$$\mathcal{H}_{Cr-Cr} = \begin{pmatrix}
0 & t_{A,Cr}e^{i(k_1-k_2)} & t_{A,Cr}e^{ik_1} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
t_{A,Cr}e^{i(-k_1+k_2)} & 0 & t_{A,Cr}e^{ik_2} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
t_{A,Cr}e^{-ik_1} & t_{A,Cr}e^{-ik_2} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & t_{in,Cr}e^{-ik_2} & t_{in,Cr}e^{-ik_2} & t_{z,Cr}e^{-ik_3} & t_{out,Cr}e^{-i(k_2+k_3)} & t_{out,Cr}e^{-i(k_2+k_3)} & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & t_{in,Cr}e^{ik_2} & 0 & t_{in,Cr} & t_{out,Cr}e^{i(k_2-k_3)} & t_{z,Cr}e^{-ik_3} & t_{out,Cr}e^{-ik_3} & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & t_{in,Cr}e^{ik_2} & t_{in,Cr} & 0 & t_{out,Cr}e^{i(k_2-k_3)} & t_{out,Cr}e^{-ik_3} & t_{z,Cr}e^{-ik_3} & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & t_{z,Cr}e^{ik_3} & t_{out,Cr}e^{i(-k_2+k_3)} & t_{out,Cr}e^{i(-k_2+k_3)} & 0 & t_{in,Cr}e^{-ik_2} & t_{in,Cr}e^{-ik_2} & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & t_{out,Cr}e^{i(k_2+k_3)} & t_{z,Cr}e^{ik_3} & t_{out,Cr}e^{ik_3} & t_{in,Cr}e^{ik_2} & 0 & t_{in,Cr} & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & t_{out,Cr}e^{i(k_2+k_3)} & t_{out,Cr}e^{ik_3} & t_{z,Cr}e^{ik_3} & t_{in,Cr}e^{ik_2} & t_{in,Cr} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & t_{in,Cr}e^{ik_1} & t_{in,Cr} & t_{z,Cr}e^{-ik_3} & t_{out,Cr}e^{i(k_1-k_3)} & t_{out,Cr}e^{-ik_3} \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & t_{in,Cr}e^{-ik_1} & 0 & t_{in,Cr}e^{-ik_1} & t_{out,Cr}e^{-i(k_1+k_3)} & t_{z,Cr}e^{-ik_3} & t_{out,Cr}e^{-i(k_1+k_3)} \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & t_{in,Cr} & t_{in,Cr}e^{ik_1} & 0 & t_{out,Cr}e^{-ik_3} & t_{out,Cr}e^{i(k_1-k_3)} & t_{z,Cr}e^{-ik_3} \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & t_{z,Cr}e^{ik_3} & t_{out,Cr}e^{i(k_1+k_3)} & t_{out,Cr}e^{ik_3} & 0 & t_{in,Cr}e^{ik_1} & t_{in,Cr} \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & t_{out,Cr}e^{i(-k_1+k_3)} & t_{z,Cr}e^{ik_3} & t_{out,Cr}e^{i(-k_1+k_3)} & t_{in,Cr}e^{-ik_1} & 0 & t_{in,Cr}e^{-ik_1} \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & t_{out,Cr}e^{ik_3} & t_{out,Cr}e^{i(k_1+k_3)} & t_{z,Cr}e^{ik_3} & t_{in,Cr} & t_{in,Cr}e^{ik_1} & 0
\end{pmatrix}$$

$$\psi_{Cr} = \begin{pmatrix}
c_{R_{+,1}} \\ c_{R_{+,2}} \\ c_{R_{+,3}} \\ c_{R_{-,1}} \\ c_{R_{-,2}} \\ c_{R_{-,3}} \\ c_{L_{+,1}} \\ c_{L_{+,2}} \\ c_{L_{+,3}} \\ c_{L_{-,1}} \\ c_{L_{-,2}} \\ c_{L_{-,3}} \\ c_{z,1} \\ c_{z,2} \\ c_{z,3}
\end{pmatrix}$$

$$\mathcal{H}_{Fe-Fe} = \begin{pmatrix}
0 & 0 & 0 & t_z e^{ik_3} & t'_z e^{ik_3} & t'_z e^{i(-k_1-k_2+k_3)} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & t'_z e^{ik_3} & t_z e^{ik_3} & t'_z e^{i(-k_1-k_2+k_3)} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & t'_z e^{i(k_1+k_2+k_3)} & t'_z e^{i(k_1+k_2+k_3)} & t_z e^{ik_3} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
t_z e^{ik_3} & t'_z e^{ik_3} & t'_z e^{i(-k_1-k_2+k_3)} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
t'_z e^{ik_3} & t_z e^{ik_3} & t'_z e^{i(-k_1-k_2+k_3)} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
t'_z e^{i(k_1+k_2+k_3)} & t'_z e^{i(k_1+k_2+k_3)} & t_z e^{ik_3} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & t_\perp e^{-ik_1} & t_\perp e^{-ik_1} & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & t_\perp e^{ik_1} & 0 & t_\perp & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & t_\perp e^{ik_1} & t_\perp & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & t_\perp e^{ik_2} & t_\perp & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & t_\perp e^{-ik_2} & 0 & t_\perp e^{-ik_2} & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & t_\perp & t_\perp e^{ik_2} & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{pmatrix}$$

$$\psi_{Fe} = \begin{pmatrix}
c_{z_{+,1}} \\ c_{z_{+,2}} \\ c_{z_{+,3}} \\ c_{z_{-,1}} \\ c_{z_{-,2}} \\ c_{z_{-,3}} \\ c_{R_1} \\ c_{R_2} \\ c_{R_3} \\ c_{L_1} \\ c_{L_2} \\ c_{L_3} \\ c_{\pi,1} \\ c_{\pi,2} \\ c_{\pi,3}
\end{pmatrix}$$

$$\mathcal{H}_{Cr-Fe} = \begin{pmatrix}
0 & 0 & 0 & 0 & 0 & 0 & t_z e^{ik_3} & t'_z e^{ik_3} & t'_z e^{i(-k_1-k_2+k_3)} & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & t'_z e^{ik_3} & t_z e^{ik_3} & t'_z e^{i(-k_1-k_2+k_3)} & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & t'_z e^{i(k_1+k_2+k_3)} & t'_z e^{i(k_1+k_2+k_3)} & t_z e^{ik_3} & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & t_z e^{ik_3} & t & t & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & t'_z e^{ik_3} & t & t & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & t'_z e^{i(k_1+k_2+k_3)} & t & t & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & t_\perp e^{-ik_1} & t_\perp e^{-ik_1} & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & t_\perp e^{ik_1} & 0 & t_\perp & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & t_\perp e^{ik_1} & t_\perp & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & t_\perp e^{ik_2} & t_\perp & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & t_\perp e^{-ik_2} & 0 & t_\perp e^{-ik_2} & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & t_\perp & t_\perp e^{ik_2} & 0 & 0 & 0 & 0 \\
t'_z & t' & t' e^{ik_3} & t_z e^{ik_3} & t & t & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
t'_z e^{ik_3} & t' e^{ik_3} & t' & t_z e^{ik_3} & t & t & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
t_z e^{ik_3} & t e^{ik_3} & t e^{ik_3} & t_z e^{ik_3} & t & t & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{pmatrix}$$

$$\mathcal{H}_{NM} = \begin{pmatrix} 1 & 0 \\ 0 & 0 \end{pmatrix} \bigotimes \mathcal{H}_{Cr-Cr} + \begin{pmatrix} 0 & 1 \\ 0 & 0 \end{pmatrix} \bigotimes \mathcal{H}_{Cr-Fe} + \begin{pmatrix} 0 & 0 \\ 1 & 0 \end{pmatrix} \bigotimes \mathcal{H}^\dagger_{Cr-Fe} + \begin{pmatrix} 0 & 0 \\ 0 & 1 \end{pmatrix} \bigotimes \mathcal{H}_{Fe-Fe}$$