}}C_0^{(0)}(2)-\frac{2(r+1)}{2^{1/2}}C_{-1}^{(0)}(2);$$

$$C_{-1}^{(-1)}(2)=-C_{-1}^{(-1)}(1);$$

REFERENCES

1. Gerdt V.P. et al. JINR, E4-85-263, Dubna, 1985.
2. Gerdt V.P. et al. JINR, E4-85-262, Dubna, 1985.

Received by Publishing Department
on April 11, 1985.

Гердт В.П. и др. E4-85-264
Вычисление матричных элементов гамильтониана модели взаимодействующих векторных базонов с использованием компьютерной алгебры. Матричные элементы гамильтониана - аналитические результаты

Представлен результат прямого действия отдельных слагаемых гамильтониана МВВБ на базис БМ и список соответствующих матричных элементов.

Работа выполнена в Лаборатории вычислительной техники и автоматизации ОИЯИ.

Препринт Объединенного института ядерных исследований. Дубна 1985

Gerdt V.P. et al. E4-85-264
Calculation of the Matrix Elements of the Hamiltonian of the Interacting Vector Boson Model Using Computer Algebra. Matrix Elements of the Hamiltonian - Analytical Results

The direct action of the terms of the IVBM Hamiltonian in the basis of BM and a list of the corresponding matrix elements are presented.

The investigation has been performed at the Laboratory of Computing Techniques and Automation, JINR.

Preprint of the Joint Institute for Nuclear Research. Dubna 1985