

Appendix A: Forward Kinematics Analysis

A.1: The DH parameter table display in the form:

Joint	Type	a	Alpha	d	Theta
1	Revolute	0	90*Degree	0	θ_1
2	Revolute	a2	0	0	θ_2
3	Revolute	a3	0	0	θ_3
4	Revolute	a4	0	0	θ_4
5	Revolute	0	-90*Degree	0	θ_1

A.2: Link transformations for OWI- 535 robot arm

$$A_1^0 = \begin{bmatrix} c1 & 0 & -s1 & 0 \\ s1 & 0 & c1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_2^1 = \begin{bmatrix} c2 & -s2 & 0 & a2c2 \\ s2 & c2 & 0 & a2s2 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$A_3^2 = \begin{bmatrix} c3 & -s3 & 0 & a3c3 \\ s3 & c3 & 0 & a3s3 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

APPENDIX A

$$A_4^3 = \begin{bmatrix} c4 & -s4 & 0 & a4c4 \\ s4 & c4 & 0 & a4c4 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

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$$A_5^4 = \begin{bmatrix} c5 & -s5 & 0 & 0 \\ s5 & c5 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

=

$$H_2^0 = A_1^0 A_2^1$$

$$H_2^0 = \begin{bmatrix} c1 & 0 & -s1 & 0 \\ s1 & 0 & c1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} c2 & -s2 & 0 & a2c2 \\ s2 & c2 & 0 & a2c2 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} c1c2 & -c1s2 & -s1 & a2c1c2 \\ c2s1 & -s1s2 & c1 & a2c2s1 \\ s2 & c2 & 0 & a2c2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$H_3^0 = A_3^2 H_2^0$$

$$H_3^0 = \begin{bmatrix} c1c2 & -c1s2 & -s1 & a2c1c2 \\ c2s1 & -s1s2 & c1 & a2c2s1 \\ s2 & c2 & 0 & a2c2 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} c3 & -s3 & 0 & a3c3 \\ s3 & c3 & 0 & a3c3 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} c1c2c3 - c1s2s3 & -c1c2s3 - c1s2c3 & -s1 & c1s2a3c3 - c1s2a3c3 + c1a2c2 \\ -s1c2c3 - s1s2s3 & -s1c2s3 - s1s2c3 & c1 & s1c2a3c3 - s1s2a3c3 + s1a2c2 \\ s2c3 + c2s3 & -s2s3 + c2c3 & 0 & s2a3c3 + c2a3c3 + a2c2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

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$$H_4^0 = A_4^3 H_3^0 =$$

APPENDIX A

$$\begin{bmatrix} c1c2c3 - c1s2s3 & -c1c2s3 - c1s2c3 & -s1 & c1s2a3c3 - c1s2a3c3 + c1a2c2 \\ -s1c2c3 - s1s2s3 & -s1c2s3 - s1s2c3 & c1 & s1c2a3c3 - s1s2a3c3 + s1a2c2 \\ s2c3 + c2s3 & -s2s3 + c2c3 & 0 & s2a3c3 + c2a3c3 + a2c2 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} c4 & -s4 & 0 & a4c4 \\ s4 & c4 & 0 & a4c4 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} (c1c2c3 - c1s2s3)c4 & - (c1c2c3 - c1s2s3)s4 + & -s1 & (s1c2c3 - s1s2s3)a4c4 + (-c1c2s3 - c1s2c3)a4s4 \\ + (-c1c2s3 - c1s2c3)s4 & (-c1c2s3 - c1s2c3)c4 & & + c1c2a3c3 - c1s2a3c3 + c1a2c2 \\ (s1c2c3 - s1s2s3)c4 & - (s1c2c3 + s1c2c3)s4 & c1 & (-s1c2c3 - s1s2s3)a4c4 + (-s1c2s3 - s1s2c3)a4s4 \\ + (-s1c2s3 - s1s2c3)s4 & + (-s1c2s3 - s1s2s3)c4 & & + s1c2a3c3 - s1s2a3c3 + s1a2c2 \\ (s2c3 + c2s3)c4 & - (s2c3 + c2s3)s4 & 0 & (s2c3 + c2s3)a4c4 + (-s2s3 + c2c3)acs4 \\ + (-s2s3 + c2c3)s4 & + (-s2s3 + c2c3)c4 & 0 & + s2a3c3 + c2a3c3 + a2c2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$H_5^0 = A_5^4 H_4^0 =$$

$$\begin{bmatrix} (c1c2c3 - c1s2s3)c4 & - (c1c2c3 - c1s2s3)s4 + & -s1 & (s1c2c3 - s1s2s3)a4c4 + (-c1c2s3 - c1s2c3)a4s4 \\ + (-c1c2s3 - c1s2c3)s4 & (-c1c2s3 - c1s2c3)c4 & & + c1c2a3c3 - c1s2a3c3 + c1a2c2 \\ (s1c2c3 - s1s2s3)c4 & - (s1c2c3 + s1c2c3)s4 & c1 & (-s1c2c3 - s1s2s3)a4c4 + (-s1c2s3 - s1s2c3)a4s4 \\ + (-s1c2s3 - s1s2c3)s4 & + (-s1c2s3 - s1s2s3)c4 & & + s1c2a3c3 - s1s2a3c3 + s1a2c2 \\ (s2c3 + c2s3)c4 & - (s2c3 + c2s3)s4 & 0 & (s2c3 + c2s3)a4c4 + (-s2s3 + c2c3)acs4 \\ + (-s2s3 + c2c3)s4 & + (-s2s3 + c2c3)c4 & 0 & + s2a3c3 + c2a3c3 + a2c2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} c5 & -s5 & 0 & 0 \\ s5 & c5 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

APPENDIX A

$$= \begin{bmatrix} ((C1C2C3 - C1S2S3)C4 + & -((C1C2C3 - C1S2S3)C4 + & (C1C2C3 - C1S2S3)a4C4 + \\ (-C1C2S3 - C1S2C3)S4)C5 + & (-C1C2S3 - C1S2C3)S4)S5 + & (-C1C2S3 - C1S2C3)a4C4 + \\ (-C1C2C3 - C1S2S3)S4 + & (-C1C2C3 - C1S2S3)S4 + & -S1 \quad C1C2a3C3 - C1S2a3C3 + C1a2C2 \\ (-C1C2S3 - C1S2C3)C4)S5 & (-C1C2S3 - C1S2C3)C4)C5 & \\ ((S1C2C3 - S1S2S3)C4 + & -((S1C2C3 - S1S2S3)C4 + & (S1C2C3 - S1S2S3)a4C4 + \\ (-S1C2S3 - S1S2C3)S4)C5 + & (-S1C2S3 - S1S2C3)S4)S5 + & C1 \quad (-S1C2S3 - S1S2C3)a4C4 + \\ (-S1C2C3 - S1S2S3)S4 + & (-S1C2C3 - S1S2S3)S4 + & S1C2a3C3 - S1S2a3C3 + S1a2C2 \\ (-S1C2S3 - S1S2C3)C4)S5 & (-S1C2S3 - S1S2C3)C4)C5 & \\ ((S2C3 + C2S3)C4 + & -((S2C3 + C2S3)C4 + & (S2C3 + C2S3)a4C4 + \\ (-S2S3 + C2C3)S4)C5 + & (-S2S3 + C2C3)S4)S5 + & 0 \quad (-S2S3 + C2C3)a4C4 + \\ (-S2C3 + C2S3)S4 + & (-S2C3 + C2S3)S4 + & S2a3C3 + C2a3C3 + a2C2 \\ (-S2S3 + C2C3)C4)S5 & (-S2S3 + C2C3)C4)C5 & \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

The final transformation matrix H_5^0 for OWI-535 is:

$$H_5^0 = A_1^0 A_2^1 A_3^2 A_4^3 A_5^4 = \begin{bmatrix} r11 & r12 & r13 & x \\ r21 & r22 & r23 & y \\ r31 & r32 & r33 & z \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Where:

$$r11 = c1c2c3 - c1s2s3)c4 + (-c1c2s3 - c1s2c3)s4)c5 + (-c1c2c3 - c1s2s3)s4 + (-c1c2s3 - c1s2c3)c4)s5$$

$$r12 = -((c1c2c3 - c1s2s3)c4 + (-c1c2s3 - c1s2c3)s4)s5 + (-c1c2c3 - c1s2s3)s4 + (-c1c2s3 - c1s2c3)c4)c5$$

$$r13 = -s1$$

$$r21 = ((s1c2c3 - s1s2s3)c4 + (-s1c2s3 - s1s2c3)s4)c5 + (-s1c2c3 - s1s2s3)s4 + (-s1c2s3 - s1s2c3)c4)s5$$

$$r22 = -((s1c2c3 - s1s2s3)c4 + (-s1c2s3 - s1s2c3)s4)s5 + (-s1c2c3 - s1s2s3)s4 + (-s1c2s3 - s1s2c3)c4)c5$$

$$r23 = c1$$

APPENDIX A

$$r31 = ((s2c3+c2s3)c4+(-s2s3+c2c3)s4)c5+(-(s2c3+c2s3)s4+(-s2s3+c2c3)c4)s5$$

$$r32 = -((s2c3+c2s3)c4+(-s2s3+c2c3)s4)s5+(-(s2c3+c2s3)s4+(-s2s3+c2c3)c4)c5$$

$$r33 = 0$$

$$x = (c1c2c3-c1s2s3)a4c4+(-c1c2s3-c1s2c3)a4c4+c1c2a3c3-c1s2a3c3+c1a2c2$$

$$y = (s1c2c3-s1s2s3)a4c4+(-s1c2s3-s1s2c3)a4c4+s1c2a3c3-s1s2a3c3+s1a2c2]$$

$$z = (s2c3+c2s3)a4c4+(-s2s3+c2c3)a4c4+s2a3c3+c2a3c3+a2c2$$

$$D(q) \dot{q} + H(q, \dot{q}) + G(q) = Q$$

Where:-

$$D_{ij} = \sum_{r=\max i,j}^n \text{tr} \left(\frac{\partial^0 T_r}{\partial q_j} \dot{q}_r \frac{\partial^0 T_r^T}{\partial q_i} \right)$$

$$H_{ijk} = \sum_{r=\max i,j,k}^n \text{tr} \left(\frac{\partial^{20} T_r}{\partial q_j \partial q_k} \dot{q}_r \frac{\partial^0 T_r^T}{\partial q_i} \right)$$

$$G_i = \sum_{r=i}^n m_r g^T \frac{\partial^0 T_r^T}{\partial q_i} \dot{q}_r$$

D1=

$$\begin{aligned} & -1/4m5a3^2s(2\theta3+2\theta2)-1/2m5a4^2s(2\theta3+2\theta2)-1/4m5a4^2s(2\theta4+2\theta3+2\theta2)+1/2m5a4^2c(2\theta4)- \\ & 1/2m5a3^2s(2\theta2)-1/4l4m4a3c(2\theta3+\theta4)-1/4m5a3^2s(-2\theta3+2\theta2)- \\ & 1/4m5a4^2s(2\theta4+2\theta3+2\theta2)+1/2m5a2^2c(2\theta2)+1/2m5a3^2c(2\theta3)+1/3l1^2m1+1/2m4a3^2- \\ & 1/4l4m4a3c(2\theta3+2\theta2+\theta4)-1/2m4a4a3s(2\theta3+2\theta2+\theta4)+1/2m5a3^2+1/2m4a2^2+1/6l4^2m4+1/2m5a2^2- \\ & 1/2l4m4a2c(2\theta2+\theta4+\theta3)-1/4l4m4a4c(2\theta4+2\theta3+2\theta2)+1/2a2^2m2+1/2m3a2^2+1/2m5a4^2- \\ & 1/4l4m4a4c(2\theta4)+1/2m4a4a2c(-\theta4+\theta3+2\theta2)-1/4m4a4^2s(- \\ & 2\theta4+2\theta3+2\theta2)+1/2m3a3^2+1/4l5m5a3s(2\theta3+2\theta2+\theta5+\theta4)-1/4l5m5a3s(\theta5+\theta4)-1/2l3m3a2C3- \\ & 1/2l3m3a2c(2\theta2+\theta3)-1/4l5m5a4s(2\theta4+\theta5)+1/4l5m5a4s(2\theta3+2\theta2+\theta5)- \\ & 1/4l5m5a4S5+1/4l5m5a4s(2\theta4+2\theta3+2\theta2+\theta5)- \\ & 1/4l4m4a4c(2\theta3+2\theta2)+1/4l4m4a4s(2\theta3+2\theta2)+1/4l4m4a3s(2\theta2+\theta4)+1/6l5^2m5c(2\theta5+2\theta4+2\theta3+2\theta2)+1/2 \\ & m4a3a2c(-\theta3+2\theta2)+m4a3C3a2-1/2m4a4a3s(-\theta4+2\theta2)-1/2m4a4a3s(-\theta4+2\theta3+2\theta2)+1/4l3m3a3s(2\theta2)- \\ & 1/4l3m3a3s(2\theta3)-1/2m4a4^2s(2\theta3+2\theta2)+1/6l5^2m5-1/2m4a4a2s(-\theta4+\theta3)-1/2m4a4a2s(-\theta4+\theta3+2\theta2)- \\ & 1/4m4a3^2s(-2\theta3+2\theta2)+1/2m4a4a2c(\theta4+\theta3)+1/6l2^2m2-1/2a2l2m2 \\ & 1/2m4a3^2s(2\theta2)+1/6l3^2m3c(2\theta3+2\theta2)+m3a3C3a2+1/2m3a3a2c(2\theta2+\theta3)-1/2m4a4a3s(2\theta2+\theta4)- \\ & 1/2l4m4a2c(\theta4+\theta3)+1/2m4a4^2-1/4l4m4a4+1/2m4a4^2c(2\theta4)-1/4l4m4a4s(2\theta4)-1/2l5m5a2c(\theta5+\theta4+\theta3)- \\ & 1/4l5m5a4C5-1/4l3m3a3+1/2m3a3^2c(2\theta3)-1/4m4a3^2s(2\theta3+2\theta2)- \\ & 1/4l4m4a3S4+1/2m3a2^2c(2\theta2)+1/2m4a2^2c(2\theta2)-1/2m3a3a2s(-\theta3+2\theta2)- \\ & 1/4l4m4a3c(2\theta2+\theta4)+m4a4C4a3+1/2m3a3a2c(-\theta3+2\theta2)+1/2m4a3a2c(2\theta2+\theta3)-1/2m4a4a2s(\theta4+\theta3)- \\ & 1/2m4a4a2s(2\theta2+\theta4+\theta3)-1/4l4m4a3s(2\theta3+\theta4)-1/2a2l2m2c(2\theta2)-1/2m4a3a2s(2\theta2+\theta3)+1/6l3^2m3- \\ & 1/4l4m4a3C4-1/4m4a4^2s(2\theta4+2\theta3+2\theta2)+1/4l5m5a3s(2\theta2+\theta5+\theta4)- \end{aligned}$$

APPENDIX A

$$\begin{aligned} &1/4l5m5a3s(2\theta3+\theta5+\theta4)+1/2a2^2m2c(2\theta2)+1/2m5a4a3c(2\theta3+\theta4)-1/2m5a4a3s(- \\ &\theta4+2\theta3+2\theta2)+m5a4C4a3+1/4l4m4a4s(2\theta4+2\theta3+2\theta2)-1/4m3a3^2s(2\theta3+2\theta2)-1/2m3a3^2s(2\theta2)- \\ &1/4m3a3^2s(-2\theta3+2\theta2)-1/2m4a3a2s(-\theta3+2\theta2)+1/2m4a4a3c(- \\ &\theta4+2\theta3)+1/6l4^2m4c(2\theta4+2\theta3+2\theta2)+1/2m4a3^2c(2\theta3)+1/2m5a4a3c(-\theta4+2\theta3)-1/2m5a4a2s(-\theta4+\theta3)- \\ &1/2m5a4a2s(-\theta4+\theta3+2\theta2)-1/2m3a3a2s(2\theta2+\theta3)+1/2m4a4a2c(2\theta2+\theta4+\theta3)-1/2l5m5a2c(2\theta2+\theta5+\theta4+\theta3)- \\ &1/4l3m3a3c(2\theta3)-1/4l3m3a3c(2\theta2)+1/4l3m3a3s(2\theta3+2\theta2)+1/4l4m4a3s(2\theta3+2\theta2+\theta4)- \\ &1/2m5a4a2s(\theta4+\theta3)-1/2m5a4a2s(2\theta2+\theta4+\theta3)+1/2m4a4a3c(2\theta3+\theta4)- \\ &1/4l3m3a3c(2\theta3+2\theta2)+1/2m4a4a2c(-\theta4+\theta3)-1/2m5a4a3s(-\theta4+2\theta2)+1/6l2^2m2c(2\theta2)- \\ &1/2m5a3a2s(2\theta2+\theta3)-1/2m5a3a2s(-\theta3+2\theta2)-1/2m5a4a3s(2\theta2+\theta4)-1/2m5a4a3s(2\theta3+2\theta2+\theta4)- \\ &1/4l5m5a4c(2\theta4+2\theta3+2\theta2+\theta5)-1/4l5m5a4c(2\theta4+\theta5)-1/4l5m5a4c(2\theta3+2\theta2+\theta5)+1/2m5a4a2c(- \\ &\theta4+\theta3)+1/2m5a4a2c(-\theta4+\theta3+2\theta2)+1/2m5a4a2c(2\theta2+\theta4+\theta3)-1/4l5m5a3c(\theta5+\theta4)- \\ &1/4l5m5a3c(2\theta3+2\theta2+\theta5+\theta4)-1/4l5m5a3c(2\theta3+\theta5+\theta4)- \\ &1/4l5m5a3c(2\theta2+\theta5+\theta4)+m5a3C3a2+1/2m5a3a2c(2\theta2+\theta3)+1/2m5a3a2c(-\theta3+2\theta2)+1/2m5a4a2c(\theta4+\theta3) \end{aligned}$$

D2= D3= D4= D5= D6=0

D7=

$$\begin{aligned} &-1/2l5m5a3s(\theta5+\theta4)-1/2l5m5a4c(2\theta4+\theta5)+1/3l4^2m4+m5a2^2-1/2l5m5a3c(2\theta3+\theta5+\theta4)- \\ &1/2l4m4a4c(2\theta4)+m3a2^2+m5a3^2-1/2l5m5a3s(2\theta3+\theta5+\theta4)+m4a4^2+m4a3^2+m4a4^2c(2\theta4)- \\ &1/2l5m5a2c(\theta5+\theta4+\theta3)-m5a3a2c(-\theta3+2\theta2)-m4a3a2c(-\theta3+2\theta2)-a2^2m2c(2\theta2)- \\ &1/2l3m3a3s(2\theta3)+m5a4a3c(2\theta3+\theta4)-1/2l4m4a3C4+2m4a4a3C4+1/2l4m4a2s(2\theta2+\theta4+\theta3)- \\ &1/2l4m4a2s(\theta4+\theta3)+m4a4a3c(2\theta3+\theta4)-m3a3a2c(2\theta2+\theta3)+m4a3^2c(2\theta3)-m4a2^2c(2\theta2)- \\ &m4a4a2c(2\theta2+\theta4+\theta3)+m4a4a3c(-\theta4+2\theta3)+1/2l3m3a2s(2\theta2+\theta3)+m4a2^2+1/2l5m5a2s(2\theta2+\theta5+\theta4+\theta3)- \\ &1/2l5m5a2s(\theta5+\theta4+\theta3)+1/2l4m4a2c(2\theta2+\theta4+\theta3)-m5a4a2c(2\theta2+\theta4+\theta3)+2m5a4a3C4- \\ &1/2l5m5a3c(\theta5+\theta4)+m5a4^2+1/2l3m3a2c(2\theta2+\theta3)+m5a4^2c(2\theta4)- \\ &m5a3a2c(2\theta2+\theta3)+1/2l5m5a2c(2\theta2+\theta5+\theta4+\theta3)+m3a3^2c(2\theta3)-1/2l4m4a4-1/2l5m5a4s(2\theta4+\theta5)- \\ &m3a2^2c(2\theta2)-m4a3a2c(2\theta2+\theta3)-m3a3a2c(-\theta3+2\theta2)+m5a4a2c(\theta4+\theta3)-1/2l4m4a4s(2\theta4)-1/2l5m5a4S5- \\ &1/2l4m4a2c(\theta4+\theta3)-1/2l4m4a3c(2\theta3+\theta4)+m5a4a3c(-\theta4+2\theta3)-1/2l4m4a3S4-m5a4a2c(- \\ &\theta4+\theta3+2\theta2)+2m4a3C3a2-1/2l3m3a2C3-1/2l3m3a2S3+2m5a3C3a2+2m3a3C3a2- \\ &1/2l4m4a3s(2\theta3+\theta4)+m5a3^2c(2\theta3)-m4a4a2c(-\theta4+\theta3+2\theta2)+m4a4a2c(- \\ &\theta4+\theta3)+m3a3^2+m4a4a2c(\theta4+\theta3)-1/2l3m3a3+a2^2m2+1/2a2l2m2c(2\theta2)- \\ &1/2l5m5a4C5+1/3l3^2m3+1/3l2^2m2+1/3l5^2m5-1/2a2l2m2-m5a2^2c(2\theta2)+m5a4a2c(- \\ &\theta4+\theta3)+1/2a2l2m2s(2\theta2)-1/2l3m3a3c(2\theta3) \end{aligned}$$

D8=

$$\begin{aligned} &-1/4l3m3C3a2-1/2l4m4a3C4+2m4a3a4C4-1/2l4m4a3S4-1/4l3m3S3a2+2m5a3a4C4-1/2l4m4a4- \\ &1/2l4m4a4c(2\theta4)-1/2l5m5a4S5+1/2m5a4a2c(\theta4+\theta3)+1/2m4a3a2c(-\theta3+2\theta2)- \\ &1/2m4a3a2c(2\theta2+\theta3)+m5a4^2c(2\theta4)-1/2l4m4a4s(2\theta4)+1/4m4l4a2s(2\theta2+\theta4+\theta3)- \\ &1/4m4l4a2s(\theta4+\theta3)+1/4m3l3a2c(2\theta2+\theta3)-1/2l5m5a4c(2\theta4+\theta5)+1/4m4l4a2c(2\theta2+\theta4+\theta3)- \\ &1/4m4l4a2c(\theta4+\theta3)+m5a4^2+1/4m5l5a2s(2\theta2+\theta5+\theta4+\theta3)- \\ &1/4m5l5a2s(\theta5+\theta4+\theta3)+1/4m5l5a2c(2\theta2+\theta5+\theta4+\theta3)-1/2m5a4a2c(-\theta4+\theta3+2\theta2)-1/2m4a4a2c(- \\ &\theta4+\theta3+2\theta2)-1/2m3a3a2c(2\theta2+\theta3)-1/2l5m5a3s(\theta5+\theta4)+1/2m5a3a2c(-\theta3+2\theta2)- \\ &1/2m5a3a2c(2\theta2+\theta3)+m4a4^2c(2\theta4)+1/2m3a3a2c(- \\ &\theta3+2\theta2)+1/3l3^2m3+1/3l4^2m4+1/3l5^2m5+1/2m5a4a2c(-\theta4+\theta3)-1/2m5a4a2c(2\theta2+\theta4+\theta3)- \\ &1/2l5m5a4C5-1/2l5m5a4s(2\theta4+\theta5)+1/2m4a4a2c(-\theta4+\theta3)-1/2l3m3a3+1/2m4a4a2c(\theta4+\theta3)- \\ &1/2m4a4a2c(2\theta2+\theta4+\theta3)+1/4m3l3a2s(2\theta2+\theta3)-1/4m5l5a2c(\theta5+\theta4+\theta3)-1/2l5m5a3c(\theta5+\theta4)+m4a4^2 \end{aligned}$$

D9=

$$\begin{aligned} &-1/4m4l4a3S4-1/4m5l5a2s(\theta5+\theta4+\theta3)+1/2m4a4a2c(\theta4+\theta3)+1/3l5^2m5- \\ &1/4m4l4a3C4+1/2m4a4a3c(2\theta3+\theta4)-1/2m4a4a3c(-\theta4+2\theta3)+1/4m4l4a2s(2\theta2+\theta4+\theta3)- \\ &1/4m4l4a2s(\theta4+\theta3)-1/4m4l4a3s(2\theta3+\theta4)-1/4m5l5a2c(\theta5+\theta4+\theta3)-1/2m5a4a2c(-\theta4+\theta3)+1/2m4a4a2c(- \\ &\theta4+\theta3+2\theta2)-1/4m4l4a3c(2\theta3+\theta4)-1/2m5a4a3c(-\theta4+2\theta3)+1/4m5l5a2s(2\theta2+\theta5+\theta4+\theta3)- \end{aligned}$$

APPENDIX A

$$\begin{aligned} &1/4m4l4a2c(04+03)-1/4m5l5a3s(203+05+04)-1/4m5l5a3s(05+04)+1/4m5l5a2c(202+05+04+03)- \\ &1/2l5m5a4S5-1/2l5m5a4C5-1/2m4a4a2c(202+04+03)+1/4m4l4a2c(202+04+03)+1/2m5a4a2c(- \\ &04+03+202)-1/2m4a4a2c(-04+03)+1/3l4^2m4+1/2m5a4a3c(203+04)-1/2l4m4a4- \\ &1/2m5a4a2c(202+04+03)+1/2m5a4a2c(04+03)-1/4m5l5a3c(05+04)-1/4m5l5a3c(203+05+04) \end{aligned}$$

D10=

$$\begin{aligned} &1/3l5^2m5+1/4l5m5a2s(202+05+04+03)-1/4l5m5a2s(05+04+03)-1/4l5m5a4s(204+05)-1/4l5m5a4S5- \\ &1/4l5m5a3s(05+04)-1/4l5m5a3s(203+05+04)+1/4l5m5a2c(202+05+04+03)-1/4l5m5a2c(05+04+03)- \\ &1/4l5m5a4C5-1/4l5m5a4c(204+05)-1/4l5m5a3c(203+05+04)-1/4l5m5a3c(05+04) \end{aligned}$$

D11=0

D12=

$$\begin{aligned} &-1/2l5m5a4c(204+05)+m5a4^2-1/2l5m5a4S5+m4a4^2- \\ &1/2l4m4a4s(204)+1/3l3^2m3+1/3l4^2m4+m4a4^2c(204)+1/4m5l5a2s(202+05+04+03)- \\ &1/4m5l5a2s(05+04+03)-1/2l5m5a3s(05+04)+1/2m4a4a2c(-04+03)-1/2m4a4a2c(202+04+03)- \\ &1/2l4m4a4+1/3l5^2m5-1/2l5m5a3c(05+04)+1/2m5a3a2c(-03+202)-1/2l5m5a4C5- \\ &1/2m3a3a2c(202+03)+1/2m4a3a2c(-03+202)-1/2m4a3a2c(202+03)+1/4m4l4a2c(202+04+03)- \\ &1/4m4l4a2c(04+03)+1/4m3l3a2s(202+03)-1/2m5a3a2c(202+03)+1/2m5a4a2c(-04+03)-1/2m5a4a2c(- \\ &04+03+202)+1/4m4l4a2s(202+04+03)-1/4m4l4a2s(04+03)-1/2l5m5a4s(204+05)-1/2l4m4a4c(204)- \\ &1/2m4a4a2c(-04+03+202)+1/2m3a3a2c(-03+202)+m5a4^2c(204)+1/4m5l5a2c(202+05+04+03)- \\ &1/4m5l5a2c(05+04+03)+1/4m3l3a2c(202+03)+1/2m4a4a2c(04+03)- \\ &1/2m5a4a2c(202+04+03)+1/2m5a4a2c(04+03)+2m4a3a4C4+2m5a3a4C4-1/2l4m4a3S4-1/4l3m3S3a2- \\ &1/2l4m4a3C4-1/4l3m3C3a2-1/2l3m3a3 \end{aligned}$$

D13=

$$\begin{aligned} &1/2l4m4a3c(203+04)+1/3l3^2m3+1/3l4^2m4+m4a4^2c(204)-1/2l4m4a4s(204)+m3a3^2- \\ &1/2l5m5a3c(05+04)-1/2l5m5a4S5+1/3l5^2m5+m5a4^2c(204)+m4a3^2+1/2l5m5a3c(203+05+04)- \\ &m4a4a3c(203+04)+1/2l4m4a3s(203+04)+m5a4^2-m5a4a3c(-04+203)+1/2l5m5a3s(203+05+04)- \\ &1/2l5m5a3s(05+04)+2m5a4C4a3-1/2l4m4a3C4-1/2l4m4a3S4+2m4a4C4a3-m4a4a3c(-04+203)- \\ &1/2l3m3a3-m4a3^2c(203)+m5a3^2-m5a4a3c(203+04)-1/2l5m5a4c(204+05)+m4a4^2-m3a3^2c(203)- \\ &1/2l4m4a4c(204)-1/2l4m4a4-m5a3^2c(203)-1/2l5m5a4C5- \\ &1/2l5m5a4s(204+05)+1/2l3m3a3c(203)+1/2l3m3a3s(203) \end{aligned}$$

D14=

$$\begin{aligned} &-1/4l4m4C4a3-1/2l5m5a4S5-1/4l4m4S4a3-1/2l5m5a4C5+1/2m5a4a3c(- \\ &04+203)+1/4m5l5a3c(203+05+04)+1/4m4l4a3s(203+04)-1/2l4m4a4+1/3l4^2m4-1/4m5l5a3s(05+04)- \\ &1/2m5a4a3c(203+04)+1/3l5^2m5-1/4m5l5a3c(05+04)+1/4m5l5a3s(203+05+04)- \\ &1/2m4a4a3c(203+04)+1/2m4a4a3c(-04+203)+1/4m4l4a3c(203+04) \end{aligned}$$

D15=

$$\begin{aligned} &-1/4l5m5a3s(05+04)+1/4l5m5a3s(203+05+04)-1/4l5m5a4C5-1/4l5m5a4c(204+05)+1/3l5^2m5- \\ &1/4l5m5a4S5-1/4l5m5a4s(204+05)+1/4l5m5a3c(203+05+04)-1/4l5m5a3c(05+04) \end{aligned}$$

D16=0

D17=

$$\begin{aligned} &1/2m4a4a2c(-04+03+202)+1/4m5l5a2s(202+05+04+03)-1/4m5l5a2s(05+04+03)-1/4m4l4a3C4- \\ &1/4m4l4a3S4-1/2m4a4a2c(-04+03)-1/2m5a4a2c(-04+03)+1/2m5a4a2c(- \end{aligned}$$

APPENDIX A

$$\begin{aligned} & \theta_4 + \theta_3 + 2\theta_2) + 1/2m_5a_4a_3c(2\theta_3 + \theta_4) - 1/4m_4l_4a_2c(\theta_4 + \theta_3) - 1/4m_4l_4a_3s(2\theta_3 + \theta_4) + 1/2m_5a_4a_2c(\theta_4 + \theta_3) - \\ & 1/2m_5a_4a_2c(2\theta_2 + \theta_4 + \theta_3) - 1/2m_5a_4a_3c(-\theta_4 + 2\theta_3) - 1/2m_4a_4a_2c(2\theta_2 + \theta_4 + \theta_3) + 1/3l_4^2m_4 - \\ & 1/4m_4l_4a_3c(2\theta_3 + \theta_4) + 1/4m_4l_4a_2c(2\theta_2 + \theta_4 + \theta_3) + 1/4m_4l_4a_2s(2\theta_2 + \theta_4 + \theta_3) - \\ & 1/4m_4l_4a_2s(\theta_4 + \theta_3) + 1/3l_5^2m_5 - 1/4m_5l_5a_3s(2\theta_3 + \theta_5 + \theta_4) - 1/4m_5l_5a_3s(\theta_5 + \theta_4) - \\ & 1/4m_5l_5a_2c(\theta_5 + \theta_4 + \theta_3) + 1/4m_5l_5a_2c(2\theta_2 + \theta_5 + \theta_4 + \theta_3) - 1/2l_5m_5a_4S_5 - 1/2l_5m_5a_4C_5 - 1/4m_5l_5a_3c(\theta_5 + \theta_4) - \\ & 1/4m_5l_5a_3c(2\theta_3 + \theta_5 + \theta_4) - 1/2l_4m_4a_4 + 1/2m_4a_4a_2c(\theta_4 + \theta_3) + 1/2m_4a_4a_3c(2\theta_3 + \theta_4) - 1/2m_4a_4a_3c(-\theta_4 + 2\theta_3) \end{aligned}$$

D18=

$$\begin{aligned} & -1/4m_5l_5a_3s(\theta_5 + \theta_4) + 1/4m_5l_5a_3s(2\theta_3 + \theta_5 + \theta_4) + 1/2m_5a_4a_3c(-\theta_4 + 2\theta_3) + 1/4m_4l_4a_3c(2\theta_3 + \theta_4) - \\ & 1/2l_5m_5a_4C_5 - 1/2l_5m_5a_4S_5 - 1/4l_4m_4S_4a_3 - 1/4l_4m_4C_4a_3 + 1/4m_5l_5a_3c(2\theta_3 + \theta_5 + \theta_4) - \\ & 1/2m_4a_4a_3c(2\theta_3 + \theta_4) + 1/3l_4^2m_4 - 1/2l_4m_4a_4 - 1/4m_5l_5a_3c(\theta_5 + \theta_4) + 1/4m_4l_4a_3s(2\theta_3 + \theta_4) + 1/3l_5^2m_5 - \\ & 1/2m_5a_4a_3c(2\theta_3 + \theta_4) + 1/2m_4a_4a_3c(-\theta_4 + 2\theta_3) \end{aligned}$$

D19=

$$\begin{aligned} & 1/2l_4m_4a_4c(2\theta_4) - 1/2l_4m_4a_4 - 1/2l_5m_5a_4C_5 + 1/2a_4l_5m_5s(2\theta_4 + \theta_5) - \\ & 1/2l_5m_5a_4S_5 + 1/2a_4l_5m_5c(2\theta_4 + \theta_5) + m_5a_4^2 + m_4a_4^2 + 1/3l_4^2m_4 - m_5a_4^2c(2\theta_4) + 1/3l_5^2m_5 - \\ & m_4a_4^2c(2\theta_4) + 1/2l_4m_4a_4s(2\theta_4) \end{aligned}$$

D20=

$$1/3l_5^2m_5 + 1/4l_5m_5a_4c(2\theta_4 + \theta_5) - 1/4l_5m_5a_4C_5 - 1/4l_5m_5a_4S_5 + 1/4l_5m_5a_4s(2\theta_4 + \theta_5)$$

D21=0

D22=

$$\begin{aligned} & 1/4l_5m_5a_2s(2\theta_2 + \theta_5 + \theta_4 + \theta_3) - 1/4l_5m_5a_2s(\theta_5 + \theta_4 + \theta_3) + 1/3l_5^2m_5 - 1/4l_5m_5a_4s(2\theta_4 + \theta_5) - \\ & 1/4l_5m_5a_4S_5 + 1/4l_5m_5a_2c(2\theta_2 + \theta_5 + \theta_4 + \theta_3) - 1/4l_5m_5a_4C_5 - 1/4l_5m_5a_3c(\theta_5 + \theta_4) - 1/4l_5m_5a_3c(2\theta_3 + \theta_5 + \theta_4) - \\ & 1/4l_5m_5a_3s(\theta_5 + \theta_4) - 1/4l_5m_5a_2c(\theta_5 + \theta_4 + \theta_3) - 1/4l_5m_5a_4c(2\theta_4 + \theta_5) - 1/4l_5m_5a_3s(2\theta_3 + \theta_5 + \theta_4) \end{aligned}$$

D23=

$$\begin{aligned} & -1/4l_5m_5a_3s(\theta_5 + \theta_4) + 1/3l_5^2m_5 - 1/4l_5m_5a_4S_5 - 1/4l_5m_5a_4s(2\theta_4 + \theta_5) - 1/4l_5m_5a_4C_5 - \\ & 1/4l_5m_5a_4c(2\theta_4 + \theta_5) + 1/4l_5m_5a_3c(2\theta_3 + \theta_5 + \theta_4) - 1/4l_5m_5a_3c(\theta_5 + \theta_4) + 1/4l_5m_5a_3s(2\theta_3 + \theta_5 + \theta_4) \end{aligned}$$

D24=

$$1/3l_5^2m_5 + 1/4l_5m_5a_4c(2\theta_4 + \theta_5) - 1/4l_5m_5a_4C_5 - 1/4l_5m_5a_4S_5 + 1/4l_5m_5a_4s(2\theta_4 + \theta_5)$$

D25=

$$1/3l_5^2m_5$$

H111=0

H112=

$$\begin{aligned} & 1/2l_5m_5a_2s(2\theta_2 + \theta_5 + \theta_4 + \theta_3) - 1/2m_3a_3a_2s(-\theta_3 + 2\theta_2) - 1/4m_3a_3^2c(2\theta_3 + 2\theta_2) - 1/2m_5a_3a_2c(- \\ & \theta_3 + 2\theta_2) + 1/4l_3m_3a_3s(2\theta_3 + 2\theta_2) - 1/2m_3a_2^2s(2\theta_2) - 1/2m_5a_4a_2s(-\theta_4 + \theta_3 + 2\theta_2) - 1/2m_5a_4a_2c(2\theta_2 + \theta_4 + \theta_3) - \\ & 1/2m_5a_4a_3c(-\theta_4 + 2\theta_3 + 2\theta_2) - 1/2m_5a_4a_3c(-\theta_4 + 2\theta_2) - \\ & 1/2m_4a_4a_2c(2\theta_2 + \theta_4 + \theta_3) + 1/2l_4m_4a_2s(2\theta_2 + \theta_4 + \theta_3) + 1/4l_5m_5a_3s(2\theta_3 + 2\theta_2 + \theta_5 + \theta_4) - \\ & 1/2m_4a_2a_3s(2\theta_2 + \theta_3) + 1/4l_5m_5a_4c(2\theta_4 + 2\theta_3 + 2\theta_2 + \theta_5) - 1/6l_4^2m_4s(2\theta_4 + 2\theta_3 + 2\theta_2) - 1/2m_3a_3a_2c(2\theta_2 + \theta_3) - \\ & 1/2m_5a_4a_2s(2\theta_2 + \theta_4 + \theta_3) + 1/4l_3m_3a_3s(2\theta_2) + 1/4l_5m_5a_4c(2\theta_3 + 2\theta_2 + \theta_5) - 1/2m_5a_4a_2c(-\theta_4 + \theta_3 + 2\theta_2) - \end{aligned}$$

APPENDIX A

$$\begin{aligned} &1/2m5a2^2s(2\theta_2)+1/4l4m4a3c(2\theta_3+2\theta_2+\theta_4)-1/2m3a3a2c(-\theta_3+2\theta_2)+1/4l4m4a4s(2\theta_4+2\theta_3+2\theta_2)- \\ &1/2m3a3a2s(2\theta_2+\theta_3)-1/2m5a3a2s(-\theta_3+2\theta_2)-1/2m3a3^2c(2\theta_2)-1/2m5a3^2c(2\theta_2)-1/6l2^2m2s(2\theta_2)- \\ &1/2m5a4^2c(2\theta_3+2\theta_2)-1/2m4a2a3s(- \\ &\theta_3+2\theta_2)+1/4l3m3a3c(2\theta_3+2\theta_2)+1/4l5m5a4s(2\theta_4+2\theta_3+2\theta_2+\theta_5)+1/4l4m4a4c(2\theta_3+2\theta_2)+1/4l4m4a3s(2\theta_3 \\ &+2\theta_2+\theta_4)-1/2m4a4a2c(-\theta_4+\theta_3+2\theta_2)+1/2l3m3a2s(2\theta_2+\theta_3)-1/2m5a3a2s(2\theta_2+\theta_3)-1/2m4a3^2c(2\theta_2)- \\ &1/4m4a3^2c(2\theta_3+2\theta_2)-1/4m4a3^2c(-2\theta_3+2\theta_2)-1/6l3^2m3s(2\theta_3+2\theta_2)- \\ &1/2m4a2^2s(2\theta_2)+1/4l5m5a3s(2\theta_2+\theta_5+\theta_4)+1/4l4m4a4s(2\theta_3+2\theta_2)+1/4l4m4a3s(2\theta_2+\theta_4)+1/4l5m5a4s(2\theta \\ &3+2\theta_2+\theta_5)-1/4m3a3^2c(-2\theta_3+2\theta_2)+1/2a2l2m2s(2\theta_2)+1/4l4m4a4c(2\theta_4+2\theta_3+2\theta_2)-1/2m4a4a3c(- \\ &\theta_4+2\theta_3+2\theta_2)-1/2m4a4a3c(-\theta_4+2\theta_2)-1/4m5a3^2c(2\theta_3+2\theta_2)-1/2m5a4a3c(2\theta_3+2\theta_2+\theta_4)- \\ &1/2m5a4a3c(2\theta_2+\theta_4)-1/2m4a4a2s(-\theta_4+\theta_3+2\theta_2)-1/2m4a4a3c(2\theta_3+2\theta_2+\theta_4)- \\ &1/2m4a4a3c(2\theta_2+\theta_4)+1/4l5m5a3c(2\theta_2+\theta_5+\theta_4)+1/4l4m4a3c(2\theta_2+\theta_4)+1/4l5m5a3c(2\theta_3+2\theta_2+\theta_5+\theta_4)- \\ &1/4m4a4^2c(2\theta_4+2\theta_3+2\theta_2)-1/4m4a4^2c(-2\theta_4+2\theta_3+2\theta_2)-1/2m4a4^2c(2\theta_3+2\theta_2)- \\ &1/4m5a4^2c(2\theta_4+2\theta_3+2\theta_2)-1/4m5a4^2c(-2\theta_4+2\theta_3+2\theta_2)-1/2m2a2^2s(2\theta_2)- \\ &1/6l5^2m5s(2\theta_5+2\theta_4+2\theta_3+2\theta_2)+1/4l3m3a3c(2\theta_2)-1/4m5a3^2c(-2\theta_3+2\theta_2)-1/2m4a2a3c(-\theta_3+2\theta_2)- \\ &1/2m4a2a3c(2\theta_2+\theta_3)-1/2m5a3a2c(2\theta_2+\theta_3)-1/2m4a4a2s(2\theta_2+\theta_4+\theta_3) \end{aligned}$$

H113=

$$\begin{aligned} &-1/4m3a3a2s(2\theta_2+\theta_3)-1/2m4a4a3s(2\theta_3+\theta_4)-1/4m4a3a2c(2\theta_2+\theta_3)-1/4m5a3a2c(2\theta_2+\theta_3)-1/2m5a4a3c(- \\ &\theta_4+2\theta_3+2\theta_2)+1/4m4a3^2c(-2\theta_3+2\theta_2)-1/4m4a3^2c(2\theta_3+2\theta_2)-1/2m4a4a3c(-\theta_4+2\theta_3+2\theta_2)- \\ &1/4m5a4a2s(\theta_4+\theta_3)-1/4m5a4a2s(2\theta_2+\theta_4+\theta_3)+1/4m3l3a2S3- \\ &1/6l4^2m4s(2\theta_4+2\theta_3+2\theta_2)+1/4l4m4a4c(2\theta_3+2\theta_2)+1/4l5m5a4c(2\theta_3+2\theta_2+\theta_5)+1/4m3a3^2c(-2\theta_3+2\theta_2)- \\ &1/2m3a3^2s(2\theta_3)+1/4l4m4a4s(2\theta_3+2\theta_2)+1/4l4m4a4s(2\theta_4+2\theta_3+2\theta_2)+1/4l3m3a3s(2\theta_3)- \\ &1/6l3^2m3s(2\theta_3+2\theta_2)-1/4m5a4a2c(-\theta_4+\theta_3+2\theta_2)+1/4l4m4a3s(2\theta_3+\theta_4)+1/4m4a3a2c(- \\ &\theta_3+2\theta_2)+1/4l4m4a3s(2\theta_3+2\theta_2+\theta_4)+1/4m5l5a2s(\theta_5+\theta_4+\theta_3)-1/2m3a3a2S3+1/4m5a3^2c(-2\theta_3+2\theta_2)- \\ &1/2m5a3^2s(2\theta_3)-1/4m5a3^2c(2\theta_3+2\theta_2)-1/4m4a4a2c(\theta_4+\theta_3)-1/4m4a4a2c(2\theta_2+\theta_4+\theta_3)-1/4m5a4a2c(- \\ &\theta_4+\theta_3)-1/4l3m3a3c(2\theta_3)+1/4l3m3a3c(2\theta_3+2\theta_2)-1/4m4a4a2c(-\theta_4+\theta_3)-1/4m4a4a2c(-\theta_4+\theta_3+2\theta_2)- \\ &1/4m3a3a2c(2\theta_2+\theta_3)-1/4m4a4^2c(-2\theta_4+2\theta_3+2\theta_2)+1/4m4l4a2s(2\theta_2+\theta_4+\theta_3)+1/4m4l4a2s(\theta_4+\theta_3)- \\ &1/2m4a4a3s(-\theta_4+2\theta_3)-1/6l5^2m5s(2\theta_5+2\theta_4+2\theta_3+2\theta_2)- \\ &1/4l4m4a3c(2\theta_3+\theta_4)+1/4l4m4a3c(2\theta_3+2\theta_2+\theta_4)+1/4m3a3a2s(-\theta_3+2\theta_2)+1/4m5a3a2c(- \\ &\theta_3+2\theta_2)+1/4m5a3a2s(-\theta_3+2\theta_2)-1/4m4a4a2s(-\theta_4+\theta_3)-1/4m4a4a2s(-\theta_4+\theta_3+2\theta_2)- \\ &1/2m5a4a3s(2\theta_3+\theta_4)+1/4m5l5a2s(2\theta_2+\theta_5+\theta_4+\theta_3)-1/4m5a4a2s(-\theta_4+\theta_3)-1/4m5a4a2c(\theta_4+\theta_3)- \\ &1/4m5a4a2c(2\theta_2+\theta_4+\theta_3)-1/2m5a3a2S3-1/2m4a4^2c(2\theta_3+2\theta_2)-1/2m4a3^2s(2\theta_3)-1/2m5a4a3s(- \\ &\theta_4+2\theta_3)+1/4l5m5a4s(2\theta_4+2\theta_3+2\theta_2+\theta_5)-1/4m5a4^2c(2\theta_4+2\theta_3+2\theta_2)-1/4m5a4^2c(- \\ &2\theta_4+2\theta_3+2\theta_2)+1/4l3m3a3s(2\theta_3+2\theta_2)-1/4m5a4a2s(-\theta_4+\theta_3+2\theta_2)- \\ &1/2m5a4^2c(2\theta_3+2\theta_2)+1/4l5m5a3s(2\theta_3+\theta_5+\theta_4)- \\ &1/4m4a4^2c(2\theta_4+2\theta_3+2\theta_2)+1/4l5m5a3s(2\theta_3+2\theta_2+\theta_5+\theta_4)+1/4l5m5a3c(2\theta_3+2\theta_2+\theta_5+\theta_4)- \\ &1/4l5m5a3c(2\theta_3+\theta_5+\theta_4)+1/4l5m5a4s(2\theta_3+2\theta_2+\theta_5)- \\ &1/4m3a3^2c(2\theta_3+2\theta_2)+1/4l5m5a4c(2\theta_4+2\theta_3+2\theta_2+\theta_5)-1/4m4a4a2s(\theta_4+\theta_3)-1/4m4a4a2s(2\theta_2+\theta_4+\theta_3)- \\ &1/4m5a3a2s(2\theta_2+\theta_3)+1/4m3l3a2s(2\theta_2+\theta_3)+1/4l4m4a4c(2\theta_4+2\theta_3+2\theta_2)-1/2m4a4a3c(2\theta_3+2\theta_2+\theta_4)- \\ &1/2m5a4a3c(2\theta_3+2\theta_2+\theta_4)+1/4m3a3a2c(-\theta_3+2\theta_2)+1/4m4a3a2s(-\theta_3+2\theta_2)-1/2m4a3a2S3- \\ &1/4m4a3a2s(2\theta_2+\theta_3) \end{aligned}$$

H114=

$$\begin{aligned} &1/8m5l5a3s(2\theta_3+\theta_5+\theta_4)+1/4m5a4^2c(- \\ &2\theta_4+2\theta_3+2\theta_2)+1/8m5l5a3s(2\theta_2+\theta_5+\theta_4)+1/8m5l5a3s(2\theta_3+2\theta_2+\theta_5+\theta_4)-1/4m5a4a3s(2\theta_3+\theta_4)- \\ &1/4m4a4a2s(2\theta_2+\theta_4+\theta_3)+1/8m4l4a3s(2\theta_3+2\theta_2+\theta_4)-1/4a4l4m4c(2\theta_4)+1/8m5l5a3c(2\theta_3+2\theta_2+\theta_5+\theta_4)- \\ &1/4m4a4^2c(2\theta_4+2\theta_3+2\theta_2)-1/4m5a4a2c(2\theta_2+\theta_4+\theta_3)-1/6l5^2m5s(2\theta_5+2\theta_4+2\theta_3+2\theta_2)+1/4m5a4a2c(- \\ &\theta_4+\theta_3)-1/4m5a4a2c(\theta_4+\theta_3)-1/4m4a4a3s(2\theta_3+\theta_4)+1/8m5l5a3c(2\theta_2+\theta_5+\theta_4)+1/4m4a4^2c(- \\ &2\theta_4+2\theta_3+2\theta_2)-1/2m4a4^2s(2\theta_4)-1/4m5a4a2s(\theta_4+\theta_3)-1/8m4l4a3C4+1/4m4l4a2s(\theta_4+\theta_3)+1/4m5a4a2s(- \\ &\theta_4+\theta_3+2\theta_2)- \\ &1/8m5l5a3c(2\theta_3+\theta_5+\theta_4)+1/8m4l4a3s(2\theta_2+\theta_4)+1/8m4l4a3s(2\theta_3+\theta_4)+1/8m4l4a3S4+1/4m4l4a2s(2\theta_2+\theta_4) \end{aligned}$$

APPENDIX A

$$\begin{aligned} &+03)+1/4m4a4a2s(-04+03+202)+1/4m4a4a2s(-04+03)-1/4m5a4a3c(203+202+04)+1/4m5a4a3c(- \\ &04+203+202)-1/2m5a4a3S4-1/6l4^2m4s(204+203+202)+1/4m4a4a2c(-04+03+202)- \\ &1/8m5l5a3c(05+04)+1/4m5a4a3s(-04+203)+1/4a4l4m4s(204+203+202)+1/4a4l5m5s(204+05)- \\ &1/4m5a4a2s(202+04+03)-1/4m4a4a3c(202+04)-1/4m4a4a3c(203+202+04)- \\ &1/4m4a4a2c(04+03)+1/4m4a4a2c(-04+03)+1/4a4l5m5c(204+203+202+05)- \\ &1/4a4l5m5c(204+05)+1/4m5l5a2s(05+04+03)-1/4m4a4a2s(04+03)+1/4m5a4a2s(-04+03)- \\ &1/8m4l4a3c(203+04)+1/8m5l5a3s(05+04)+1/4a4l4m4c(204+203+202)+1/4a4l4m4s(204)- \\ &1/4m5a4a3c(202+04)+1/8m4l4a3c(202+04)+1/8m4l4a3c(203+202+04)-1/2m4a4a3S4+1/4m5a4a2c(- \\ &04+03+202)+1/4m4a4a3s(-04+203)-1/4m4a4a2c(202+04+03)+1/4m4a4a3c(-04+202)+1/4m4a4a3c(- \\ &04+203+202)+1/4m5l5a2s(202+05+04+03)+1/4a4l5m5s(204+203+202+05)-1/2m5a4^2s(204)- \\ &1/4m5a4^2c(204+203+202)+1/4m5a4a3c(-04+202) \end{aligned}$$

H115=

$$\begin{aligned} &1/8l5m5a3s(203+202+05+04)+1/8l5m5a3c(202+05+04)-1/8l5m5a3c(203+05+04)- \\ &1/8l5m5a3c(05+04)+1/8l5m5a4c(204+203+202+05)+1/8l5m5a4c(203+202+05)-1/8l5m5a4c(204+05)- \\ &1/8l5m5a4C5+1/8l5m5a3s(05+04)+1/8l5m5a3s(203+05+04)+1/8l5m5a3s(202+05+04)- \\ &1/6l5^2m5s(205+204+203+202)+1/8l5m5a3c(203+202+05+04)+1/4l5m5a2s(202+05+04+03)+1/4l5m5a2 \\ &s(05+04+03)+1/8l5m5a4S5+1/8l5m5a4s(204+05)+1/8l5m5a4s(203+202+05)+1/8l5m5a4s(204+203+202+ \\ &05) \end{aligned}$$

H121=

$$\begin{aligned} &-1/2m4a4a3c(202+04)-1/2m4a4a3c(203+202+04)-1/4m5a4^2c(- \\ &204+203+202)+1/4l4m4a3c(203+202+04)-1/2m5a3a2c(- \\ &03+202)+1/4l4m4a4s(204+203+202)+1/2l4m4a2s(202+04+03)+1/4l4m4a3s(202+04)-1/2m4a4a3c(- \\ &04+202)+1/4l4m4a4c(203+202)-1/2m2a2^2s(202)-1/2m4a4a2s(-04+03+202)-1/4m3a3^2c(203+202)- \\ &1/4m3a3^2c(-203+202)-1/2m3a3^2c(202)-1/2m3a2^2s(202)+1/2l3m3a2s(202+03)-1/2m5a3a2s(-03+202)- \\ &1/2m3a3a2s(-03+202)-1/4m5a4^2c(204+203+202)-1/2m4a4^2c(203+202)-1/2m4a4a2s(202+04+03)- \\ &1/2m4a3a2c(202+03)- \\ &1/2m4a3^2c(202)+1/4l5m5a4c(204+203+202+05)+1/4l4m4a3s(203+202+04)+1/2l5m5a2s(202+05+04+0 \\ &3)-1/4m4a4^2c(204+203+202)-1/4m4a3^2c(203+202)-1/2m4a3a2c(-03+202)-1/2m5a4a3c(-04+203+202)- \\ &1/6l4^2m4s(204+203+202)-1/2m4a4a2c(-04+03+202)-1/2m5a3a2c(202+03)-1/2m5a3a2s(202+03)- \\ &1/2m5a2a4s(-04+03+202)-1/2m4a4a2c(202+04+03)-1/2m5a4^2c(203+202)-1/2m5a3^2c(202)- \\ &1/2m5a4a3c(-04+202)+1/4l5m5a3s(203+202+05+04)+1/4l5m5a3s(202+05+04)- \\ &1/6l5^2m5s(205+204+203+202)+1/4l5m5a4c(203+202+05)+1/4l4m4a4c(204+203+202)+1/4l3m3a3s(203 \\ &+202)+1/4l3m3a3s(202)+1/4l3m3a3c(203+202)+1/4l3m3a3c(202)-1/4m4a3^2c(-203+202)- \\ &1/2m5a2a4s(202+04+03)+1/4l4m4a4s(203+202)-1/6l3^2m3s(203+202)-1/2m4a2^2s(202)-1/4m4a4^2c(- \\ &204+203+202)-1/2m4a4a3c(-04+203+202)+1/2a2l2m2s(202)-1/2m5a4a3c(203+202+04)- \\ &1/2m4a3a2s(202+03)-1/2m4a3a2s(-03+202)-1/2m3a3a2c(202+03)-1/2m3a3a2c(-03+202)- \\ &1/2m5a4a3c(202+04)-1/2m5a2a4c(-04+03+202)-1/2m5a2a4c(202+04+03)- \\ &1/6l2^2m2s(202)+1/4l5m5a4s(203+202+05)+1/4l5m5a4s(204+203+202+05)+1/4l5m5a3c(203+202+05+0 \\ &4)+1/4l5m5a3c(202+05+04)+1/4l4m4a3c(202+04)-1/2m5a2^2s(202)-1/4m5a3^2c(-203+202)- \\ &1/4m5a3^2c(203+202)-1/2m3a3a2s(202+03) \end{aligned}$$

H122=H123=H124=H125=0

H131=

$$\begin{aligned} &1/4l4m4a4s(204+203+202)+1/4l4m4a3s(203+202+04)-1/4m4a4^2c(204+203+202)- \\ &1/6l4^2m4s(204+203+202)-1/4l4m4a3c(203+04)-1/4m5a4a2s(-04+03+202)-1/4m5a4a2s(-04+03)- \\ &1/4m5a3^2c(203+202)-1/4m4a4a2s(202+04+03)+1/4m4l4a2s(202+04+03)-1/4m4a4a2s(-04+03)- \\ &1/4l5m5a3c(203+05+04)+1/4l5m5a3c(203+202+05+04)+1/4m4a3a2s(-03+202)- \\ &1/4l3m3a3c(203)+1/4l3m3a3c(203+202)+1/4m5a3a2c(-03+202)+1/4m5a3a2s(-03+202)+1/4m4a3^2c(- \end{aligned}$$

APPENDIX A

203+202)-

$$\begin{aligned} &1/4m3a3a2s(202+03)+1/4l5m5a4c(203+202+05)+1/4m5l5a2s(202+05+04+03)+1/4l4m4a3s(203+04)- \\ &1/2m4a3a2S3-1/4m4a3^2c(203+202)-1/2m3a3a2S3+1/4m3a3a2s(- \\ &03+202)+1/4l5m5a4s(204+203+202+05)-1/6l3^2m3s(203+202)-1/4m4a4a2c(-04+03+202)- \\ &1/4m4a3a2c(202+03)-1/2m5a3a2S3-1/4m5a4a2c(-04+03)-1/4m5a4a2c(-04+03+202)-1/2m5a4a3c(- \\ &04+203+202)-1/2m5a4a3s(-04+203)-1/2m4a4a3c(-04+203+202)-1/2m5a4a3c(203+202+04)- \\ &1/2m5a4^2c(203+202)-1/4m5a4^2c(-204+203+202)-1/2m5a4a3s(203+04)+1/4m3a3a2c(- \\ &03+202)+1/4l4m4a4c(203+202)-1/4m4a4a2s(-04+03+202)-1/4m5a4^2c(204+203+202)-1/4m4a4a2c(- \\ &04+03)+1/4m3l3a2s(202+03)-1/4m5a3a2s(202+03)-1/2m4a4a3s(-04+203)-1/2m4a4a3c(203+202+04)- \\ &1/6l5^2m5s(205+204+203+202)-1/2m4a3^2s(203)+1/4l4m4a3c(203+202+04)-1/4m4a4a2c(04+03)- \\ &1/4m3a3a2c(202+03)-1/4m5a4a2s(04+03)+1/4m4a3a2c(-03+202)- \\ &1/4m4a3a2s(202+03)+1/4l5m5a3s(203+05+04)+1/4l4m4a4s(203+202)-1/4m4a4^2c(- \\ &204+203+202)+1/4m5l5a2s(05+04+03)+1/4m4l4a2s(04+03)+1/4l5m5a4s(203+202+05)- \\ &1/4m4a4a2s(04+03)-1/4m5a4a2s(202+04+03)-1/4m5a3a2c(202+03)- \\ &1/2m4a4^2c(203+202)+1/4l5m5a4c(204+203+202+05)+1/4l5m5a3s(203+202+05+04)- \\ &1/4m4a4a2c(202+04+03)+1/4m3l3a2S3-1/2m3a3^2s(203)+1/4m3a3^2c(-203+202)- \\ &1/4m3a3^2c(203+202)-1/2m5a3^2s(203)+1/4m5a3^2c(-203+202)- \\ &1/2m4a4a3s(203+04)+1/4l3m3a3s(203+202)+1/4l3m3a3s(203)+1/4l4m4a4c(204+203+202)- \\ &1/4m5a4a2c(202+04+03)-1/4m5a4a2c(04+03) \end{aligned}$$

H132=H133=H134=H135=0

H141=

$$\begin{aligned} &-1/4m5a4^2c(204+203+202)-1/2m5a4^2s(204)+1/4m5a4^2c(-204+203+202)-1/2m4a4^2s(204)- \\ &1/4m4a4a3c(202+04)+1/4a4l5m5s(204+203+202+05)+1/4m4a4^2c(- \\ &204+203+202)+1/4a4l4m4c(204+203+202)+1/4m5a4a2c(-04+03+202)- \\ &1/4m4a4a2s(04+03)+1/8m4l4a3c(203+202+04)+1/4m4l4a2s(202+04+03)- \\ &1/8m4l4a3c(203+04)+1/8m4l4a3c(202+04)-1/6l5^2m5s(205+204+203+202)- \\ &1/4m4a4a3s(203+04)+1/4m4a4a2c(-04+03)+1/4m4a4a2c(-04+03+202)+1/4m4a4a3c(-04+203+202)- \\ &1/4m4a4a2s(202+04+03)+1/8m4l4a3s(203+202+04)+1/8m5l5a3s(05+04)+1/8m5l5a3s(202+05+04)+1/8m \\ &5l5a3s(203+202+05+04)+1/4a4l4m4s(204+203+202)-1/4m4a4a2c(202+04+03)-1/4m4a4a2c(04+03)- \\ &1/4m4a4a3c(203+202+04)+1/4m4a4a2s(-04+03+202)+1/4m4a4a3c(- \\ &04+202)+1/4a4l4m4s(204)+1/4m5a4a3c(-04+202)+1/4m5a4a3c(-04+203+202)- \\ &1/4m5a4a3s(203+04)+1/4a4l5m5s(204+05)+1/4m4a4a3s(-04+203)- \\ &1/2m4a4a3S4+1/8m4l4a3s(202+04)+1/8m4l4a3s(203+04)+1/8m4l4a3S4-1/4a4l4m4c(204)- \\ &1/4m5a4a2c(04+03)-1/4m5a4a2c(202+04+03)-1/8m4l4a3C4+1/4a4l5m5c(204+203+202+05)- \\ &1/4a4l5m5c(204+05)+1/8m5l5a3c(203+202+05+04)+1/8m5l5a3c(202+05+04)-1/8m5l5a3c(203+05+04)- \\ &1/8m5l5a3c(05+04)+1/4m5l5a2s(05+04+03)+1/4m5l5a2s(202+05+04+03)-1/4m5a4a2s(04+03)- \\ &1/4m4a4^2c(204+203+202)-1/4m5a4a3c(203+202+04)-1/4m5a4a3c(202+04)+1/4m5a4a3s(-04+203)- \\ &1/2m5a4a3S4+1/4m5a4a2c(-04+03)+1/4m4a4a2s(-04+03)+1/4m4l4a2s(04+03)+1/4m5a4a2s(- \\ &04+03+202)+1/4m5a4a2s(-04+03)-1/6l4^2m4s(204+203+202)- \\ &1/4m5a4a2s(202+04+03)+1/8m5l5a3s(203+05+04) \end{aligned}$$

H142=H143=H144=H145=0

H151=

$$\begin{aligned} &1/4l5m5a2s(05+04+03)+1/8l5m5a4c(203+202+05)- \\ &1/8l5m5a3c(203+05+04)+1/8l5m5a4s(204+203+202+05)+1/8l5m5a4s(203+202+05)+1/8l5m5a3c(202+05 \\ &+04)- \\ &1/8l5m5a3c(05+04)+1/8l5m5a4s(204+05)+1/8l5m5a3s(05+04)+1/8l5m5a3c(203+202+05+04)+1/8l5m5a3 \\ &s(203+05+04)+1/8l5m5a4S5+1/8l5m5a4c(204+203+202+05)+1/8l5m5a3s(202+05+04)+1/8l5m5a3s(203+ \end{aligned}$$

APPENDIX A

$$2\theta_2+\theta_5+\theta_4)-1/8l_5m_5a_4c(2\theta_4+\theta_5)-1/8l_5m_5a_4C_5+1/4l_5m_5a_2s(2\theta_2+\theta_5+\theta_4+\theta_3)-1/6l_5^2m_5s(2\theta_5+2\theta_4+2\theta_3+2\theta_2)$$

$$H_{152}=H_{153}=H_{15}=H_{155}=0$$

$$H_{211}=$$

$$\begin{aligned} & -1/4l_3m_3a_3s(2\theta_3+2\theta_2)+1/2m_5a_3a_2s(2\theta_2+\theta_3)+1/2m_5a_3a_2c(-\theta_3+2\theta_2)+1/4m_5a_4^2c(- \\ & 2\theta_4+2\theta_3+2\theta_2)+1/2m_4a_4a_2s(2\theta_2+\theta_4+\theta_3)+1/2m_3a_3a_2c(2\theta_2+\theta_3)-1/2l_3m_3a_2s(2\theta_2+\theta_3)- \\ & 1/4l_3m_3a_3c(2\theta_3+2\theta_2)-1/4l_4m_4a_4c(2\theta_3+2\theta_2)-1/4l_4m_4a_4c(2\theta_4+2\theta_3+2\theta_2)+1/2m_5a_4a_2s(- \\ & \theta_4+\theta_3+2\theta_2)+1/2m_4a_3a_2s(2\theta_2+\theta_3)+1/2m_4a_3a_2s(-\theta_3+2\theta_2)+1/2m_5a_2^2s(2\theta_2)+1/2m_4a_4a_2s(-\theta_4+\theta_3+2\theta_2)- \\ & 1/4l_5m_5a_3c(2\theta_3+2\theta_2+\theta_5+\theta_4)-1/4l_4m_4a_3s(2\theta_2+\theta_4)- \\ & 1/4l_4m_4a_3s(2\theta_3+2\theta_2+\theta_4)+1/6l_2^2m_2s(2\theta_2)+1/2m_4a_4a_2c(- \\ & \theta_4+\theta_3+2\theta_2)+1/2m_5a_4a_3c(2\theta_3+2\theta_2+\theta_4)+1/2m_5a_4a_3c(2\theta_2+\theta_4)+1/6l_5^2m_5s(2\theta_5+2\theta_4+2\theta_3+2\theta_2)+1/2m_5a_ \\ & 3a_2s(-\theta_3+2\theta_2)+1/2m_5a_4a_3c(-\theta_4+2\theta_3+2\theta_2)+1/2m_5a_4^2c(2\theta_3+2\theta_2)- \\ & 1/4l_5m_5a_3s(2\theta_2+\theta_5+\theta_4)+1/2m_3a_3a_2c(-\theta_3+2\theta_2)-1/4l_5m_5a_3s(2\theta_3+2\theta_2+\theta_5+\theta_4)- \\ & 1/4l_3m_3a_3c(2\theta_2)+1/2m_3a_3^2c(2\theta_2)+1/4m_3a_3^2c(2\theta_3+2\theta_2)-1/4l_5m_5a_4s(2\theta_3+2\theta_2+\theta_5)- \\ & 1/4l_4m_4a_4s(2\theta_4+2\theta_3+2\theta_2)+1/2m_5a_3^2c(2\theta_2)+1/4m_5a_3^2c(2\theta_3+2\theta_2)+1/2m_4a_4a_3c(2\theta_3+2\theta_2+\theta_4)+1/2m_4 \\ & a_4a_3c(2\theta_2+\theta_4)+1/2m_5a_3a_2c(2\theta_2+\theta_3)+1/2m_3a_3a_2s(2\theta_2+\theta_3)+1/2m_3a_3a_2s(- \\ & \theta_3+2\theta_2)+1/6l_3^2m_3s(2\theta_3+2\theta_2)-1/4l_3m_3a_3s(2\theta_2)-1/2l_4m_4a_2s(2\theta_2+\theta_4+\theta_3)+1/2m_2a_2^2s(2\theta_2)- \\ & 1/4l_5m_5a_4c(2\theta_3+2\theta_2+\theta_5)-1/4l_5m_5a_4c(2\theta_4+2\theta_3+2\theta_2+\theta_5)+1/4m_5a_3^2c(-2\theta_3+2\theta_2)- \\ & 1/2a_2l_2m_2s(2\theta_2)+1/4m_4a_3^2c(2\theta_3+2\theta_2)+1/4m_4a_3^2c(- \\ & 2\theta_3+2\theta_2)+1/2m_4a_3^2c(2\theta_2)+1/4m_5a_4^2c(2\theta_4+2\theta_3+2\theta_2)+1/2m_4a_3a_2c(2\theta_2+\theta_3)+1/2m_4a_3a_2c(- \\ & \theta_3+2\theta_2)+1/2m_5a_4a_2s(2\theta_2+\theta_4+\theta_3)-1/2l_5m_5a_2s(2\theta_2+\theta_5+\theta_4+\theta_3)-1/4l_5m_5a_4s(2\theta_4+2\theta_3+2\theta_2+\theta_5)- \\ & 1/4l_5m_5a_3c(2\theta_2+\theta_5+\theta_4)+1/2m_4a_4^2c(2\theta_3+2\theta_2)+1/4m_4a_4^2c(- \\ & 2\theta_4+2\theta_3+2\theta_2)+1/4m_4a_4^2c(2\theta_4+2\theta_3+2\theta_2)- \\ & 1/4l_4m_4a_3c(2\theta_2+\theta_4)+1/2m_5a_4a_2c(2\theta_2+\theta_4+\theta_3)+1/2m_5a_4a_2c(-\theta_4+\theta_3+2\theta_2)+1/2m_4a_4a_3c(- \\ & \theta_4+2\theta_3+2\theta_2)+1/2m_4a_4a_3c(-\theta_4+2\theta_2)- \\ & 1/4l_4m_4a_3c(2\theta_3+2\theta_2+\theta_4)+1/2m_3a_2^2s(2\theta_2)+1/2m_4a_2^2s(2\theta_2)+1/6l_4^2m_4s(2\theta_4+2\theta_3+2\theta_2)+1/4m_3a_3^2c \\ & (-2\theta_3+2\theta_2)+1/2m_4a_4a_2c(2\theta_2+\theta_4+\theta_3)+1/2m_5a_4a_3c(-\theta_4+2\theta_2)-1/4l_4m_4a_4s(2\theta_3+2\theta_2) \end{aligned}$$

$$H_{212}=H_{213}=H_{214}=H_{215}=0$$

$$H_{221}=0$$

$$H_{222}=$$

$$\begin{aligned} & m_3a_3a_2s(2\theta_2+\theta_3)-1/2a_2l_2m_2s(2\theta_2)-1/2l_3m_3a_2s(2\theta_2+\theta_3)+1/2a_2l_2m_2c(2\theta_2)- \\ & 1/2l_4m_4a_2s(2\theta_2+\theta_4+\theta_3)+m_4a_3a_2s(2\theta_2+\theta_3)+m_2a_2^2s(2\theta_2)+m_4a_4a_2s(2\theta_2+\theta_4+\theta_3)+1/2l_4m_4a_2c(2\theta_2+\theta_4+ \\ & \theta_3)+m_5a_4a_2s(2\theta_2+\theta_4+\theta_3)+m_4a_4a_2s(-\theta_4+\theta_3+2\theta_2)-1/2l_5m_5a_2s(2\theta_2+\theta_5+\theta_4+\theta_3)+m_3a_3a_2s(- \\ & \theta_3+2\theta_2)+m_4a_2^2s(2\theta_2)+1/2l_3m_3a_2c(2\theta_2+\theta_3)+m_3a_2^2s(2\theta_2)+m_5a_4a_2s(- \\ & \theta_4+\theta_3+2\theta_2)+m_5a_3a_2s(2\theta_2+\theta_3)+m_5a_2^2s(2\theta_2)+m_4a_3a_2s(- \\ & \theta_3+2\theta_2)+1/2l_5m_5a_2c(2\theta_2+\theta_5+\theta_4+\theta_3)+m_5a_3a_2s(-\theta_3+2\theta_2) \end{aligned}$$

$$H_{223}=$$

$$\begin{aligned} & 1/2l_3m_3a_3s(2\theta_3)-m_5a_3^2s(2\theta_3)-1/2m_5a_3a_2s(-\theta_3+2\theta_2)-1/2m_4a_4a_2s(\theta_4+\theta_3)- \\ & 1/2l_4m_4a_3c(2\theta_3+\theta_4)+1/2m_4a_3a_2s(2\theta_2+\theta_3)+1/4m_5l_5a_2s(\theta_5+\theta_4+\theta_3)- \\ & 1/4m_5l_5a_2s(2\theta_2+\theta_5+\theta_4+\theta_3)+1/4m_3l_3a_2c(2\theta_2+\theta_3)-m_4a_4a_3s(-\theta_4+2\theta_3)-1/2l_5m_5a_3c(2\theta_3+\theta_5+\theta_4)- \\ & 1/2m_5a_4a_2s(-\theta_4+\theta_3)-m_5a_4a_3s(2\theta_3+\theta_4)-1/2l_3m_3a_3c(2\theta_3)+1/2m_4a_4a_2s(2\theta_2+\theta_4+\theta_3)-1/2m_4a_4a_2s(- \\ & \theta_4+\theta_3)+1/2m_3a_3a_2s(2\theta_2+\theta_3)-m_3a_3^2s(2\theta_3)- \\ & 1/4m_3l_3a_2s(2\theta_2+\theta_3)+1/2m_5a_4a_2s(2\theta_2+\theta_4+\theta_3)+1/2l_5m_5a_3s(2\theta_3+\theta_5+\theta_4)+1/2m_5a_4a_2s(- \\ & \theta_4+\theta_3+2\theta_2)+1/4m_4l_4a_2s(\theta_4+\theta_3)-1/4m_4l_4a_2s(2\theta_2+\theta_4+\theta_3)-m_3a_3S_3a_2-1/4l_3m_3C_3a_2+1/4l_3m_3S_3a_2- \\ & 1/2m_3a_3a_2s(-\theta_3+2\theta_2)+1/2m_5a_3a_2s(2\theta_2+\theta_3)-1/2m_4a_3a_2s(-\theta_3+2\theta_2)- \end{aligned}$$

APPENDIX A

$$\begin{aligned} &1/4m4l4a2c(04+03)+1/4m4l4a2c(202+04+03)+1/2m4a4a2s(-04+03+202)-m4a4a3s(203+04)- \\ &1/2m5a4a2s(04+03)-m5a4a3s(-04+203)-m4a3^2s(203)-m4a3S3a2-m5a3S3a2- \\ &1/4m5l5a2c(05+04+03)+1/4m5l5a2c(202+05+04+03)+1/2l4m4a3s(203+04) \end{aligned}$$

H224=

$$\begin{aligned} &1/2a4l5m5s(204+05)-1/4m4l4a3c(203+04)+1/4m4l4a2c(202+04+03)-1/4m4l4a3C4+1/4m4l4a2s(04+03)- \\ &1/4m4l4a2s(202+04+03)-1/2m5a4a2s(-04+03+202)+1/2m5a4a2s(-04+03)-m5a4^2s(204)+1/2m4a4a3s(- \\ &04+203)+1/2m5a4a2s(202+04+03)-1/4m5l5a2s(202+05+04+03)+1/4m5l5a2s(05+04+03)- \\ &1/4m5l5a2c(05+04+03)+1/4m5l5a2c(202+05+04+03)-1/2m4a4a2s(04+03)+1/2m4a4a2s(202+04+03)- \\ &1/4m5l5a3c(203+05+04)+1/4m5l5a3s(203+05+04)+1/4m5l5a3s(05+04)- \\ &1/4m5l5a3c(05+04)+1/2l4m4a4s(204)-1/2l4m4a4c(204)-m5a4a3S4+1/2m5a4a3s(-04+203)- \\ &1/2m5a4a2s(04+03)+1/2m4a4a2s(-04+03)-1/2m4a4a2s(-04+03+202)-m4a4a3S4-1/2m4a4a3s(203+04)- \\ &1/2a4l5m5c(204+05)-m4a4^2s(204)-1/2m5a4a3s(203+04)+1/4m4l4a3S4+1/4m4l4a3s(203+04)- \\ &1/4m4l4a2c(04+03) \end{aligned}$$

H225=

$$\begin{aligned} &-1/4l5m5a3c(203+05+04)+1/4l5m5a4s(204+05)+1/4l5m5a4S5- \\ &1/4l5m5a2c(05+04+03)+1/4l5m5a2c(202+05+04+03)-1/4l5m5a4C5- \\ &1/4l5m5a3c(05+04)+1/4l5m5a2s(05+04+03)- \\ &1/4l5m5a2s(202+05+04+03)+1/4l5m5a3s(203+05+04)+1/4l5m5a3s(05+04)-1/4l5m5a4c(204+05) \end{aligned}$$

H231=0

H232=

$$\begin{aligned} &1/2l3m3a3s(203)-1/4m5l5a2c(05+04+03)+1/4m5l5a2c(202+05+04+03)-m4a3^2s(203)-m5a4a3s(203+04)- \\ &1/2m4a4a2s(-04+03)+1/2m4a4a2s(-04+03+202)-m4a4a3s(203+04)-m3a3^2s(203)-1/2l4m4a3c(203+04)- \\ &1/2m4a3a2s(-03+202)+1/2m5a4a2s(202+04+03)-1/4m3l3a2s(202+03)+1/4m5l5a2s(05+04+03)- \\ &1/4m5l5a2s(202+05+04+03)+1/4m3l3a2c(202+03)- \\ &1/4m4l4a2c(04+03)+1/4m4l4a2c(202+04+03)+1/2l5m5a3s(203+05+04)-1/2m5a4a2s(04+03)- \\ &1/2m5a3a2s(-03+202)+1/2l4m4a3s(203+04)-1/2m4a4a2s(04+03)+1/2m5a3a2s(202+03)- \\ &1/4m4l4a2s(202+04+03)+1/4m4l4a2s(04+03)-m5a3^2s(203)-m4a3S3a2-1/2m5a4a2s(- \\ &04+03)+1/2m5a4a2s(-04+03+202)-1/2l3m3a3c(203)-m3a3S3a2-m5a3S3a2-1/2l5m5a3c(203+05+04)- \\ &1/4l3m3C3a2-m5a4a3s(-04+203)+1/4l3m3S3a2-m4a4a3s(- \\ &04+203)+1/2m4a3a2s(202+03)+1/2m4a4a2s(202+04+03)+1/2m3a3a2s(202+03)-1/2m3a3a2s(-03+202) \end{aligned}$$

H233=

$$\begin{aligned} &1/4m4l4a2s(04+03)-1/4m4l4a2s(202+04+03)-1/4m4l4a2c(04+03)+1/4m4l4a2c(202+04+03)-1/2m4a4a2s(- \\ &04+03)+1/2m4a4a2s(-04+03+202)+1/2m3a3a2s(-03+202)+1/2m5a4a2s(-04+03+202)- \\ &1/4m5l5a2s(202+05+04+03)+1/4m5l5a2s(05+04+03)-1/4m3l3a2C3+1/4m3l3a2c(202+03)- \\ &1/4m5l5a2c(05+04+03)+1/4m5l5a2c(202+05+04+03)-1/2m5a4a2s(04+03)+1/2m5a3a2s(- \\ &03+202)+1/4m3l3a2S3-1/4m3l3a2s(202+03)-1/2m4a4a2s(04+03)+1/2m4a4a2s(202+04+03)- \\ &1/2m5a4a2s(- \\ &04+03)+1/2m5a4a2s(202+04+03)+1/2m3a3a2s(202+03)+1/2m5a3a2s(202+03)+1/2m4a3a2s(202+03)+1/2 \\ &m4a3a2s(-03+202) \end{aligned}$$

H234=

$$\begin{aligned} &1/4m4l4a2s(04+03)+1/2m4a4a3s(-04+203)+1/4m4l4a3S4-m5a4a3S4-1/2m4a4a2s(-04+03+202)- \\ &1/2m4a4a2s(04+03)-1/4m5l5a2c(05+04+03)+1/4m5l5a2c(202+05+04+03)-1/2m4a4a3s(203+04)- \end{aligned}$$

APPENDIX A

$1/2l4m4a4c(204)-1/2m5a4a3s(203+04)-1/4m4l4a3C4-1/2a4l5m5c(204+05)-$
 $1/4m4l4a3c(203+04)+1/4m4l4a3s(203+04)+1/2m5a4a3s(-04+203)-$
 $1/2m5a4a2s(04+03)+1/2m5a4a2s(202+04+03)+1/4m5l5a2s(05+04+03)+1/2m4a4a2s(202+04+03)-$
 $m4a4^2s(204)-1/2m5a4a2s(-04+03+202)+1/2a4l5m5s(204+05)-1/4m4l4a2s(202+04+03)-$
 $m4a4a3S4+1/2m5a4a2s(-04+03)+1/2l4m4a4s(204)-1/4m5l5a3c(203+05+04)-$
 $1/4m5l5a2s(202+05+04+03)-1/4m5l5a3c(05+04)+1/2m4a4a2s(-04+03)-m5a4^2s(204)-$
 $1/4m4l4a2c(04+03)+1/4m4l4a2c(202+04+03)+1/4m5l5a3s(203+05+04)+1/4m5l5a3s(05+04)$

H235=

$1/4l5m5a4S5-1/4l5m5a2s(202+05+04+03)+1/4l5m5a2s(05+04+03)+1/4l5m5a3s(05+04)-$
 $1/4l5m5a3c(05+04)+1/4l5m5a4s(204+05)-$
 $1/4l5m5a2c(05+04+03)+1/4l5m5a2c(202+05+04+03)+1/4l5m5a3s(203+05+04)-1/4l5m5a3c(203+05+04)-$
 $1/4l5m5a4c(204+05)-1/4l5m5a4C5$

H241=

$-1/2m4a4a3s(203+04)-m4a4a3S4-1/4m5l5a2s(202+05+04+03)-1/2m5a4a2s(04+03)+1/2l4m4a4s(204)-$
 $1/2m5a4a2s(-04+03+202)+1/4m5l5a3s(05+04)+1/4m5l5a3s(203+05+04)+1/2m5a4a3s(-04+203)-$
 $m5a4a3S4-1/4m4l4a2s(202+04+03)-1/4m5l5a3c(05+04)-1/2a4l5m5c(204+05)+1/2m4a4a2s(202+04+03)-$
 $1/2m4a4a2s(04+03)-1/2m5a4a3s(203+04)-1/4m5l5a3c(203+05+04)-m4a4^2s(204)-$
 $1/4m4l4a2c(04+03)+1/2m4a4a2s(-04+03)-1/2l4m4a4c(204)+1/4m4l4a2c(202+04+03)-$
 $1/4m5l5a2c(05+04+03)+1/4m5l5a2c(202+05+04+03)+1/4m5l5a2s(05+04+03)+1/4m4l4a2s(04+03)+1/2m$
 $5a4a2s(-04+03)+1/2m5a4a2s(202+04+03)-m5a4^2s(204)+1/4m4l4a3s(203+04)+1/2m4a4a3s(-$
 $04+203)+1/2a4l5m5s(204+05)+1/4m4l4a3S4-1/4m4l4a3C4-1/4m4l4a3c(203+04)-1/2m4a4a2s(-$
 $04+03+202)$

H242=

$1/4m5l5a3s(203+05+04)+1/4m4l4a2c(202+04+03)-1/4m4l4a2c(04+03)-$
 $1/2m5a4a2s(04+03)+1/2m4a4a2s(202+04+03)+1/2a4l5m5s(204+05)-1/2m5a4a2s(-04+03+202)-$
 $m5a4a3S4-1/4m5l5a3c(05+04)+1/2l4m4a4s(204)+1/4m5l5a2c(202+05+04+03)+1/2m5a4a2s(-04+03)-$
 $m5a4^2s(204)+1/2m4a4a3s(-04+203)+1/4m4l4a3S4-1/2m4a4a2s(-04+03+202)+1/2m4a4a2s(-04+03)-$
 $1/4m5l5a3c(203+05+04)-1/2m5a4a3s(203+04)-1/4m4l4a3c(203+04)-1/4m4l4a3C4-$
 $1/4m5l5a2c(05+04+03)-1/2m4a4a2s(04+03)-1/2a4l5m5c(204+05)+1/4m4l4a2s(04+03)-$
 $1/4m4l4a2s(202+04+03)+1/4m5l5a3s(05+04)+1/4m5l5a2s(05+04+03)-1/2l4m4a4c(204)-$
 $m4a4^2s(204)+1/2m5a4a2s(202+04+03)-1/4m5l5a2s(202+05+04+03)-1/2m4a4a3s(203+04)-$
 $m4a4a3S4+1/2m5a4a3s(-04+203)+1/4m4l4a3s(203+04)$

H243=

$-1/4m5l5a3c(05+04)-1/2m5a4a3s(-04+203)-1/2m5a4a2s(04+03)+1/4m4l4a3s(203+04)-1/2m5a4a2s(-$
 $04+03)-1/2m5a4a3s(203+04)-1/2m4a4a2s(-04+03)-1/2m4a4a3s(-04+203)-$
 $1/2m4a4a2s(04+03)+1/2m5a4a2s(202+04+03)-1/4m4l4a2c(04+03)+1/4m4l4a2c(202+04+03)-$
 $1/4m5l5a2c(05+04+03)+1/4m5l5a2c(202+05+04+03)+1/4m5l5a2s(05+04+03)+1/2m4a4a2s(202+04+03)+$
 $1/4m4l4a3S4-1/4m4l4a3C4-1/4m4l4a3c(203+04)+1/2m4a4a2s(-04+03+202)+1/4m5l5a3s(05+04)-$
 $1/4m4l4a2s(202+04+03)+1/4m4l4a2s(04+03)-1/4m5l5a2s(202+05+04+03)+1/4m5l5a3s(203+05+04)-$
 $1/2m4a4a3s(203+04)+1/2m5a4a2s(-04+03+202)-1/4m5l5a3c(203+05+04)$

H244=

$-1/4m5l5a3c(05+04)-1/2m5a4a3s(-04+203)-1/2m5a4a2s(04+03)+1/4m4l4a3s(203+04)-1/2m5a4a2s(-$
 $04+03)-1/2m5a4a3s(203+04)-1/2m4a4a2s(-04+03)-1/2m4a4a3s(-04+203)-$

APPENDIX A

$$\begin{aligned} &1/2m4a4a2s(04+03)+1/2m5a4a2s(202+04+03)-1/4m4l4a2c(04+03)+1/4m4l4a2c(202+04+03)- \\ &1/4m5l5a2c(05+04+03)+1/4m5l5a2c(202+05+04+03)+1/4m5l5a2s(05+04+03)+1/2m4a4a2s(202+04+03)+ \\ &1/4m4l4a3S4-1/4m4l4a3C4-1/4m4l4a3c(203+04)+1/2m4a4a2s(-04+03+202)+1/4m5l5a3s(05+04)- \\ &1/4m4l4a2s(202+04+03)+1/4m4l4a2s(04+03)-1/4m5l5a2s(202+05+04+03)+1/4m5l5a3s(203+05+04)- \\ &1/2m4a4a3s(203+04)+1/2m5a4a2s(-04+03+202)-1/4m5l5a3c(203+05+04) \end{aligned}$$

H245=

$$\begin{aligned} &-1/4l5m5a2s(202+05+04+03)-1/4l5m5a4c(204+05)-1/4l5m5a3c(203+05+04)- \\ &1/4l5m5a3c(05+04)+1/4l5m5a3s(05+04)+1/4l5m5a4s(204+05)+1/4l5m5a2s(05+04+03)- \\ &1/4l5m5a4C5+1/4l5m5a3s(203+05+04)+1/4l5m5a4S5- \\ &1/4l5m5a2c(05+04+03)+1/4l5m5a2c(202+05+04+03) \end{aligned}$$

H251=0

H252=

$$\begin{aligned} &-1/4l5m5a4C5+1/4l5m5a3s(203+05+04)+1/4l5m5a3s(05+04)+1/4l5m5a4S5+1/4l5m5a4s(204+05)- \\ &1/4l5m5a2s(202+05+04+03)-1/4l5m5a2c(05+04+03)+1/4l5m5a2c(202+05+04+03)- \\ &1/4l5m5a4c(204+05)+1/4l5m5a2s(05+04+03)-1/4l5m5a3c(05+04)-1/4l5m5a3c(203+05+04) \end{aligned}$$

H253=

$$\begin{aligned} &1/4l5m5a2s(05+04+03)-1/4l5m5a4C5- \\ &1/4l5m5a4c(204+05)+1/4l5m5a3s(203+05+04)+1/4l5m5a3s(05+04)+1/4l5m5a4s(204+05)- \\ &1/4l5m5a3c(05+04)-1/4l5m5a3c(203+05+04)- \\ &1/4l5m5a2c(05+04+03)+1/4l5m5a2c(202+05+04+03)+1/4l5m5a4S5-1/4l5m5a2s(202+05+04+03) \end{aligned}$$

H254=

$$\begin{aligned} &-1/4l5m5a2c(05+04+03)+1/4l5m5a2c(202+05+04+03)- \\ &1/4l5m5a4c(204+05)+1/4l5m5a3s(203+05+04)+1/4l5m5a3s(05+04)-1/4l5m5a3c(203+05+04)- \\ &1/4l5m5a3c(05+04)+1/4l5m5a2s(05+04+03)- \\ &1/4l5m5a2s(202+05+04+03)+1/4l5m5a4s(204+05)+1/4l5m5a4S5-1/4l5m5a4C5 \end{aligned}$$

H255=

$$\begin{aligned} &-1/4l5m5a2c(05+04+03)+1/4l5m5a2c(202+05+04+03)-1/4l5m5a3c(203+05+04)- \\ &1/4l5m5a3c(05+04)+1/4l5m5a2s(05+04+03)- \\ &1/4l5m5a2s(202+05+04+03)+1/4l5m5a4S5+1/4l5m5a3s(203+05+04)+1/4l5m5a3s(05+04)-1/4l5m5a4C5- \\ &1/4l5m5a4c(204+05)+1/4l5m5a4s(204+05) \end{aligned}$$

H311=

$$\begin{aligned} &1/4m5a2a4s(202+04+03)+1/6l3^2m3s(203+202)+1/4m5a2a4s(- \\ &04+03+202)+1/2m5a4^2c(203+202)+1/4m3a3a2c(202+03)+1/2m5a3^2s(203)+1/2m5a4a3c(203+202+04) \\ &-1/4l4m4a3s(203+04)-1/4m5a3^2c(-203+202)+1/4l3m3a3c(203)+1/4m5a3^2c(203+202)+1/4m5a2a4c(- \\ &04+03)-1/4m5a2a3s(-03+202)+1/2m4a4a3s(- \\ &04+03)+1/4m5a2a3s(202+03)+1/2m4a4^2c(203+202)+1/4m4a4^2c(- \\ &204+203+202)+1/4m5a2a3c(202+03)-1/4l4m4a4c(204+203+202)+1/2m4a4a3c(203+202+04)- \\ &1/4l4m4a2s(04+03)-1/4l4m4a2s(202+04+03)+1/2m3a3^2s(203)+1/4m4a2a4s(-04+03)-1/4m3a3^2c(- \\ &203+202)+1/4m5a4^2c(204+203+202)+1/4m3a3^2c(203+202)+1/2m5a4a3s(-04+203)-1/4m3a3a2c(- \\ &03+202)+1/4m4a3^2c(203+202)+1/4m4a2a3s(202+03)-1/4l3m3a2S3+1/2m5a2a3S3- \\ &1/4l5m5a2s(05+04+03)-1/4l3m3a2s(202+03)- \\ &1/4l5m5a4s(204+203+202+05)+1/4m4a2a4c(202+04+03)+1/4m4a2a4c(04+03)+1/4m5a2a4c(04+03)- \end{aligned}$$

APPENDIX A

$$\begin{aligned} &1/4l3m3a3s(203+202)+1/2m5a4a3s(203+04)-1/4m5a2a3c(- \\ &03+202)+1/6l4^2m4s(204+203+202)+1/4l4m4a3c(203+04)+1/4m4a4^2c(204+203+202)+1/4m5a2a4c(- \\ &04+03+202)-1/4l4m4a3s(203+202+04)+1/2m3a3a2S3+1/4m5a2a4s(04+03)+1/2m4a4a3c(- \\ &04+203+202)+1/4m4a2a4s(04+03)+1/4m4a2a4s(202+04+03)- \\ &1/4l3m3a3s(203)+1/4m5a2a4c(202+04+03)+1/4m3a3a2s(202+03)- \\ &1/4l4m4a3c(203+202+04)+1/6l5^2m5s(205+204+203+202)+1/4m4a2a4s(-04+03+202)+1/4m4a2a4c(- \\ &04+03+202)+1/2m4a4a3s(203+04)-1/4l4m4a4c(203+202)-1/4m4a2a3s(-03+202)-1/4m4a2a3c(- \\ &03+202)+1/4m4a2a3c(202+03)-1/4m4a3^2c(-203+202)+1/2m5a4a3c(-04+203+202)- \\ &1/4l4m4a4s(203+202)-1/4l5m5a4s(203+202+05)- \\ &1/4l5m5a3c(203+202+05+04)+1/4l5m5a3c(203+05+04)-1/4l5m5a3s(203+202+05+04)- \\ &1/4l5m5a3s(203+05+04)+1/4m4a2a4c(-04+03)+1/2m4a2a3S3-1/4l5m5a4c(203+202+05)- \\ &1/4l5m5a4c(204+203+202+05)+1/4m5a2a4s(-04+03)+1/4m5a4^2c(-204+203+202)+1/2m4a3^2s(203)- \\ &1/4m3a3a2s(-03+202)-1/4l5m5a2s(202+05+04+03)-1/4l4m4a4s(204+203+202)-1/4l3m3a3c(203+202) \end{aligned}$$

H312=H313=H314=H315=0

H321=0

H322=

$$\begin{aligned} &m3a3a2S3-1/2m3a3a2s(-03+202)-1/2m5a2a3s(- \\ &03+202)+1/2m5a2a3s(202+03)+m4a2a3S3+1/2m5a2a4s(202+04+03)+m5a2a3S3+1/2l5m5a3c(203+05+0 \\ &4)+m3a3^2s(203)+m5a3^2s(203)+m5a4a3s(-04+203)-1/4l3m3a2S3- \\ &1/2l4m4a3s(203+04)+1/2m3a3a2s(202+03)+1/2m4a2a4s(- \\ &04+03+202)+1/2m4a2a4s(202+04+03)+1/2m4a2a4s(04+03)+m5a4a3s(203+04)- \\ &1/4l5m5a2s(202+05+04+03)+m4a4a3s(-04+203)-1/4l4m4a2s(04+03)- \\ &1/4l4m4a2s(202+04+03)+1/4l5m5a2c(05+04+03)+1/4l5m5a2c(202+05+04+03)-1/2m4a2a3s(- \\ &03+202)+1/2m4a2a3s(202+03)+1/4l4m4a2c(202+04+03)+1/4l4m4a2c(04+03)+1/2m5a2a4s(04+03)+m4a \\ &4a3s(203+04)+1/4l3m3a2C3+1/4l3m3a2c(202+03)+m4a3^2s(203)-1/4l3m3a2s(202+03)+1/2m5a2a4s(- \\ &04+03)+1/2m4a2a4s(-04+03)+1/2l3m3a3c(203)-1/2l5m5a3s(203+05+04)- \\ &1/4l5m5a2s(05+04+03)+1/2m5a2a4s(-04+03+202)+1/2l4m4a3c(203+04)-1/2l3m3a3s(203) \end{aligned}$$

H323=0

H324=

$$\begin{aligned} &1/2l4m4a4s(204)-1/2l5m5a4c(204+05)+1/4m4l4a3c(203+04)-1/2m4a4a3s(-04+203)-m4a4^2s(204)- \\ &m5a4^2s(204)+1/2l5m5a4s(204+05)-1/2l4m4a4c(204)+1/4m5l5a3s(05+04)-1/4m5l5a3s(203+05+04)- \\ &1/4m5l5a3c(05+04)-1/4m4l4a3s(203+04)+1/2m4a4a3s(203+04)+1/4l4m4S4a3-1/2m5a4a3s(- \\ &04+203)+1/4m5l5a3c(203+05+04)-m5a4S4a3-m4a4S4a3-1/4l4m4C4a3+1/2m5a4a3s(203+04) \end{aligned}$$

H325=

$$\begin{aligned} &-1/4l5m5a4C5-1/4l5m5a4c(204+05)-1/4l5m5a3s(203+05+04)+1/4l5m5a3s(05+04)- \\ &1/4l5m5a3c(05+04)+1/4l5m5a3c(203+05+04)+1/4l5m5a4s(204+05)+1/4l5m5a4S5 \end{aligned}$$

H331=H332=0

H333=

$$\begin{aligned} &m5a4a3s(203+04)+a3^2m3s(203)-1/2a3l3m3s(203)- \\ &1/2l4m4a3s(203+04)+m4a3^2s(203)+1/2l5m5a3c(203+05+04)+m5a3^2s(203)+m5a4a3s(- \\ &04+203)+m4a4a3s(-04+203)+1/2a3l3m3c(203)+1/2l4m4a3c(203+04)- \\ &1/2l5m5a3s(203+05+04)+m4a4a3s(203+04) \end{aligned}$$

APPENDIX A

H334=

$-1/2a4l5m5c(2\theta4+\theta5)-m5a4^2s(2\theta4)+1/4m4l4a3c(2\theta3+\theta4)-1/4m5l5a3c(\theta5+\theta4)+1/4m5l5a3s(\theta5+\theta4)-m4a4^2s(2\theta4)+1/2m4a4a3s(2\theta3+\theta4)+1/2l4m4a4s(2\theta4)-1/4m4l4a3s(2\theta3+\theta4)+1/2m5a4a3s(2\theta3+\theta4)-1/4m5l5a3s(2\theta3+\theta5+\theta4)+1/4m5l5a3c(2\theta3+\theta5+\theta4)+1/4l4m4S4a3-m4a4S4a3-m5a4S4a3-1/4l4m4C4a3-1/2l4m4a4c(2\theta4)-1/2m5a4a3s(-\theta4+2\theta3)-1/2m4a4a3s(-\theta4+2\theta3)+1/2a4l5m5s(2\theta4+\theta5)$

H335=

$1/4l5m5a3s(\theta5+\theta4)-1/4l5m5a3s(2\theta3+\theta5+\theta4)+1/4l5m5a3c(2\theta3+\theta5+\theta4)-1/4l5m5a4C5-1/4l5m5a3c(\theta5+\theta4)+1/4l5m5a4S5+1/4l5m5a4s(2\theta4+\theta5)-1/4l5m5a4c(2\theta4+\theta5)$

H341=0

H342=

$-m5a4^2s(2\theta4)-1/4m5l5a3s(2\theta3+\theta5+\theta4)-1/2m5a4a3s(-\theta4+2\theta3)+1/2a4l5m5s(2\theta4+\theta5)-1/4m5l5a3c(\theta5+\theta4)+1/4m5l5a3s(\theta5+\theta4)+1/2m5a4a3s(2\theta3+\theta4)-m4a4^2s(2\theta4)-1/2m4a4a3s(-\theta4+2\theta3)-1/4m4l4a3s(2\theta3+\theta4)+1/2m4a4a3s(2\theta3+\theta4)-1/2l4m4a4c(2\theta4)+1/2l4m4a4s(2\theta4)+1/4m5l5a3c(2\theta3+\theta5+\theta4)-m4a4S4a3-1/2a4l5m5c(2\theta4+\theta5)+1/4l4m4S4a3-m5a4S4a3-1/4l4m4C4a3+1/4m4l4a3c(2\theta3+\theta4)$

H343=

$-1/2m4a4a3s(-\theta4+2\theta3)-m4a4^2s(2\theta4)-1/2l4m4a4c(2\theta4)-m5a4^2s(2\theta4)-1/4m5l5a3c(\theta5+\theta4)+1/4m5l5a3c(2\theta3+\theta5+\theta4)+1/2m5a4a3s(2\theta3+\theta4)-1/4m5l5a3s(2\theta3+\theta5+\theta4)+1/4m5l5a3s(\theta5+\theta4)-1/2a4l5m5c(2\theta4+\theta5)+1/2m4a4a3s(2\theta3+\theta4)+1/4m4l4a3c(2\theta3+\theta4)+1/2a4l5m5s(2\theta4+\theta5)-1/4l4m4C4a3-m5a4S4a3-m4a4S4a3+1/4l4m4S4a3-1/2m5a4a3s(-\theta4+2\theta3)-1/4m4l4a3s(2\theta3+\theta4)+1/2l4m4a4s(2\theta4)$

H344=

$1/2m5a4a3s(-\theta4+2\theta3)-1/4m5l5a3c(\theta5+\theta4)+1/2m4a4a3s(2\theta3+\theta4)-1/4m4l4a3s(2\theta3+\theta4)+1/4m4l4a3c(2\theta3+\theta4)+1/4m5l5a3s(\theta5+\theta4)-1/4m5l5a3s(2\theta3+\theta5+\theta4)+1/4m4l4a3S4+1/2m5a4a3s(2\theta3+\theta4)-1/4m4l4a3C4+1/4m5l5a3c(2\theta3+\theta5+\theta4)+1/2m4a4a3s(-\theta4+2\theta3)$

H345=

$-1/4l5m5a3c(\theta5+\theta4)+1/4l5m5a4S5+1/4l5m5a4s(2\theta4+\theta5)-1/4l5m5a4c(2\theta4+\theta5)-1/4l5m5a4C5+1/4l5m5a3s(\theta5+\theta4)-1/4l5m5a3s(2\theta3+\theta5+\theta4)+1/4l5m5a3c(2\theta3+\theta5+\theta4)$

H351=0

H352=

$-1/4l5m5a4C5+1/4l5m5a3c(2\theta3+\theta5+\theta4)-1/4l5m5a3c(\theta5+\theta4)+1/4l5m5a4s(2\theta4+\theta5)+1/4l5m5a3s(\theta5+\theta4)-1/4l5m5a4c(2\theta4+\theta5)-1/4l5m5a3s(2\theta3+\theta5+\theta4)+1/4l5m5a4S5$

H353=

$-1/4l5m5a4c(2\theta4+\theta5)-1/4l5m5a3s(2\theta3+\theta5+\theta4)-1/4l5m5a4C5+1/4l5m5a3c(2\theta3+\theta5+\theta4)+1/4l5m5a3s(\theta5+\theta4)+1/4l5m5a4S5-1/4l5m5a3c(\theta5+\theta4)+1/4l5m5a4s(2\theta4+\theta5)$

H354=

APPENDIX A

$$1/4l5m5a4S5+1/4l5m5a4s(2\theta4+\theta5)-1/4l5m5a3s(2\theta3+\theta5+\theta4)+1/4l5m5a3s(\theta5+\theta4)-1/4l5m5a4C5-1/4l5m5a4c(2\theta4+\theta5)-1/4l5m5a3c(\theta5+\theta4)+1/4l5m5a3c(2\theta3+\theta5+\theta4)$$

$$H355=$$

$$1/4l5m5a4s(2\theta4+\theta5)-1/4l5m5a3s(2\theta3+\theta5+\theta4)+1/4l5m5a3s(\theta5+\theta4)+1/4l5m5a4S5-1/4l5m5a4C5+1/4l5m5a3c(2\theta3+\theta5+\theta4)-1/4l5m5a4c(2\theta4+\theta5)-1/4l5m5a3c(\theta5+\theta4)$$

$$H411=$$

$$\begin{aligned} &1/8l5m5a3c(\theta5+\theta4)-1/4m4a4a3c(-\theta4+2\theta2)-1/4m4a4a2c(-\theta4+\theta3+2\theta2)-1/4m4a4a3s(-\theta4+2\theta3)- \\ &1/8l4m4a3S4-1/8l4m4a3s(2\theta2+\theta4)+1/4m4a4a3c(2\theta3+2\theta2+\theta4)-1/4m4a4^2c(- \\ &2\theta4+2\theta3+2\theta2)+1/4m4a4a2s(2\theta2+\theta4+\theta3)+1/8l4m4a3C4+1/4m5a4a2s(\theta4+\theta3)+1/4m4a4a3s(2\theta3+\theta4)- \\ &1/4m5a4a3s(-\theta4+2\theta3)+1/4m5a4a3s(2\theta3+\theta4)-1/4l4m4a4s(2\theta4)+1/6l5^2m5s(2\theta5+2\theta4+2\theta3+2\theta2)- \\ &1/4m5a4a2s(- \\ &\theta4+\theta3+2\theta2)+1/4m4a4^2c(2\theta4+2\theta3+2\theta2)+1/4l4m4a4c(2\theta4)+1/4m4a4a2c(\theta4+\theta3)+1/4l5m5a4c(2\theta4+\theta5)- \\ &1/4l5m5a4c(2\theta4+2\theta3+2\theta2+\theta5)-1/4m4a4a3c(-\theta4+2\theta3+2\theta2)+1/2m4a4^2s(2\theta4)-1/4l5m5a4s(2\theta4+\theta5)- \\ &1/8l4m4a3c(2\theta2+\theta4)+1/2m5a4a3S4+1/4m5a4a2c(\theta4+\theta3)+1/4m4a4a3c(2\theta2+\theta4)+1/4m5a4a2c(2\theta2+\theta4+\theta3) \\ &-1/4m5a4a2c(-\theta4+\theta3+2\theta2)-1/4m5a4a2c(-\theta4+\theta3)-1/8l5m5a3s(2\theta2+\theta5+\theta4)-1/8l5m5a3s(2\theta3+\theta5+\theta4)- \\ &1/4l4m4a4s(2\theta4+2\theta3+2\theta2)-1/4m5a4^2c(- \\ &2\theta4+2\theta3+2\theta2)+1/4m5a4^2c(2\theta4+2\theta3+2\theta2)+1/4m4a4a2c(2\theta2+\theta4+\theta3)-1/4m4a4a2c(- \\ &\theta4+\theta3)+1/4m5a4a3c(2\theta2+\theta4)-1/4m5a4a3c(-\theta4+2\theta2)+1/2m4a4a3S4-1/8l4m4a3s(2\theta3+2\theta2+\theta4)- \\ &1/8l4m4a3c(2\theta3+2\theta2+\theta4)+1/8l4m4a3c(2\theta3+\theta4)+1/4m4a4a2s(\theta4+\theta3)+1/4m5a4a3c(2\theta3+2\theta2+\theta4)- \\ &1/8l4m4a3s(2\theta3+\theta4)-1/8l5m5a3c(2\theta3+2\theta2+\theta5+\theta4)+1/8l5m5a3c(2\theta3+\theta5+\theta4)-1/8l5m5a3c(2\theta2+\theta5+\theta4)- \\ &1/4l4m4a4c(2\theta4+2\theta3+2\theta2)-1/4m4a4a2s(-\theta4+\theta3+2\theta2)-1/4m5a4a3c(-\theta4+2\theta3+2\theta2)- \\ &1/4l4m4a2s(2\theta2+\theta4+\theta3)-1/4l4m4a2s(\theta4+\theta3)+1/6l4^2m4s(2\theta4+2\theta3+2\theta2)+1/4m5a4a2s(2\theta2+\theta4+\theta3)- \\ &1/4m5a4a2s(-\theta4+\theta3)-1/4l5m5a4s(2\theta4+2\theta3+2\theta2+\theta5)-1/4l5m5a2s(2\theta2+\theta5+\theta4+\theta3)- \\ &1/4l5m5a2s(\theta5+\theta4+\theta3)-1/8l5m5a3s(2\theta3+2\theta2+\theta5+\theta4)-1/8l5m5a3s(\theta5+\theta4)+1/2m5a4^2s(2\theta4)- \\ &1/4m4a4a2s(-\theta4+\theta3) \end{aligned}$$

$$H412=H413=H414=H415=0$$

$$H421=0$$

$$H422=$$

$$\begin{aligned} &1/4l4m4a2c(\theta4+\theta3)-1/4l5m5a2s(2\theta2+\theta5+\theta4+\theta3)-1/2l5m5a4s(2\theta4+\theta5)+1/2l4m4a4c(2\theta4)+1/4l4m4a3C4- \\ &1/4l4m4a2s(2\theta2+\theta4+\theta3)+1/4l4m4a2c(2\theta2+\theta4+\theta3)+1/2l5m5a4c(2\theta4+\theta5)-1/2m4a4a2s(-\theta4+\theta3)- \\ &1/2m4a4a2s(-\theta4+\theta3+2\theta2)+1/2m5a4a3s(2\theta3+\theta4)- \\ &1/4l4m4a3S4+1/2m4a4a3s(2\theta3+\theta4)+1/2m4a4a2s(2\theta2+\theta4+\theta3)+m4a4a3S4+1/2m5a4a2s(\theta4+\theta3)+m5a4^2s \\ &(2\theta4)-1/4l5m5a3s(\theta5+\theta4)-1/4l5m5a3s(2\theta3+\theta5+\theta4)-1/4l4m4a2s(\theta4+\theta3)-1/2m5a4a3s(- \\ &\theta4+2\theta3)+1/4l5m5a3c(\theta5+\theta4)-1/4l4m4a3s(2\theta3+\theta4)- \\ &1/4l5m5a2s(\theta5+\theta4+\theta3)+m5a4a3S4+m4a4^2s(2\theta4)+1/4l5m5a2c(2\theta2+\theta5+\theta4+\theta3)+1/4l5m5a2c(\theta5+\theta4+\theta3) \\ &-1/2l4m4a4s(2\theta4)+1/2m4a4a2s(\theta4+\theta3)-1/2m4a4a3s(-\theta4+2\theta3)+1/4l4m4a3c(2\theta3+\theta4)-1/2m5a4a2s(- \\ &\theta4+\theta3)-1/2m5a4a2s(-\theta4+\theta3+2\theta2)+1/4l5m5a3c(2\theta3+\theta5+\theta4)+1/2m5a4a2s(2\theta2+\theta4+\theta3) \end{aligned}$$

$$H423=$$

$$\begin{aligned} &-1/2m4a4a3s(2\theta3+\theta4)+1/2m4a4a3s(-\theta4+2\theta3)+1/4l5m5a3s(2\theta3+\theta5+\theta4)- \\ &1/4l5m5a3s(\theta5+\theta4)+m4a4^2s(2\theta4)-1/4l4m4a3c(2\theta3+\theta4)+1/2m5a4a3s(-\theta4+2\theta3)- \\ &1/2m5a4a3s(2\theta3+\theta4)+m5a4^2s(2\theta4)+1/4l4m4a3s(2\theta3+\theta4)-1/4l4m4a3S4+m4a3a4S4+1/4l4m4a3C4- \\ &1/2l4m4a4s(2\theta4)-1/4l5m5a3c(2\theta3+\theta5+\theta4)+1/4l5m5a3c(\theta5+\theta4)+1/2l5m5a4c(2\theta4+\theta5)+1/2l4m4a4c(2\theta4)- \\ &1/2l5m5a4s(2\theta4+\theta5)+m5a3a4S4 \end{aligned}$$

$$H424=0$$

APPENDIX A

H425=

$$-1/4l5m5a4C5+1/4l5m5a4c(2\theta4+\theta5)-1/4l5m5a4s(2\theta4+\theta5)+1/4l5m5a4S5$$

H431=0

H432=

$$\begin{aligned} & m4a4^2s(2\theta4)-1/4l5m5a3c(2\theta3+\theta5+\theta4)+1/4l5m5a3c(\theta5+\theta4)+m5a4^2s(2\theta4)- \\ & 1/2m4a4a3s(2\theta3+\theta4)+1/2l5m5a4c(2\theta4+\theta5)+1/2m4a4a3s(-\theta4+2\theta3)+1/4l4m4a3s(2\theta3+\theta4)- \\ & 1/2l5m5a4s(2\theta4+\theta5)-1/2l4m4a4s(2\theta4)+1/2l4m4a4c(2\theta4)+m4a3a4S4+m5a3a4S4- \\ & 1/4l4m4a3S4+1/4l4m4a3C4+1/2m5a4a3s(-\theta4+2\theta3)-1/2m5a4a3s(2\theta3+\theta4)-1/4l4m4a3c(2\theta3+\theta4)- \\ & 1/4l5m5a3s(\theta5+\theta4)+1/4l5m5a3s(2\theta3+\theta5+\theta4) \end{aligned}$$

H433=

$$\begin{aligned} & 1/2l5m5a4c(2\theta4+\theta5)+1/4l4m4a3C4-1/4l4m4a3s(2\theta3+\theta4)+m5a4^2s(2\theta4)+1/2m4a4a3s(2\theta3+\theta4)- \\ & 1/2m4a4a3s(-\theta4+2\theta3)-1/4l5m5a3s(2\theta3+\theta5+\theta4)+1/4l5m5a3c(\theta5+\theta4)- \\ & 1/2l4m4a4s(2\theta4)+m4a4a3S4+1/2l4m4a4c(2\theta4)+m4a4^2s(2\theta4)-1/2l5m5a4s(2\theta4+\theta5)- \\ & 1/4l5m5a3s(\theta5+\theta4)+1/4l4m4a3c(2\theta3+\theta4)+1/4l5m5a3c(2\theta3+\theta5+\theta4)-1/2m5a4a3s(-\theta4+2\theta3)- \\ & 1/4l4m4a3S4+1/2m5a4a3s(2\theta3+\theta4)+m5a4a3S4 \end{aligned}$$

H434=0

H435=

$$-1/4l5m5a4s(2\theta4+\theta5)+1/4l5m5a4S5-1/4l5m5a4C5+1/4l5m5a4c(2\theta4+\theta5)$$

H441=H442=H443=0

H444=

$$\begin{aligned} & a4^2m5s(2\theta4)+1/2a4l5m5c(2\theta4+\theta5)+a4^2m4s(2\theta4)-1/2a4l4m4s(2\theta4)+1/2a4l4m4c(2\theta4)- \\ & 1/2a4l5m5s(2\theta4+\theta5) \end{aligned}$$

H445=

$$1/4l5m5a4c(2\theta4+\theta5)-1/4l5m5a4s(2\theta4+\theta5)+1/4l5m5a4S5-1/4l5m5a4C5$$

H451=0

H452=

$$1/4l5m5a4S5-1/4l5m5a4C5+1/4l5m5a4c(2\theta4+\theta5)-1/4l5m5a4s(2\theta4+\theta5)$$

H453=

$$-1/4l5m5a4C5+1/4l5m5a4c(2\theta4+\theta5)-1/4l5m5a4s(2\theta4+\theta5)+1/4l5m5a4S5$$

H454=

$$1/4l5m5a4S5-1/4l5m5a4s(2\theta4+\theta5)-1/4l5m5a4C5+1/4l5m5a4c(2\theta4+\theta5)$$

H455=

$$-1/4l5m5a4s(2\theta4+\theta5)-1/4l5m5a4C5+1/4l5m5a4c(2\theta4+\theta5)+1/4l5m5a4S5$$

APPENDIX A

H511=

$$\begin{aligned} & -1/8l5m5a3s(05+04)+1/8l5m5a3c(05+04)-1/8l5m5a3c(203+202+05+04)+1/8l5m5a4c(204+05)- \\ & 1/8l5m5a4c(204+203+202+05)+1/8l5m5a4C5-1/8l5m5a3s(202+05+04)-1/8l5m5a3s(203+05+04)- \\ & 1/8l5m5a3s(203+202+05+04)-1/8l5m5a4c(203+202+05)+1/8l5m5a3c(203+05+04)- \\ & 1/8l5m5a3c(202+05+04)-1/8l5m5a4s(204+05)+1/6l5^2m5s(205+204+203+202)- \\ & 1/4l5m5a2s(202+05+04+03)-1/4l5m5a2s(05+04+03)-1/8l5m5a4S5-1/8l5m5a4s(204+203+202+05)- \\ & 1/8l5m5a4s(203+202+05) \end{aligned}$$

H512=H513=H514=H515=0

H521=0

H522=

$$\begin{aligned} & -1/4l5m5a2s(202+05+04+03)-1/4l5m5a4s(204+05)+1/4l5m5a3c(203+05+04)- \\ & 1/4l5m5a2s(05+04+03)+1/4l5m5a4c(204+05)- \\ & 1/4l5m5a3s(203+05+04)+1/4l5m5a2c(05+04+03)+1/4l5m5a2c(202+05+04+03)- \\ & 1/4l5m5a4S5+1/4l5m5a3c(05+04)-1/4l5m5a3s(05+04)+1/4l5m5a4C5 \end{aligned}$$

H523=

$$\begin{aligned} & 1/4l5m5a3s(203+05+04)-1/4l5m5a3s(05+04)+1/4l5m5a4C5- \\ & 1/4l5m5a3c(203+05+04)+1/4l5m5a3c(05+04)+1/4l5m5a4c(204+05)-1/4l5m5a4s(204+05)-1/4l5m5a4S5 \end{aligned}$$

H524=

$$1/4a4l5m5s(204+05)-1/4a4l5m5c(204+05)+1/4a4l5m5C5-1/4a4l5m5S5$$

H525=0

H531=0

H532=

$$\begin{aligned} & -1/4l5m5a4s(204+05)+1/4l5m5a3c(05+04)+1/4l5m5a4c(204+05)+1/4l5m5a3s(203+05+04)- \\ & 1/4l5m5a4S5+1/4l5m5a4C5-1/4l5m5a3s(05+04)-1/4l5m5a3c(203+05+04) \end{aligned}$$

H533=

$$\begin{aligned} & 1/4l5m5a3c(05+04)-1/4l5m5a4S5-1/4l5m5a4s(204+05)- \\ & 1/4l5m5a3s(05+04)+1/4l5m5a4c(204+05)+1/4l5m5a4C5- \\ & 1/4l5m5a3s(203+05+04)+1/4l5m5a3c(203+05+04) \end{aligned}$$

H534=

$$-1/4a4l5m5S5-1/4a4l5m5c(204+05)+1/4a4l5m5s(204+05)+1/4a4l5m5C5$$

H535=0

H541=0

H542=

$$-1/4a4l5m5c(204+05)+1/4a4l5m5C5+1/4a4l5m5s(204+05)-1/4a4l5m5S5$$

APPENDIX A

H543=

$$1/4a4l5m5s(2\theta4+\theta5)+1/4a4l5m5C5-1/4a4l5m5c(2\theta4+\theta5)-1/4a4l5m5S5$$

H544=

$$-1/2l5m5a4C4(S5S4+C5S4-C4C5+C4S5)$$

H545=0

H551=H552=H553=H553=H554=H555=0