List of Figures

The terms contributing to the cluster diagrams arising from the form of V_N as shown in the figure below are,

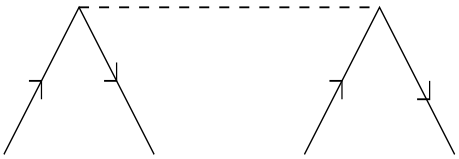


Figure 1: Particle-hole, particle-hole form of V_N

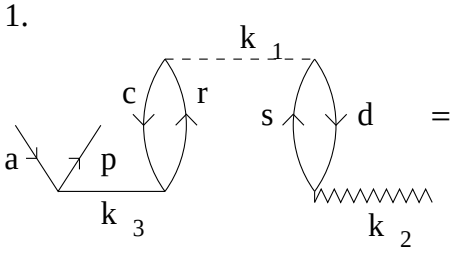
$$\langle \Phi_{ab}^{rs} | V_N T_2^{(0)} T_1^{(1)} + V_N T_2^{(0)} T_2^{(1)} + V_N T_1^{(0)} T_2^{(1)} + V_N T_2^{(0)} T_1^{(0)} T_1^{(1)} + \frac{1}{2} V_N T_1^{(0)} T_1^{(0)} T_2^{(1)} +$$

$$\frac{1}{2} V_N T_1^{(0)} T_1^{(0)} T_1^{(1)} + \frac{1}{6} V_N T_1^{(0)} T_1^{(0)} T_1^{(0)} T_1^{(1)} | \Phi_0 \rangle \qquad (1)$$

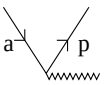
In the list of figures, figures from Page No. 4 to Page No. 22 refer to the cluster diagrams arising from the V_N given in Fig. 1. The notation used to denote the form of V_N is as follows:

- The Coulomb matrix element is written in order of the vertices, first vertex-1, then vertex-2. For each of the vertices, first the annihilated particle/hole index is mentioned, then the created particle/hole index is mentioned. For example the above diagram is denoted as (particle-hole, particle-hole) form of V_N.

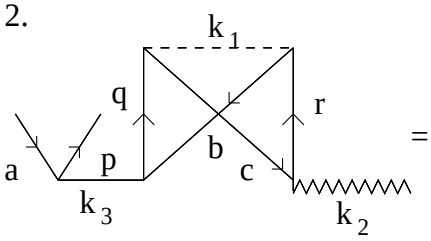
1.



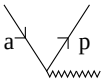
$$= \frac{\delta(k_2, k_3)\,\delta(k_1, k_3)}{[k_3]\,[k_3]}\,(-1)^{J_r + J_s + J_c + J_d}$$



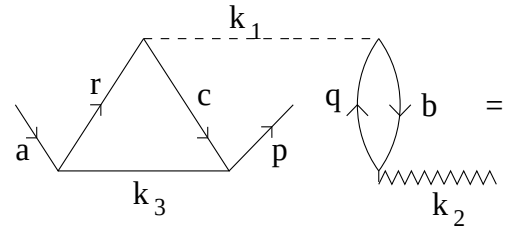
2.



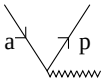
$$= \frac{\delta(k_2, k_3)}{[k_3]}\,(-1)^{J_b + J_r + J_q + J_c + 2J_b} \begin{Bmatrix} k_1 & J_r & J_b \\ k_3 & J_q & J_c \end{Bmatrix}$$



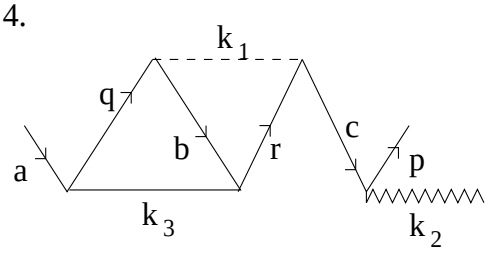
3.



$$= \frac{\delta(k_2, k_1)}{[k_1]}\,(-1)^{J_q + J_b + J_c + J_r + 2J_b} \begin{Bmatrix} k_1 & J_p & J_a \\ k_3 & J_r & J_c \end{Bmatrix}$$



4.



$$= \frac{\delta(J_a, J_c)}{[J_a]}\,(-1)^{J_q + J_b + J_a + J_r + 2J_r}$$

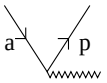
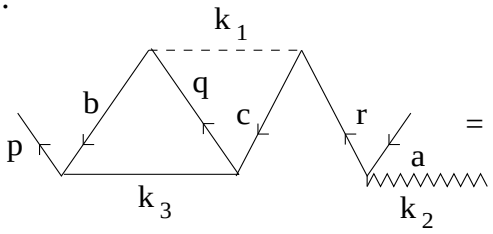
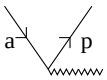


Figure 2: Diagrams contributing to $V_N T_2^{(0)} T_1^{(1)}$

5.



$$= \frac{\delta(J_p, J_r)}{[J_p]} (-1)^{J_b + J_q + J_p + J_c + 2J_q} \begin{Bmatrix} k_1 & J_q & J_b \\ k_3 & J_p & J_c \end{Bmatrix}$$



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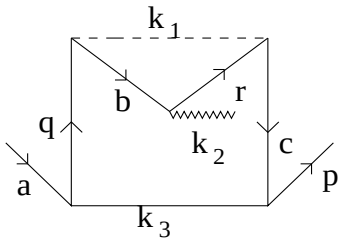
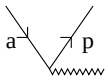
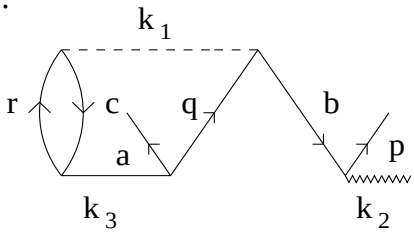


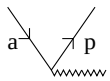
$$= (-1)^{J_b + J_q + J_c + J_r} \begin{Bmatrix} k_2 & J_q & J_c \\ k_1 & J_r & J_b \end{Bmatrix} \begin{Bmatrix} k_2 & J_p & J_a \\ k_3 & J_q & J_c \end{Bmatrix}$$



7.



$$= \frac{\delta(k_1, k_3)}{[k_1]} \frac{\delta(J_b, J_a)}{[J_b]} (-1)^{J_a + J_q + J_r + J_c}$$



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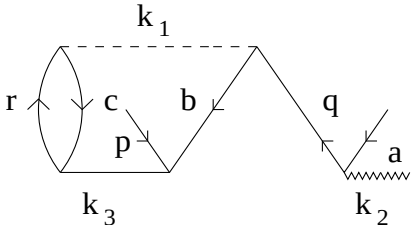


$$= \frac{\delta(k_1, k_3)}{[k_1]} \frac{\delta(J_p, J_q)}{[J_q]} (-1)^{J_r + J_c + J_q + J_b}$$

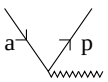
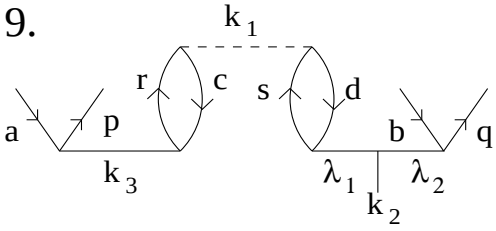
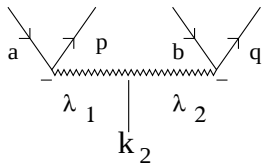


Figure 3: Diagrams contributing to $V_N T_2^{(0)} T_1^{(1)}$

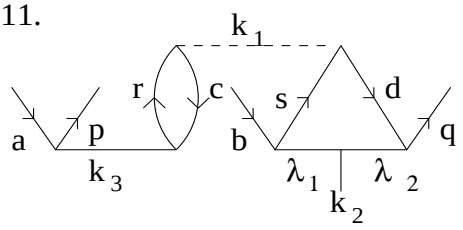
9.



$$= \frac{\delta(\lambda_1, k_3)}{[k_3]} \frac{\delta(k_3, k_1)}{[k_1]} (-1)^{J_r + J_c + J_s + J_d}$$

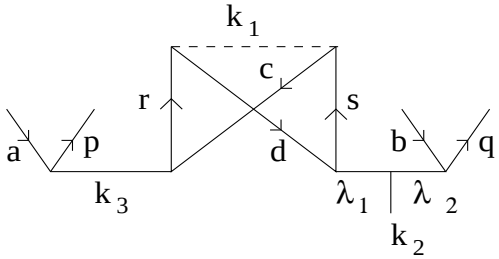


11.

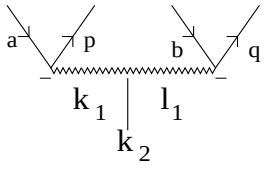


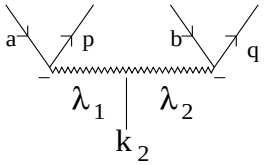
$$= \sum_{l_1} [l_1] \frac{\delta(k_1, k_3)}{[k_1]} (-1)^{J_r + J_c + J_d + J_q} (-1)^{k_1 + k_2 + \lambda_1} \begin{Bmatrix} J_s & J_b & \lambda_1 \\ k_1 & l_1 & k_2 \\ J_d & J_q & \lambda_2 \end{Bmatrix}$$

13.

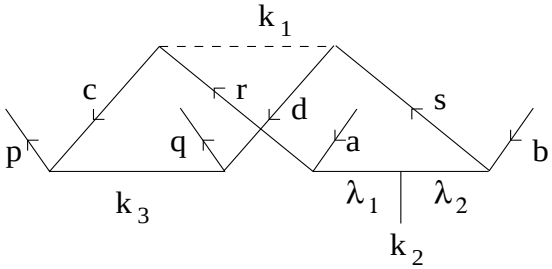


$$= \frac{\delta(\lambda_1, k_3)}{[k_3]} (-1)^{3J_c + J_r + J_d + J_s} \begin{Bmatrix} J_s & J_c & k_1 \\ \lambda_1 & J_r & J_d \end{Bmatrix}$$





15.



$$= \sum_{l_1 l_2 \lambda} [l_1 l_2 \lambda] (-1)^{J_r + J_a + J_b + J_s + 2J_d} (-1)^{\lambda + l_2 + k_2 + \lambda_2} \begin{Bmatrix} k_1 & k_3 & \lambda \\ J_p & J_r & J_c \end{Bmatrix} \begin{Bmatrix} J_d & J_q & k_3 \\ \lambda & k_1 & J_s \end{Bmatrix} \begin{Bmatrix} l_1 & l_2 & k_2 \\ \lambda_2 & \lambda_1 & \lambda \end{Bmatrix} \begin{Bmatrix} \lambda & \lambda_2 & l_2 \\ J_b & J_q & J_s \end{Bmatrix} \begin{Bmatrix} \lambda & l_1 & \lambda_1 \\ J_a & J_r & J_p \end{Bmatrix}$$

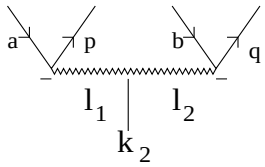


Figure 4: Diagrams contributing to $V_N T_2^{(0)} T_2^{(1)}$

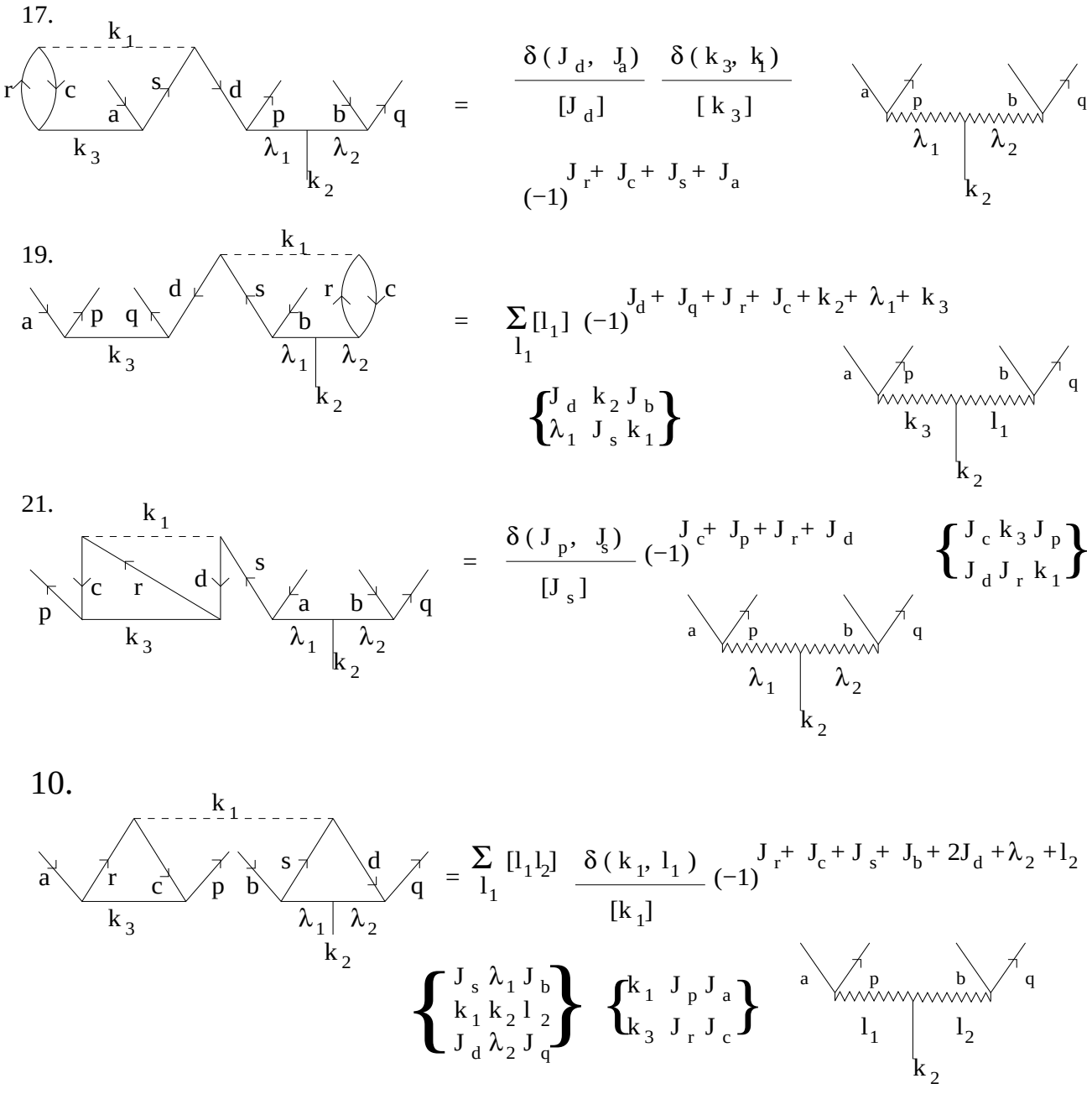
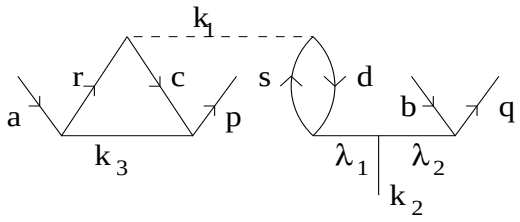
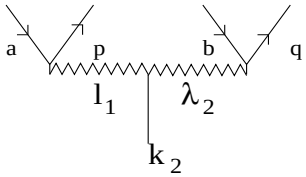


Figure 5: Diagrams contributing to $V_N T_2^{(0)} T_2^{(1)}$

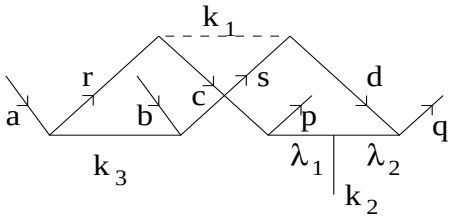
12.



$$= \sum_{l_1} [l_1]\,(-1)^{J_r + J_c + J_s + J_d + k_1 + l_1 + 2J_p}\, \delta(k_1, l_1)\, \frac{\delta(l_1, \lambda_1)}{[l_1]\,[k_1]} \begin{Bmatrix} k_1 & J_p & J_a \\ k_3 & J_r & J_c \end{Bmatrix}$$

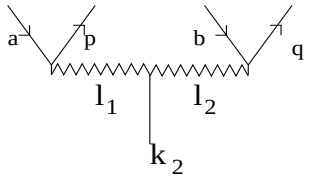


14.

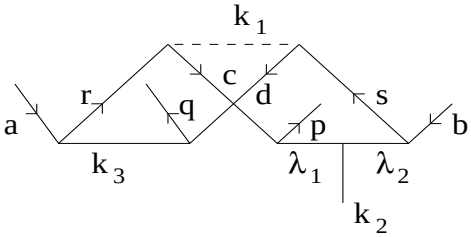


$$= \sum_{\substack{l_1, l_2, \\ l_1', l_2'}} [l_1, l_2, l_1', l_2']\,(-1)^{J_r + J_q + J_d + J_a + \lambda_1 + l_2 + l_1' + l_1 + k_3} \begin{Bmatrix} k_1 & \lambda_1 & l_1' \\ J_p & J_r & J_c \end{Bmatrix} \begin{Bmatrix} k_1 & l_2' & \lambda_2 \\ J_q & J_d & J_s \end{Bmatrix} \begin{Bmatrix} l_1' & l_1 & k_3 \\ J_a & J_r & J_p \end{Bmatrix}$$

$$\begin{Bmatrix} l_2' & l_2 & k_3 \\ l_1 & l_1' & k_2 \end{Bmatrix} \begin{Bmatrix} l_2' & k_3 & l_2 \\ J_b & J_q & J_s \end{Bmatrix} \begin{Bmatrix} l_1' & l_2' & k_2 \\ \lambda_2 & \lambda_1 & k_1 \end{Bmatrix}$$



16.



$$= \sum_{\substack{l_1, l_2, \\ \lambda}} [l_1\ l_2\ \lambda]\,(-1)^{J_c + J_b + J_p + J_s + k_1 + l_1 + \lambda_2 + k_2 + \lambda + l_2 + k_3 + \lambda_1} \begin{Bmatrix} k_1 & k_3 & \lambda \\ J_a & J_c & J_r \end{Bmatrix} \begin{Bmatrix} k_1 & \lambda & k_3 \\ J_q & J_d & J_s \end{Bmatrix} \begin{Bmatrix} \lambda & l_1 & \lambda_1 \\ J_p & J_c & J_a \end{Bmatrix}$$

$$\begin{Bmatrix} l_2 & k_2 & l_1 \\ \lambda_1 & \lambda & \lambda_2 \end{Bmatrix} \begin{Bmatrix} \lambda & \lambda_2 & l_1 \\ J_b & J_q & J_s \end{Bmatrix}$$

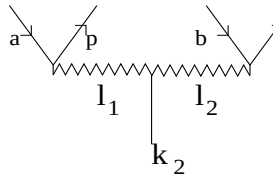
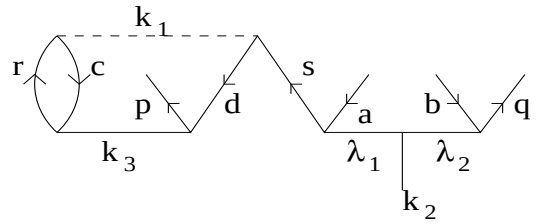


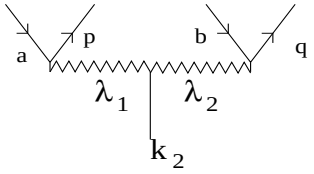
Figure 6: Diagrams contributing to $V_N T_2^{(0)} T_2^{(1)}$

18.

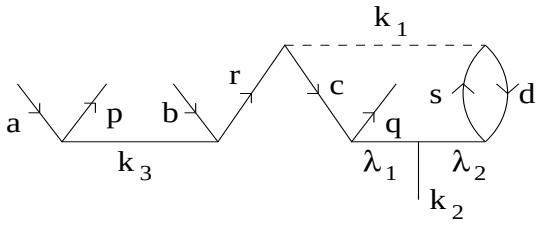


$$= \frac{\delta(k_1, k_3)}{[k_1]} \quad \frac{\delta(J_p, J_s)}{[J_s]}$$

$$(-1)^{J_r + J_c + J_d + J_p}$$

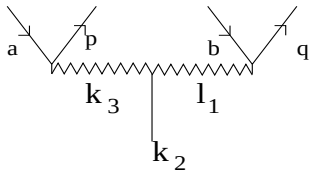


20.

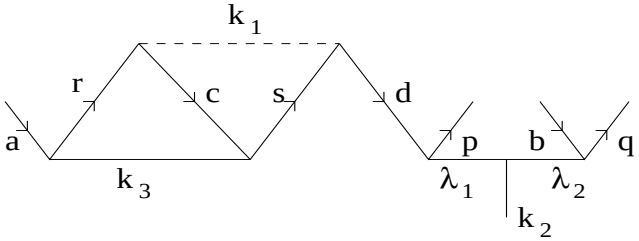


$$= \frac{\delta(k_1, \lambda_2)}{[k_1]} \sum_{l_1} [l_1] \; (-1)^{J_s + J_d + J_r + J_b + k_1 + k_2 + l_1}$$

$$\begin{Bmatrix} J_b & J_q & l_1 \\ k_2 & k_3 & J_r \end{Bmatrix} \quad \begin{Bmatrix} J_c & \lambda_1 & J_q \\ k_2 & J_r & k_1 \end{Bmatrix}$$



22.



$$= (-1)^{J_r + J_c + J_a + J_s} \begin{Bmatrix} J_s & J_a & k_1 \\ J_r & J_c & k_3 \end{Bmatrix}$$

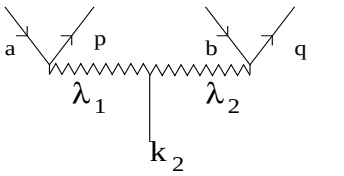
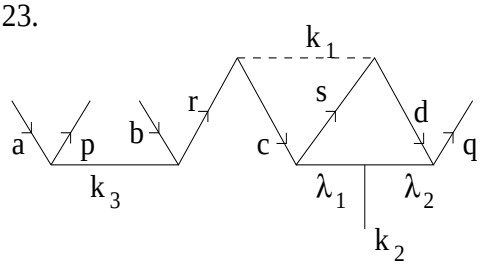
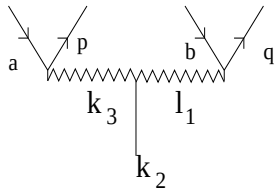


Figure 7: Diagrams contributing to $V_N T_2^{(0)} T_2^{(1)}$

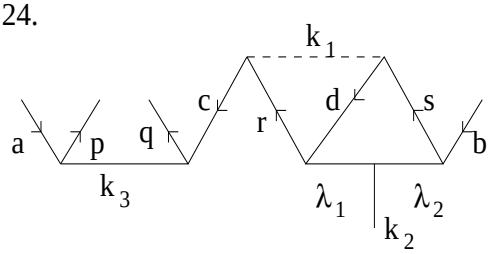
23.



$$= \sum_{l_1} [\,l_1\,]\ \ (-1)^{J_c + J_r + J_s + J_r + \lambda_2 + l_1 + J_r + J_b} \begin{Bmatrix} k_2 & l_1 & k_3 \\ J_b & J_r & J_q \end{Bmatrix} \begin{Bmatrix} J_r & J_d & \lambda_1 \\ J_s & J_c & k_1 \end{Bmatrix} \begin{Bmatrix} J_r & J_q & k_2 \\ \lambda_2 & \lambda_1 & J_d \end{Bmatrix}$$



24.



$$= \sum_{l_1} [\,l_1\,]\,(-1)^{J_r + J_d + J_c + J_q + 2J_b + \lambda_1 + k_3} \begin{Bmatrix} J_c & J_s & \lambda_1 \\ J_d & J_r & k_1 \end{Bmatrix} \begin{Bmatrix} k_1 & l_1 & k_3 \\ J_q & J_c & J_b \end{Bmatrix} \begin{Bmatrix} \lambda_1 & \lambda_2 & k_2 \\ J_b & J_c & J_s \end{Bmatrix}$$

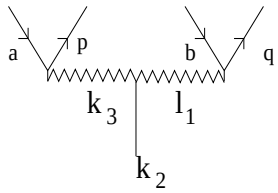
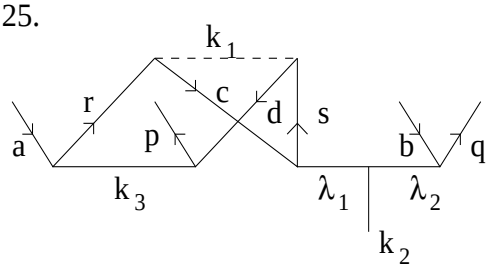
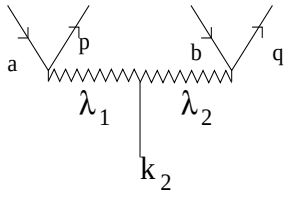


Figure 8: Diagrams contributing to $V_N T_2^{(0)} T_2^{(1)}$

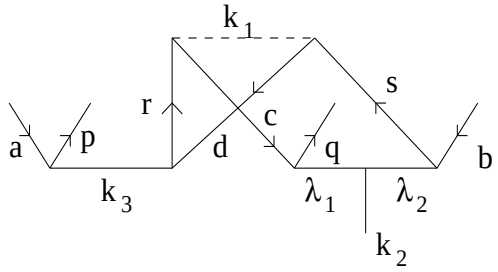
25.



$$= \sum_{l_1} [l_1] \frac{\delta(\lambda_1, l_1)}{[l_1]} (-1)^{J_c + J_s + J_r + J_d} \begin{Bmatrix} J_d & J_r & \lambda_1 \\ J_c & J_s & k_1 \end{Bmatrix} \begin{Bmatrix} J_r & J_d & \lambda_1 \\ J_p & J_a & k_3 \end{Bmatrix}$$



26.



$$= \sum_{l_1} [l_1] (-1)^{J_r + J_d + J_b + J_q + \lambda_2 + k_2 + J_q + l_1} \begin{Bmatrix} J_c & J_q & \lambda_1 \\ k_3 & l_1 & k_2 \\ J_s & J_b & \lambda_2 \end{Bmatrix}$$

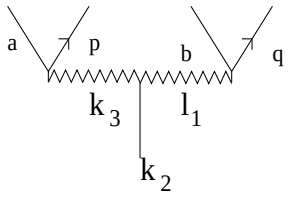
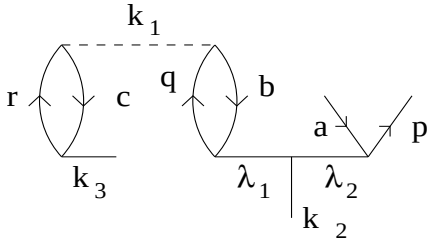
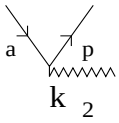


Figure 9: Diagrams contributing to $V_N T_2^{(0)} T_2^{(1)}$

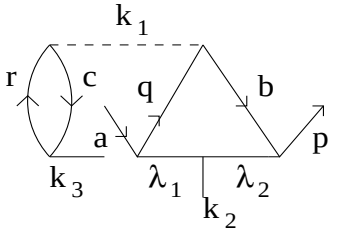
27.



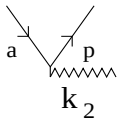
$$= \delta(k_1, 0)\,\delta(k_1, \lambda_1)\;\delta(k_2, \lambda_2)\;[k_2]^{-1/2}\;(-1)^{J_r + J_c + J_q + J_b}\;\delta(J_r, J_c)$$



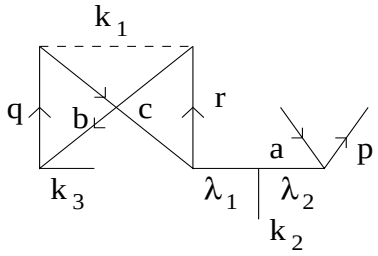
28.



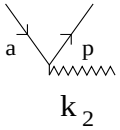
$$= \delta(k_1, 0)\;\delta(J_q, J_b)\,(-1)^{J_r + J_c + J_a + J_p}\;(-1)^{2J_c + k_1 + \lambda_1 + \lambda_2}\;[J_b]^{-1/2}\;\begin{Bmatrix} J_a & J_p & k_2 \\ \lambda_2 & \lambda_1 & J_q \end{Bmatrix}\;\delta(J_r, J_c)$$



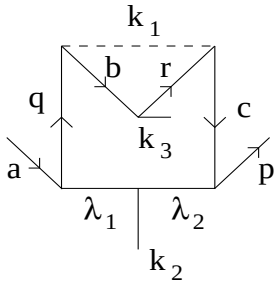
29.



$$= \delta(J_q, J_b)\;\frac{\delta(J_c, J_r)}{[J_c]}\;(-1)^{J_q + J_c + k_1}\;[J_c]^{1/2}\;\delta(\lambda_1, 0)\;\delta(k_2, \lambda_2)\;[\lambda_2]^{-1/2}\;[J_b]^{-1/2}$$



30.



$$= \delta(J_r, J_b)\;(-1)^{2J_p + J_q + J_b + J_a + J_p}\;\delta(J_q, J_c)\;(-1)^{k_1 + \lambda_1 + \lambda_2}\;\frac{[J_b]^{-1/2}}{[J_q]}\;\begin{Bmatrix} J_a & J_p & k_2 \\ \lambda_2 & \lambda_1 & J_q \end{Bmatrix}$$

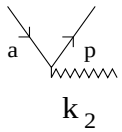
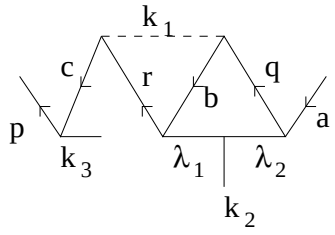
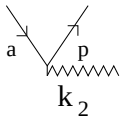


Figure 10: Diagrams contributing to $V_N T_1^{(0)} T_2^{(1)}$

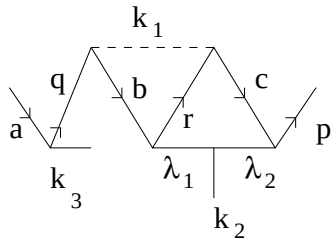
31.



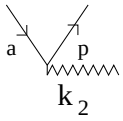
$$= \delta(J_p, J_c)\,[J_p]^{-1/2}\,(-1)^{J_p + J_b + J_r + J_a + \lambda_1 + k_2} \begin{Bmatrix} J_p & J_q & \lambda_1 \\ J_b & J_r & k_1 \end{Bmatrix} \begin{Bmatrix} J_p & J_a & k_2 \\ \lambda_2 & \lambda_1 & J_q \end{Bmatrix}$$



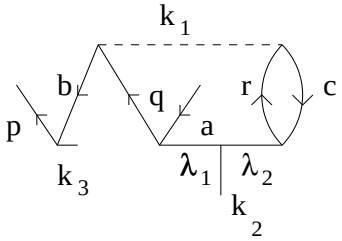
32.



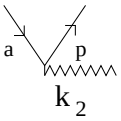
$$= \delta(J_q, J_a)\,[J_q]^{-1/2}\,(-1)^{J_a + J_r + J_b + J_p + \lambda_2} \begin{Bmatrix} J_a & J_c & \lambda_1 \\ J_r & J_b & k_1 \end{Bmatrix} \begin{Bmatrix} J_a & J_p & k_2 \\ \lambda_2 & \lambda_1 & J_c \end{Bmatrix}$$



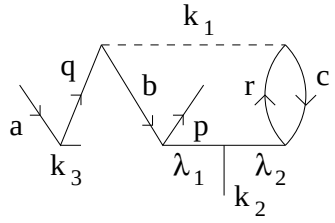
33.



$$= \delta(J_p, J_b)\,[J_b]^{-1/2}\,\frac{\delta(k_1, \lambda_2)}{[k_1]}\,(-1)^{J_a + J_p + J_r + J_c + 2J_c + \lambda_1} \begin{Bmatrix} J_p & k_2 & J_a \\ \lambda_1 & J_q & k_1 \end{Bmatrix}$$



34.



$$= \delta(J_q, J_a)\,[J_q]^{-1/2}\,\frac{\delta(k_1, \lambda_2)}{[k_1]}\,(-1)^{J_a + J_p + J_r + J_c + 2J_b + k_1 + k_2} \begin{Bmatrix} J_a & k_2 & J_p \\ \lambda_1 & J_b & k_1 \end{Bmatrix}$$

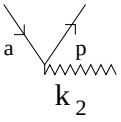
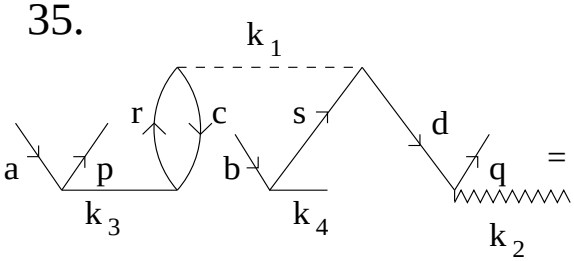
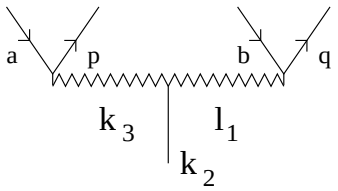


Figure 11: Diagrams contributing to $V_N T_1^{(0)} T_2^{(1)}$

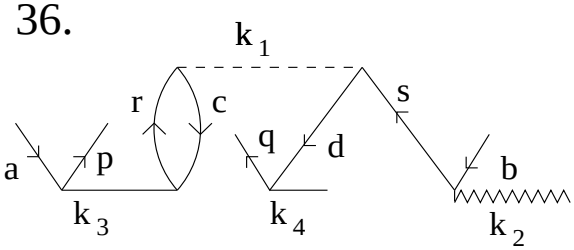
35.



$$= (-1)^{J_r + J_c + J_b + J_q + 2J_d + k_3 + l_1} \sum_{l_1} [l_1] \frac{\delta(k_1, k_3)}{[k_1]} [J_b]^{-1/2} \delta(J_b, J_s) \begin{Bmatrix} k_3 & k_2 & l_1 \\ J_q & J_b & J_d \end{Bmatrix}$$



36.



$$= (-1)^{J_r + J_c + J_b + J_q + 2J_s + k_1 + k_2 + k_3} \sum_{l_1} [l_1] \frac{\delta(k_1, k_3)}{[k_1]} [J_q]^{-1/2} \delta(J_q, J_d) \begin{Bmatrix} k_3 & k_2 & l_1 \\ J_b & J_q & J_s \end{Bmatrix}$$

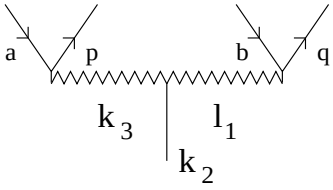
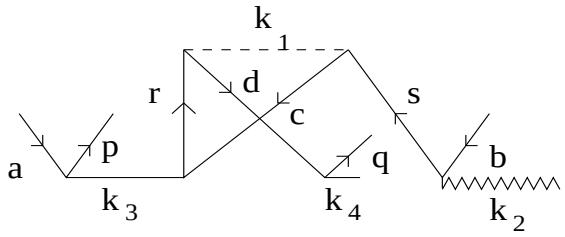


Figure 12: Diagrams contributing to $V_N T_2^{(0)} T_1^{(0)} T_1^{(1)}$

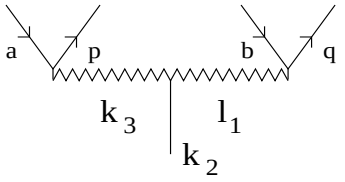
37.



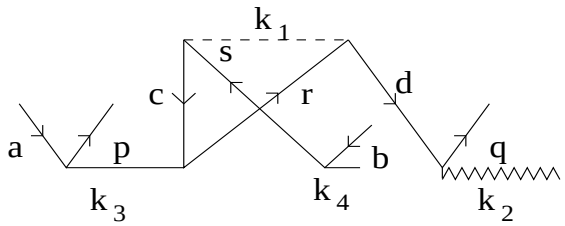
$$= \sum_{l_1} [l_1]\ (-1)^{J_b + J_q + J_r + J_c + k_2}$$

$$\delta(J_q, J_d)\ [J_q]^{-1/2} \begin{Bmatrix} J_q & J_s & k_3 \\ J_c & J_r & k_1 \end{Bmatrix}$$

$$\begin{Bmatrix} k_3 & k_2 & l_1 \\ J_b & J_q & J_s \end{Bmatrix}$$



38.



$$= \sum_{l_1} [l_1]\ (-1)^{J_c + J_b + J_r + J_q + l_1 + k_3}$$

$$\delta(J_s, J_b)\ [J_s]^{-1/2} \begin{Bmatrix} J_b & J_d & k_3 \\ J_r & J_c & k_1 \end{Bmatrix}$$

$$\begin{Bmatrix} l_1 & k_3 & k_2 \\ J_d & J_q & J_b \end{Bmatrix}$$

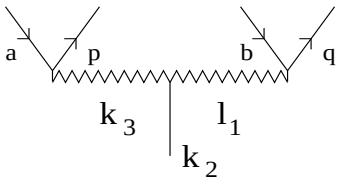
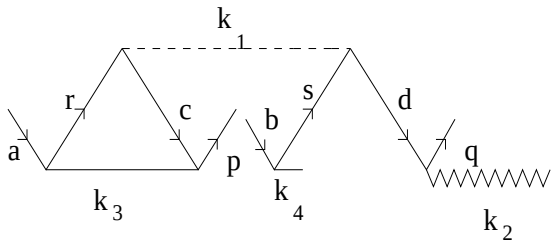
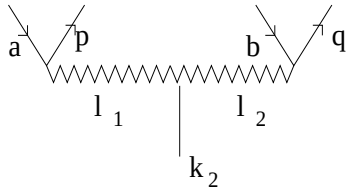


Figure 13: Diagrams contributing to $V_N T_2^{(0)} T_1^{(0)} T_1^{(1)}$

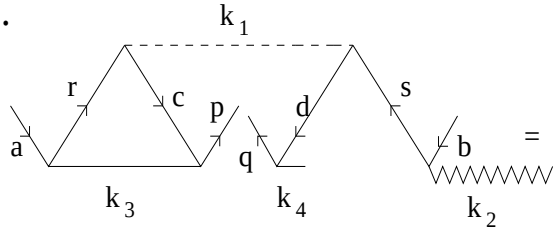
39.



$$= \sum_{l_1, l_2} [l_1 l_2] \quad (-1)^{J_r + J_c + J_q + J_b + l_1 + l_2} \quad \frac{\delta(k_1, l_1)}{[k_1]} \quad \delta(J_b, J_s) \, [J_b]^{-1/2} \quad \begin{Bmatrix} J_p & J_a & l_1 \\ J_r & J_c & k_3 \end{Bmatrix} \quad \begin{Bmatrix} J_q & J_b & J_d \\ l_1 & k_2 & l_2 \end{Bmatrix}$$



40.



$$= \sum_{l_1, l_2} [l_1 l_2] \quad (-1)^{J_b + J_q + J_c + J_r + k_2} \quad \delta(J_q, J_d) \quad [J_q]^{-1/2} \quad \frac{\delta(k_1, l_1)}{[k_1]} \quad \begin{Bmatrix} J_p & J_a & k_1 \\ J_r & J_c & k_3 \end{Bmatrix} \quad \begin{Bmatrix} k_1 & k_2 & l_2 \\ J_b & J_q & J_s \end{Bmatrix}$$

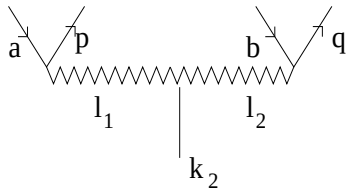
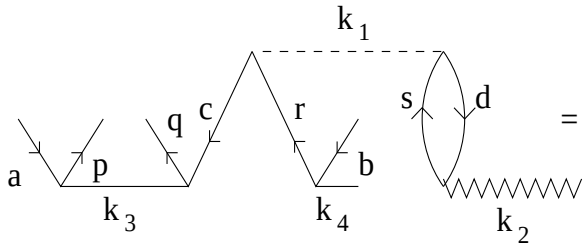
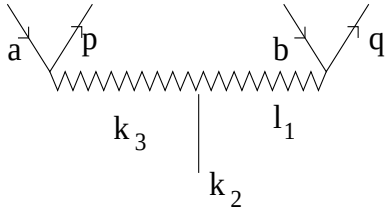


Figure 14: Diagrams contributing to $V_N T_2^{(0)} T_1^{(0)} T_1^{(1)}$

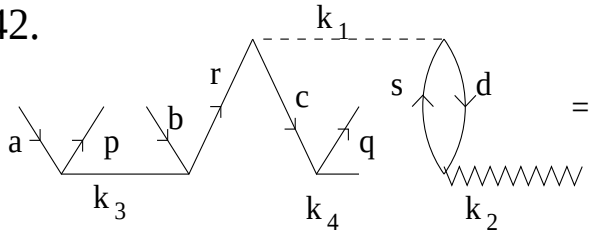
41.



$$= \sum_{l_1} [\, l_1 \,] \quad (-1)^{J_s + J_d + J_b + J_q + 2J_d + k_3} \quad \delta(J_r, J_b) \quad [J_b]^{-1/2} \quad \frac{\delta(k_1, k_2)}{[k_1]} \quad \begin{Bmatrix} k_2 & l_1 & k_3 \\ J_q & J_c & J_b \end{Bmatrix}$$



42.



$$= \sum_{l_1} [\, l_1 \,] \quad (-1)^{J_r + J_q + J_b + J_d + J_s + J_r + k_1 + l_1} \quad \delta(J_c, J_q) \quad [J_c]^{-1/2} \quad \frac{\delta(k_1, k_2)}{[k_1]} \quad \begin{Bmatrix} k_1 & l_1 & k_3 \\ J_b & J_r & J_q \end{Bmatrix}$$

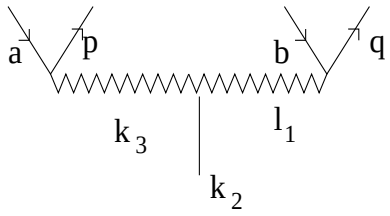
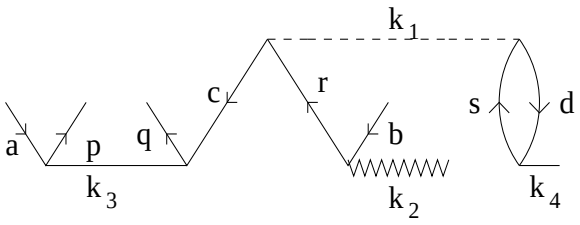
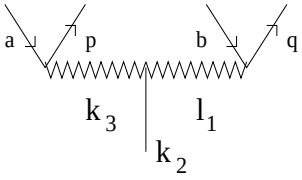


Figure 15: Diagrams contributing to $V_N T_2^{(0)} T_1^{(0)} T_1^{(1)}$

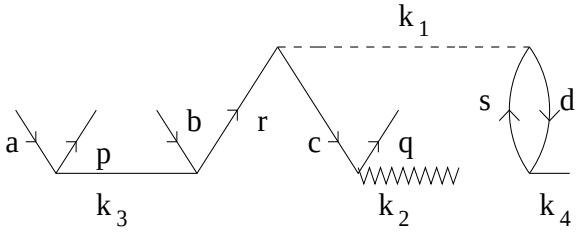
43.



$$= \sum_{l_1} [l_1]\ (-1)^{J_s+J_d+J_b+J_q+2J_q+k_1+k_2+k_3} \frac{\delta(k_1,k_4)}{[k_1]}\ \delta(J_r, J_c)\ [J_r]^{-1/2} \begin{Bmatrix} k_3 & k_2 & l_1 \\ J_b & J_q & J_r \end{Bmatrix}$$



44.



$$= \sum_{l_1} [l_1]\ (-1)^{J_s+J_d+J_r+J_b+J_r+J_q+k_1+l_1} \frac{\delta(k_1,k_4)}{[k_1]}\ \delta(J_r, J_c)\ [J_r]^{-1/2} \begin{Bmatrix} k_3 & k_2 & l_1 \\ J_q & J_b & J_r \end{Bmatrix}$$

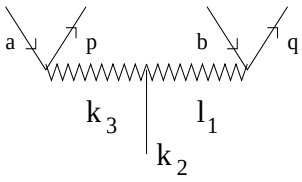
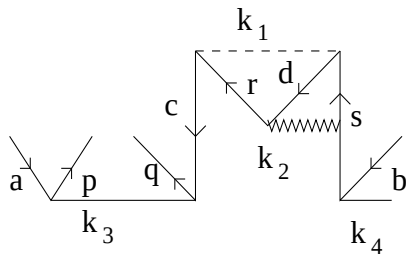
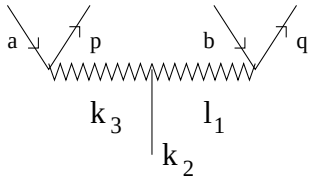


Figure 16: Diagrams contributing to $V_N T_2^{(0)} T_1^{(0)} T_1^{(1)}$

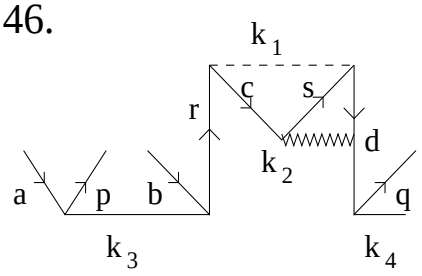
45.



$$= \sum_{l_1} [l_1]\ \delta(J_s, J_b)\ [J_s]^{-1/2}\ (-1)^{J_r + J_d + J_b + J_q + k_3} \begin{Bmatrix} J_c & J_b & k_2 \\ J_d & J_r & k_1 \end{Bmatrix} \begin{Bmatrix} k_3 & k_2 & l_1 \\ J_b & J_q & J_c \end{Bmatrix}$$



46.



$$= \sum_{l_1} [l_1]\ \delta(J_q, J_d)\ [J_q]^{-1/2}\ (-1)^{J_c + J_s + J_q + J_b + k_2 + l_1} \begin{Bmatrix} J_r & J_q & k_2 \\ J_s & J_c & k_1 \end{Bmatrix} \begin{Bmatrix} k_3 & k_2 & l_1 \\ J_b & J_r & J_q \end{Bmatrix}$$

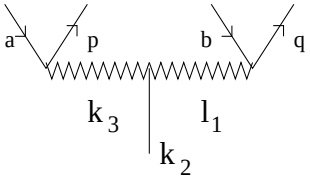
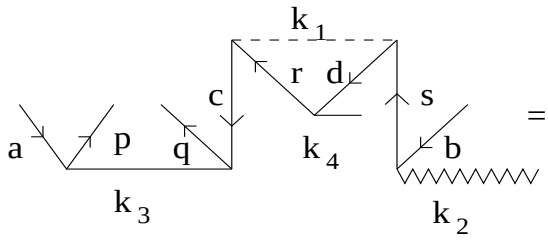
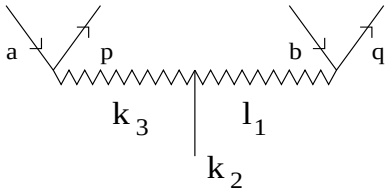


Figure 17: Diagrams contributing to $V_N T_2^{(0)} T_1^{(0)} T_1^{(1)}$

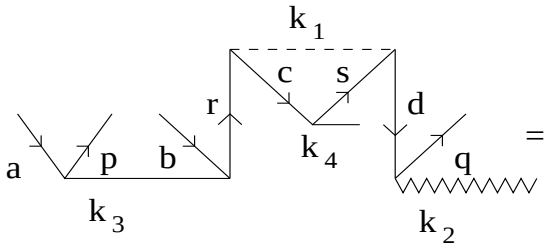
47.



$$= \sum_{l_1} [l_1]\,[J_r]^{-1/2}\,(-1)^{J_r+J_c+J_b+J_q+2J_c+k_1+k_2+k_3}\,\delta(J_r, J_d)\,\frac{\delta(J_s, J_c)}{[J_c]}\,\begin{Bmatrix} k_3 & k_2 & l_1 \\ J_b & J_q & J_c \end{Bmatrix}$$



48.



$$= \sum_{l_1} [l_1]\,[J_c]^{-1/2}\,(-1)^{J_r+J_c+J_b+J_q+2J_r+k_1+l_1}\,\delta(J_c, J_s)\,\frac{\delta(J_r, J_d)}{[J_r]}\,\begin{Bmatrix} k_3 & k_2 & l_1 \\ J_q & J_b & J_r \end{Bmatrix}$$

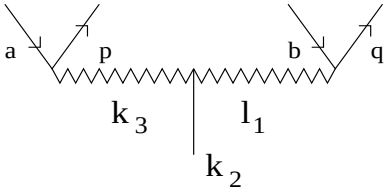
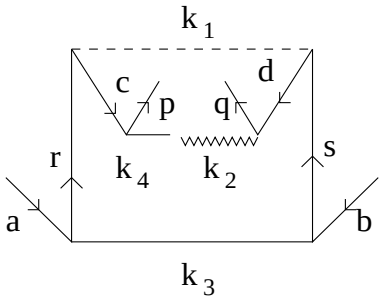


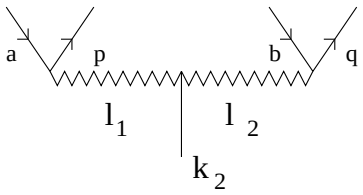
Figure 18: Diagrams contributing to $V_N T_2^{(0)} T_1^{(0)} T_1^{(1)}$

49.

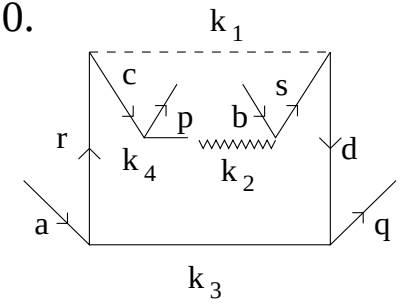


$$= \sum_{l_1',\, l_2} [\, l_1\, l_2\,]\ \delta(J_c,\, J_p)\,(-1)^{J_p + J_a + J_b + J_d + J_b + J_q + l_2}$$

$$[\, J_c\,]^{-1/2} \begin{Bmatrix} l_1 & l_2 & k_2 \\ J_q & J_d & J_b \end{Bmatrix} \begin{Bmatrix} k_1 & l_1 & k_3 \\ J_a & J_r & J_p \end{Bmatrix} \begin{Bmatrix} J_d & J_b & l_1 \\ k_3 & k_1 & J_s \end{Bmatrix}$$



50.



$$= \sum_{l_1,\, l_2} [\, l_1\, l_2\,]\, \delta(J_c,\, J_p)\,(-1)^{J_b + J_s + 2J_a + J_p + J_a + k_1 + k_3 + k_2}$$

$$[\, J_p\,]^{-1/2} \begin{Bmatrix} l_1 & l_2 & k_2 \\ J_b & J_s & J_q \end{Bmatrix} \begin{Bmatrix} k_1 & l_1 & k_3 \\ J_a & J_r & J_p \end{Bmatrix} \begin{Bmatrix} J_s & J_q & l_1 \\ k_3 & k_1 & J_d \end{Bmatrix}$$

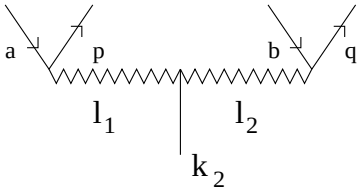
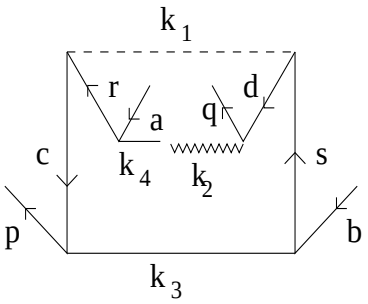


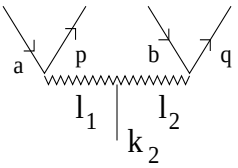
Figure 19: Diagrams contributing to $V_N T_2^{(0)} T_1^{(0)} T_1^{(1)}$

51.

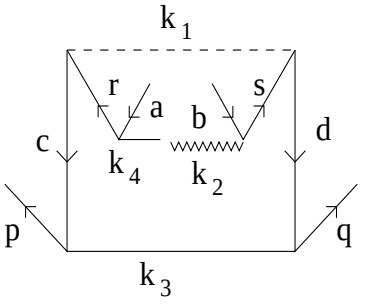


$$= \sum_{l_1,\, l_2} [l_1 l_2]\ \delta(J_r, J_a)\ (-1)^{J_d + J_a + J_p + J_q + k_1 + k_3 + l_1 + l_2 + 2J_d}$$

$$[J_a]^{-1/2} \begin{Bmatrix} k_1 & l_1 & k_3 \\ J_p & J_c & J_a \end{Bmatrix} \begin{Bmatrix} J_d & J_b & l_1 \\ k_3 & k_1 & J_s \end{Bmatrix} \begin{Bmatrix} l_1 & l_2 & k_2 \\ J_q & J_d & J_b \end{Bmatrix}$$



52.



$$= \sum_{l_1,\, l_2} [l_1 l_2]\ \delta(J_r, J_a)\ (-1)^{J_s + J_b + J_a + J_p + 2J_b + k_2 + l_1}$$

$$[J_a]^{-1/2} \begin{Bmatrix} k_1 & l_1 & k_3 \\ J_p & J_c & J_a \end{Bmatrix} \begin{Bmatrix} J_s & J_q & l_1 \\ k_3 & k_1 & J_d \end{Bmatrix} \begin{Bmatrix} l_1 & l_2 & k_2 \\ J_b & J_s & J_q \end{Bmatrix}$$

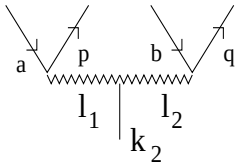
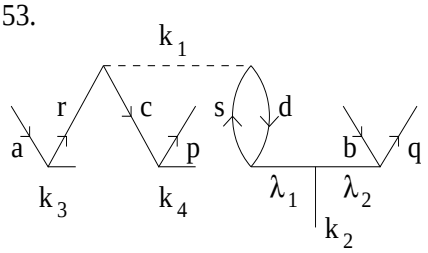
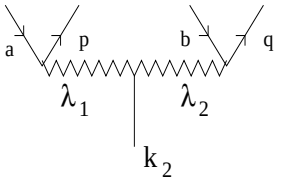


Figure 20: Diagrams contributing to $V_N T_2^{(0)} T_1^{(0)} T_1^{(1)}$

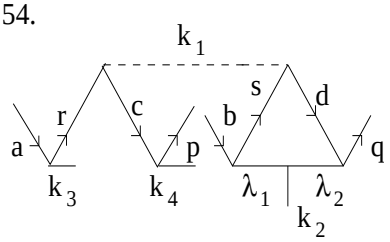
53.



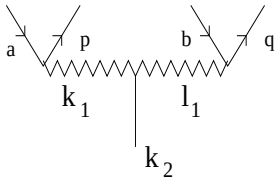
$$= \delta(J_r, J_a)\,\delta(J_p, J_c)\,[J_r\,J_p]^{-1/2}\,\frac{\delta(k_1, \lambda_1)}{[k_1]}\,(-1)^{J_s + J_d + 2J_d + k_1}$$



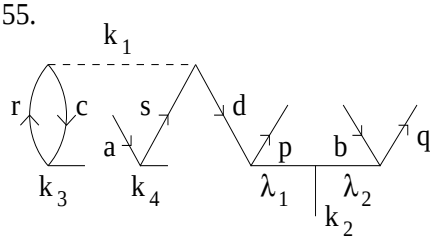
54.



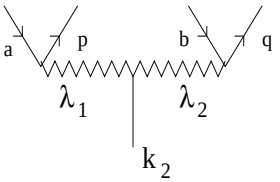
$$= \delta(J_r, J_a)\,\delta(J_c, J_p)\,[J_r\,J_p]^{-1/2}\,(-1)^{J_b + J_s + 2J_q} \sum_{l_1} [l_1]\,(-1)^{l_1 + k_1 + \lambda_2} \begin{Bmatrix} J_s & J_b & \lambda_1 \\ J_d & J_q & \lambda_2 \\ k_1 & l_1 & k_2 \end{Bmatrix}$$



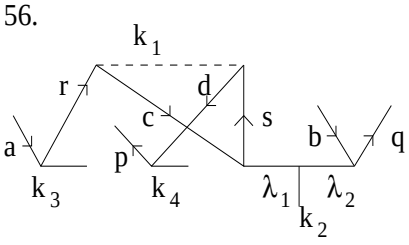
55.



$$= \frac{\delta(k_1, k_3)}{[k_1]}\,\delta(J_s, J_a)\,\delta(J_a, J_c)\,[J_s\,J_a]^{-1/2}\,(-1)^{J_r + J_d + J_a + J_c}$$



56.



$$= \delta(J_r, J_a)\,\delta(J_p, J_d)\,[J_r\,J_p]^{-1/2}\,(-1)^{J_c + J_s + \lambda_1} \begin{Bmatrix} J_a & J_p & \lambda_1 \\ J_s & J_c & k_1 \end{Bmatrix}$$

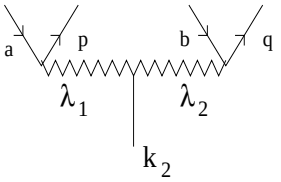
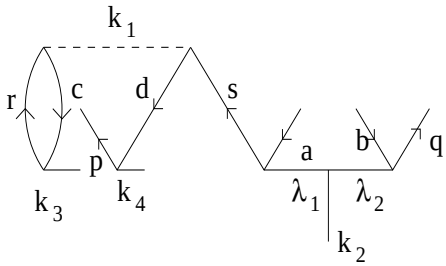


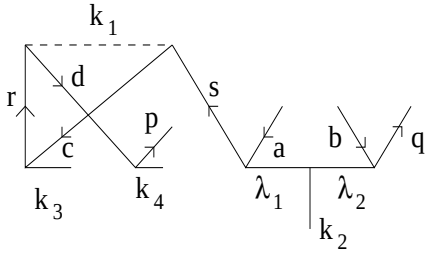
Figure 21: Diagrams contributing to $V_N T_1^{(0)} T_1^{(0)} T_2^{(1)}$

57.



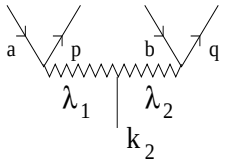
$$= \frac{\delta(k_1, 0)}{[k_1]}\ \delta(J_p, J_d)\,[J_p]^{-1/2}\ \delta(J_p, J_s)\,[J_p]^{-1/2}$$

58.

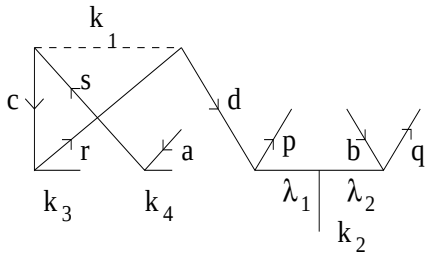


$$= \delta(J_r, J_c)\ \delta(J_d, J_p)\,\frac{[J_r J_p]^{-1/2}}{[J_p]}\ \delta(J_p, J_s)$$

$$(-1)^{J_r + J_c + 2J_c + k_1}$$

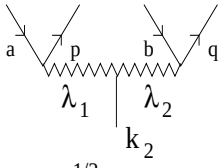


59.

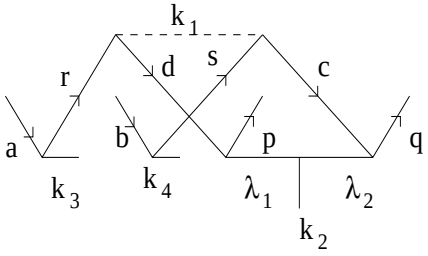


$$= \delta(J_s, J_a)\,\frac{\delta(J_a, J_d)}{[J_a]}\,[J_c\ J_s]^{-1/2}\,\delta(J_r, J_c)$$

$$(-1)^{J_p + J_r + 2J_p + k_1}$$



60.



$$= \delta(J_r, J_a)\,\delta(J_s, J_b)\,[J_r\ J_s]^{-1/2} \sum_{l_1,\, l_2} [l_1\ l_2]$$

$$(-1)^{J_a + J_b + J_p + J_q + l_1 + k_1 + k_2 + \lambda_1}$$

$$\begin{Bmatrix} k_1 & \lambda_1 & l_1 \\ J_p & J_a & J_d \end{Bmatrix} \begin{Bmatrix} l_2 & k_2 & l_1 \\ \lambda_1 & k_1 & \lambda_2 \end{Bmatrix} \begin{Bmatrix} k_1 & l_2 & \lambda_2 \\ J_q & J_c & J_b \end{Bmatrix}$$

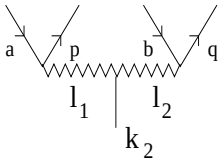
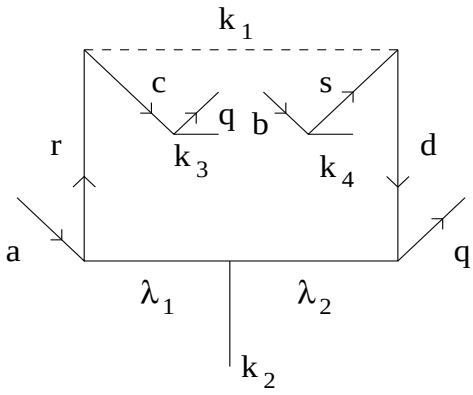
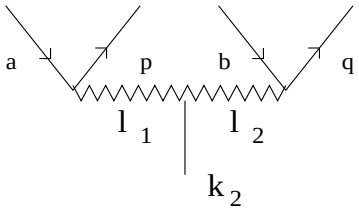


Figure 22: Diagrams contributing to $V_N T_1^{(0)} T_1^{(0)} T_2^{(1)}$

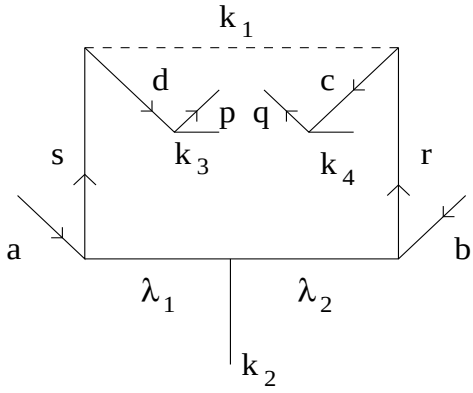
61.



$$= \delta(J_c, J_p)\ \delta(J_b, J_s)\ [J_b J_c]^{-1/2} \sum_{l_1 l_2} [l_1\ l_2]\ (-1)^{J_a + J_p + J_b + J_q + k_2} \begin{Bmatrix} k_1 & \lambda_1 & l_1 \\ J_a & J_p & J_r \end{Bmatrix} \begin{Bmatrix} l_2 & k_2 & l_1 \\ \lambda_1 & k_1 & \lambda_2 \end{Bmatrix} \begin{Bmatrix} k_1 & l_2 & \lambda_2 \\ J_q & J_d & J_b \end{Bmatrix}$$



62(a) .



$$= \delta(J_d, J_p)\ \delta(J_c, J_q)\ [J_p J_q]^{-1/2} \sum_{l_1 l_2} [l_1\ l_2]\ (-1)^{J_q + J_b + k_1 + \lambda_1 + 2J_p + k_2} \begin{Bmatrix} k_1 & \lambda_1 & l_1 \\ J_a & J_p & J_s \end{Bmatrix} \begin{Bmatrix} l_2 & k_2 & l_1 \\ \lambda_1 & k_1 & \lambda_2 \end{Bmatrix} \begin{Bmatrix} k_1 & l_2 & \lambda_2 \\ J_b & J_r & J_q \end{Bmatrix}$$

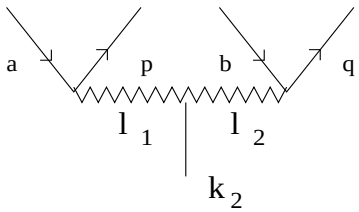
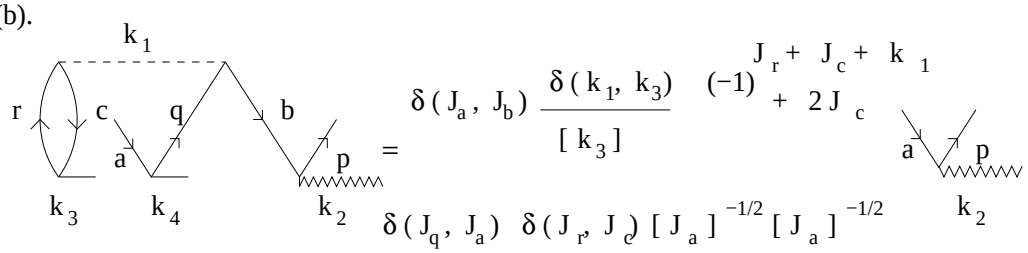
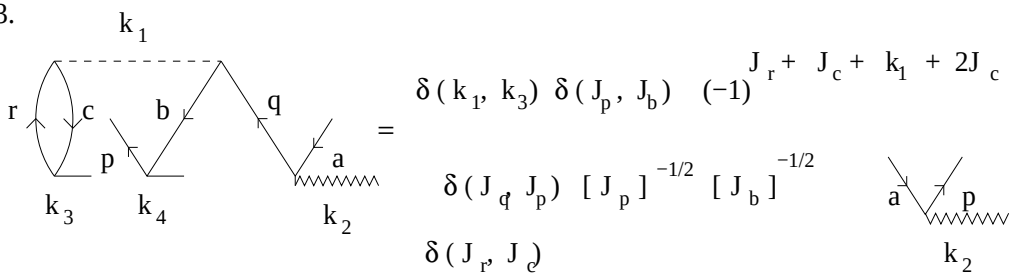


Figure 23: Diagrams contributing to $V_N T_1^{(0)} T_1^{(0)} T_2^{(1)}$

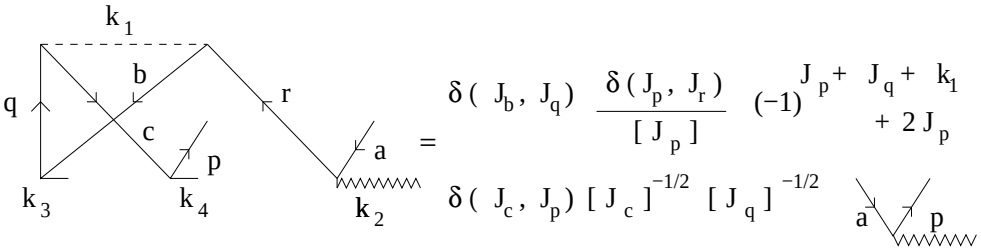
62(b).



63.



64.



65.

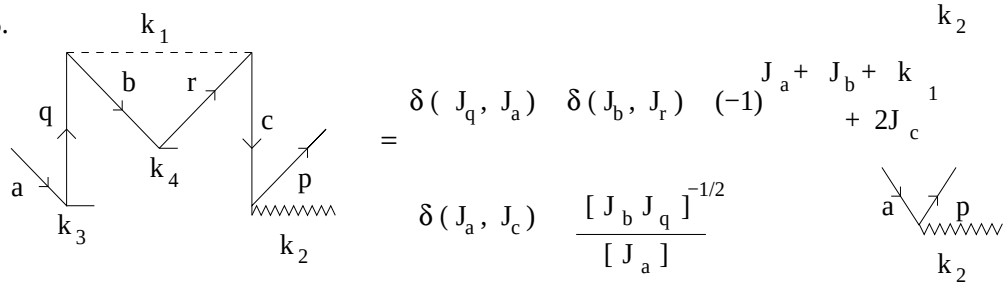
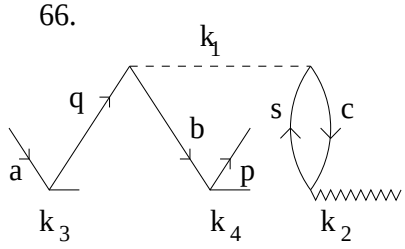
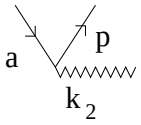


Figure 24: Diagrams contributing to $V_N T_1^{(0)} T_1^{(0)} T_1^{(1)}$

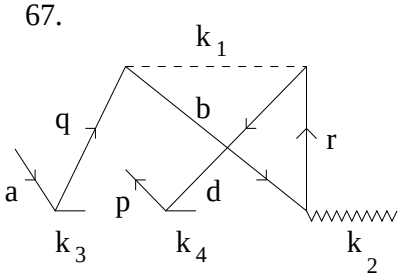
66.



$$= \delta(J_q, J_a)\ \delta(J_b, J_p)\ \frac{\delta(k_1, k_2)}{[k_2]}\ (-1)^{J_s + J_c + k_2 + 2J_c}\ [J_a\ J_b]^{-1/2}$$



67.



$$= \delta(J_q, J_a)\ \delta(J_p, J_d)\ [J_q J_d]^{-1/2}\ (-1)^{J_b + J_r + k_2} \begin{Bmatrix} J_a & J_p & k_2 \\ J_r & J_b & k_1 \end{Bmatrix}$$

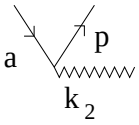
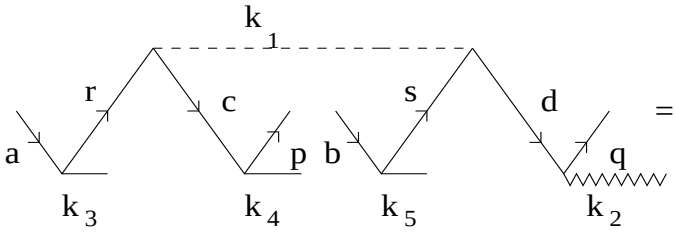


Figure 25: Diagrams contributing to $V_N T_1^{(0)} T_1^{(0)} T_1^{(1)}$

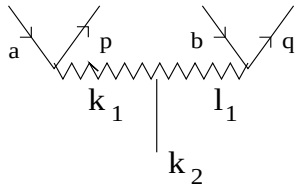
68.



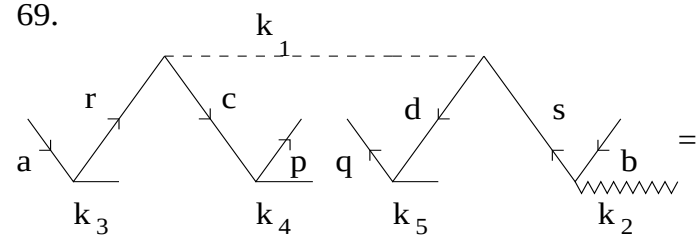
$$= \sum_{l_1} [l_1] \; \delta(J_a, J_r)\, \delta(J_p, J_c)$$

$$[J_a J_b J_p]^{-1/2} \; \delta(J_b, J_s)$$

$$(-1)^{J_b + J_q + l_1} \begin{Bmatrix} k_1 & k_2 & l_1 \\ J_q & J_b & J_d \end{Bmatrix}$$



69.



$$= \sum_{l_1} [l_1] \; \delta(J_r, J_a)\, \delta(J_c, J_p)$$

$$(-1)^{J_q + J_b + k_1 + k_2}$$

$$\delta(J_q, J_d) \; [J_a J_p J_q]^{-1/2} \begin{Bmatrix} J_b & k_2 & J_s \\ k_1 & J_q & l_1 \end{Bmatrix}$$

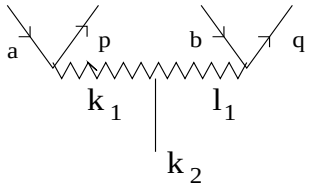
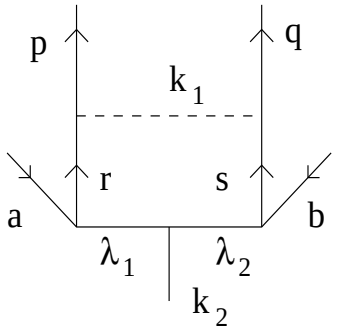
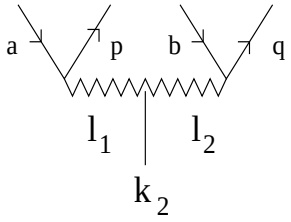


Figure 26: Diagrams contributing to $V_N T_1^{(0)} T_1^{(0)} T_1^{(0)} T_1^{(1)}$

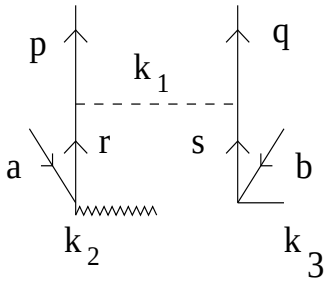
1.



$$= \sum_{l_1,\, l_2} [\, l_1\, l_2\,]\ (-1)^{J_a + J_p + J_b + J_q + k_1 + k_2 + l_2 + \lambda_2} \begin{Bmatrix} l_1 & k_1 & \lambda_1 \\ J_r & J_a & J_p \end{Bmatrix} \begin{Bmatrix} l_1 & l_2 & k_2 \\ \lambda_2 & \lambda_1 & k_1 \end{Bmatrix} \begin{Bmatrix} l_2 & \lambda_2 & k_1 \\ J_s & J_q & J_b \end{Bmatrix}$$



2.



$$= \delta(J_s, J_b)\ [J_s]^{-1/2} \sum_{\lambda} [\,\lambda\,]\ (-1)^{J_a + J_p + \lambda} \begin{Bmatrix} \lambda & k_2 & k_1 \\ J_r & J_p & J_a \end{Bmatrix}$$

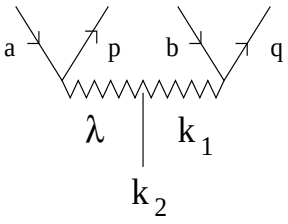
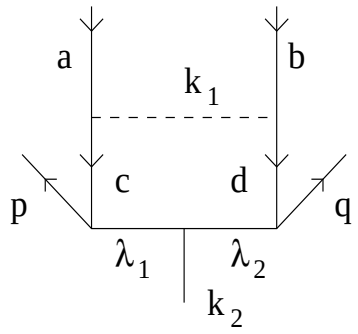
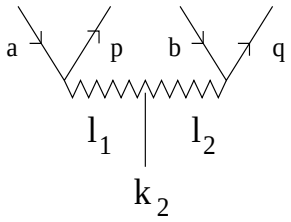


Figure 27: Cluster amplitude diagrams arising from (particle-particle , particle-particle) form of V_N

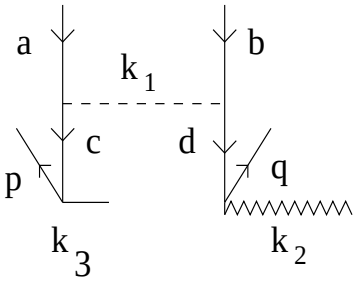
1.



$$= \sum_{l_1,\, l_2} [\, l_1\, l_2\,]\ (-1)^{\begin{matrix} J_a + J_p + J_b + J_q + \\ k_1 + k_2 + l_1 + \lambda_1 \end{matrix}} \begin{Bmatrix} l_1 & k_1 & \lambda_1 \\ J_c & J_p & J_a \end{Bmatrix} \begin{Bmatrix} l_1 & l_2 & k_2 \\ \lambda_2 & \lambda_1 & k_1 \end{Bmatrix} \begin{Bmatrix} l_2 & \lambda_2 & k_1 \\ J_d & J_b & J_q \end{Bmatrix}$$



2.



$$= \delta(J_c, J_p)\ [J_c]^{-1/2} \sum_{\lambda} [\,\lambda\,]\ (-1)^{J_b + J_q + \lambda} \begin{Bmatrix} \lambda & k_2 & k_1 \\ J_d & J_b & J_q \end{Bmatrix}$$

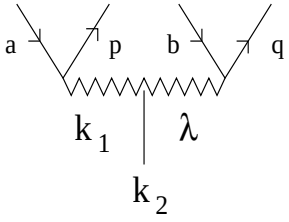
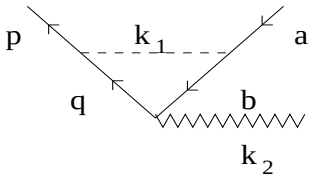
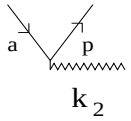


Figure 28: Cluster amplitude diagrams arising from (hole-hole , hole-hole) form of V_N

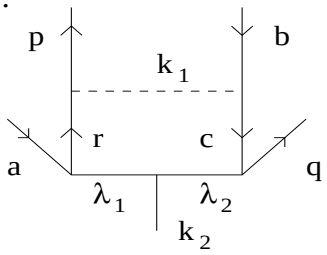
1.



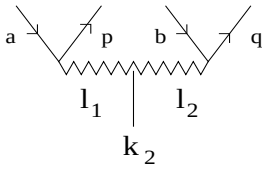
$$= (-1)^{J_q + J_b + k_2} \begin{Bmatrix} J_p & J_a & k_2 \\ J_b & J_q & k_1 \end{Bmatrix}$$



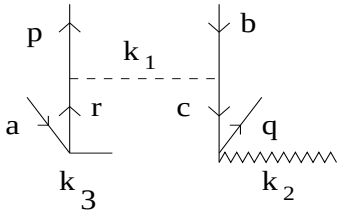
2.



$$= \sum_{l_1,\, l_2} [\, l_1\, l_2\,]\ (-1)^{J_a + J_p + J_b + J_q + k_2} \begin{Bmatrix} l_1 & k_1 & \lambda_1 \\ J_r & J_a & J_p \end{Bmatrix} \begin{Bmatrix} l_1 & l_2 & k_2 \\ \lambda_2 & \lambda_1 & k_1 \end{Bmatrix} \begin{Bmatrix} l_2 & \lambda_2 & k_1 \\ J_c & J_b & J_q \end{Bmatrix}$$



3.



$$= \delta(J_r, J_a)\ [J_r]^{-1/2} \sum_{\lambda} [\lambda]\ (-1)^{J_b + J_q + \lambda} \begin{Bmatrix} \lambda & k_2 & k_1 \\ J_c & J_b & J_q \end{Bmatrix}$$

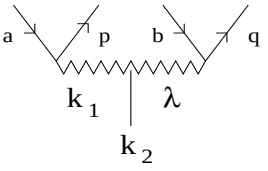
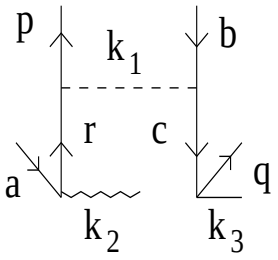
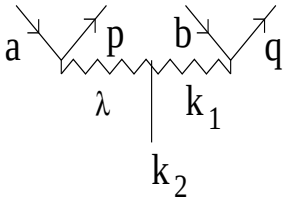


Figure 29: Cluster amplitude diagrams arising from (particle-particle, hole-hole) form of V_N

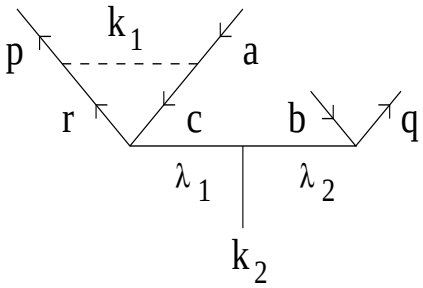
4.



$$= \delta(J_c, J_q)\ [J_q]^{-1/2} \sum_{\lambda} [\lambda]\ (-1)^{J_a + J_p + \lambda} \begin{Bmatrix} \lambda & k_1 & k_2 \\ J_r & J_a & J_p \end{Bmatrix}$$



5.



$$= \sum_{l_1} [l_1]\ \frac{\delta(l_1, \lambda_1)}{[l_1]}\ (-1)^{J_r + J_c + l_1} \begin{Bmatrix} l_1 & J_c & J_r \\ k_1 & J_p & J_a \end{Bmatrix}$$

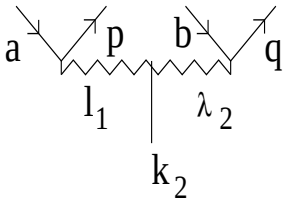
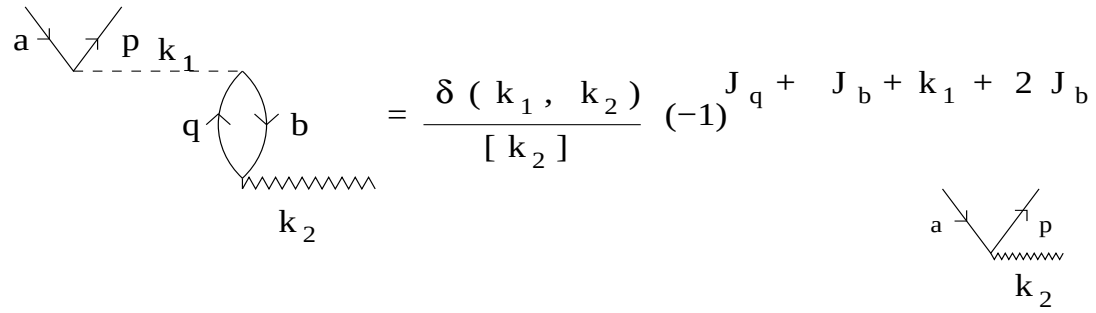
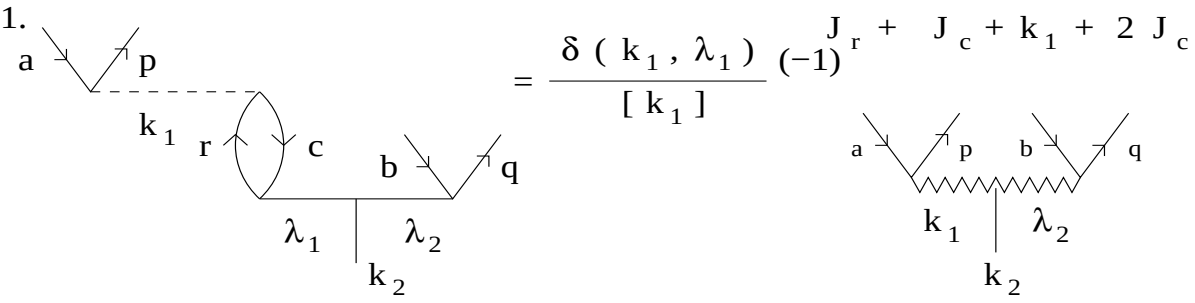


Figure 30: Cluster amplitude diagrams arising from (particle-particle, hole-hole) form of V_N

10.



11.



12.

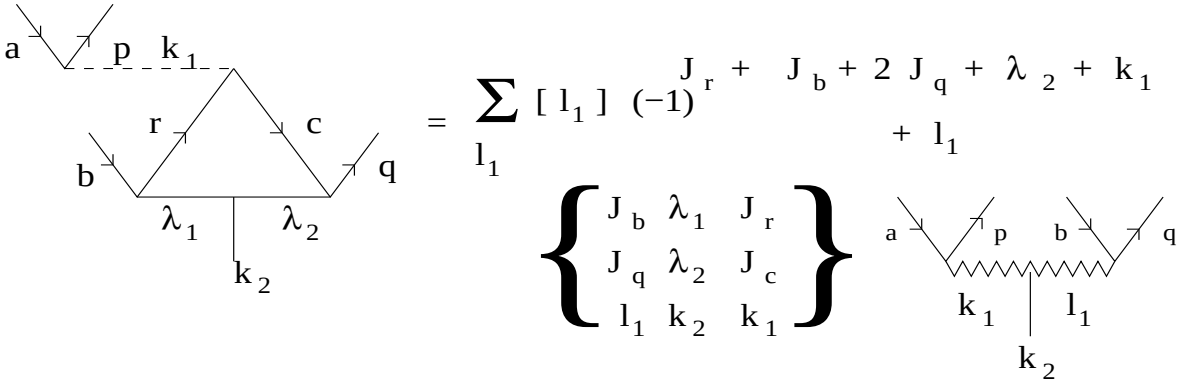
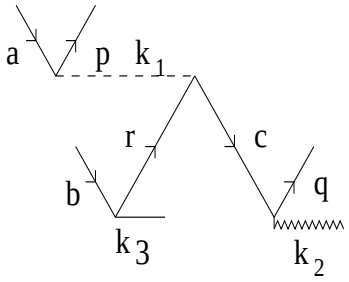
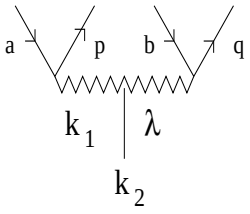


Figure 31: Cluster amplitude diagrams arising from the (hole-particle, particle-hole) form of V_N

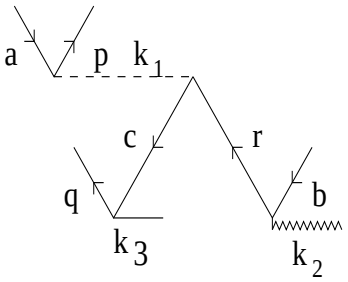
13.



$$= \delta(J_r, J_b)\,[J_b]^{-1/2} \sum_{\lambda} [\lambda]\,(-1)^{J_b + J_q + \lambda} \begin{Bmatrix} \lambda & k_2 & k_1 \\ J_c & J_b & J_q \end{Bmatrix}$$



14.



$$= \delta(J_c, J_q)\,[J_q]^{-1/2} \sum_{l_1} [l_1]\,(-1)^{J_q + J_b + k_1 + k_2} \begin{Bmatrix} l_1 & k_2 & k_1 \\ J_r & J_q & J_b \end{Bmatrix}$$

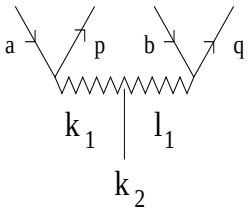
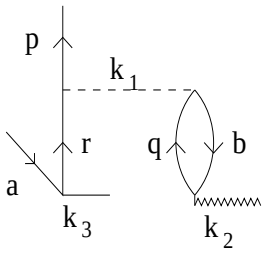
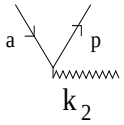


Figure 32: Cluster amplitude diagrams arising from the (hole-particle, particle-hole) form of V_N

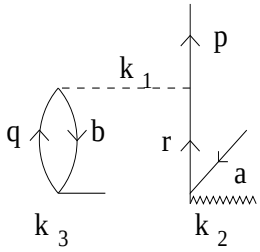
15.



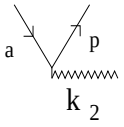
$$= \delta(J_r, J_a)\,[J_a]^{-1/2}\,\frac{\delta(k_1, k_2)}{[k_1]}\,(-1)^{J_q + J_b + k_1 + 2J_b}$$



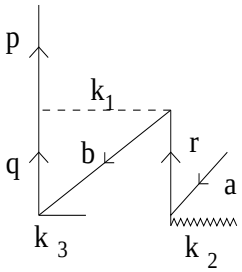
16.



$$= \frac{\delta(k_1, k_3)}{[k_1]}\,[J_p]^{-1/2}\,(-1)^{J_q + J_b + k_1 + 2J_b}\;\delta(J_q, J_b)$$



17.



$$= \delta(J_q, J_b)\,[J_q]^{-1/2}\,\frac{\delta(J_p, J_r)}{[J_p]}\,(-1)^{3J_p + J_q + k_1}$$

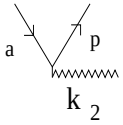
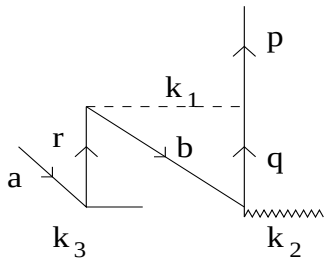
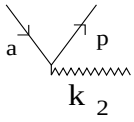


Figure 33: Cluster amplitude diagrams arising from the (particle-particle, particle-hole) form of V_N

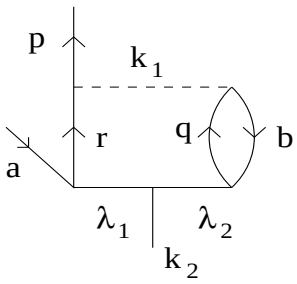
18.



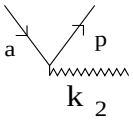
$$= \delta(J_r, J_a)\,[J_a]^{-1/2}\,(-1)^{J_b + J_q + k_2} \begin{Bmatrix} J_a & J_p & k_2 \\ J_q & J_b & k_1 \end{Bmatrix}$$



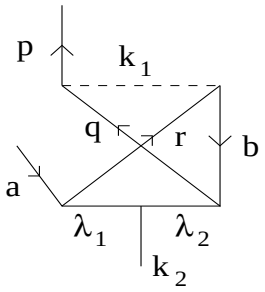
19.



$$= (-1)^{J_a + J_p + J_q + 3J_b + \lambda_1} \begin{Bmatrix} k_2 & J_a & J_p \\ J_r & \lambda_2 & \lambda_1 \end{Bmatrix}$$



20.



$$= (-1)^{J_a + J_p + J_q + J_b + \lambda_1} \begin{Bmatrix} J_r & J_p & \lambda_2 \\ J_q & J_b & k_1 \end{Bmatrix} \begin{Bmatrix} J_a & k_2 & J_p \\ \lambda_2 & J_r & \lambda_1 \end{Bmatrix}$$

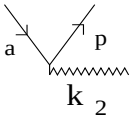
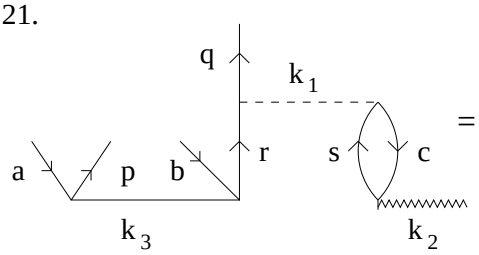
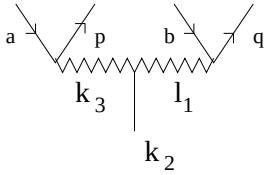


Figure 34: Cluster amplitude diagrams arising from the (particle-particle, particle-hole) form of V_N

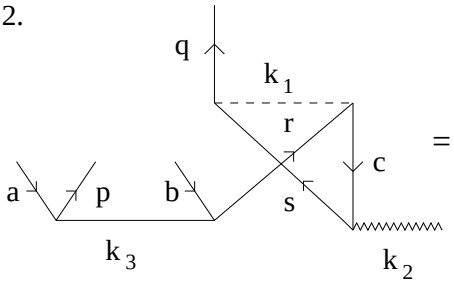
21.



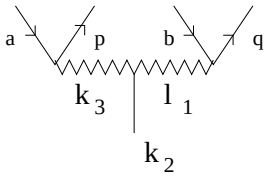
$$= \frac{\delta(k_1, k_2)}{[k_1]} \sum_{l_1} [l_1] (-1)^{3J_c + J_s + J_q + J_b + k_1 + l_1} \begin{Bmatrix} l_1 & k_1 & k_3 \\ J_r & J_b & J_q \end{Bmatrix}$$



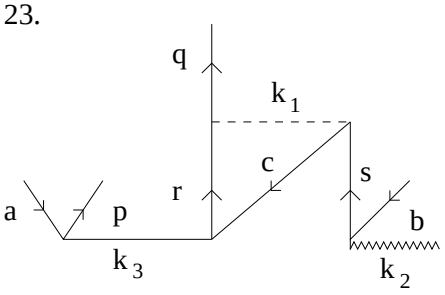
22.



$$= \sum_{l_1} [l_1] (-1)^{J_b + J_q + J_s + J_c + k_2 + l_1} \begin{Bmatrix} J_q & J_r & k_2 \\ J_c & J_s & k_1 \end{Bmatrix} \begin{Bmatrix} k_2 & k_3 & l_1 \\ J_b & J_q & J_r \end{Bmatrix}$$



23.



$$= \sum_{l_1} [l_1] (-1)^{J_r + J_c + J_q + J_b + k_2} \begin{Bmatrix} J_q & J_s & k_3 \\ J_c & J_r & k_1 \end{Bmatrix} \begin{Bmatrix} k_3 & k_2 & l_1 \\ J_b & J_q & J_s \end{Bmatrix}$$

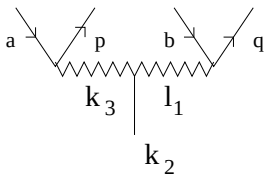
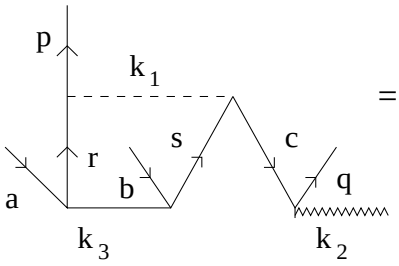
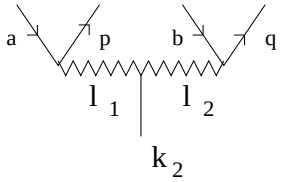


Figure 35: Cluster amplitude diagrams arising from the (particle-particle, particle-hole) form of V_N

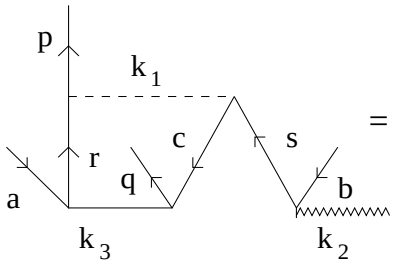
24.



$$= \sum_{l_1\ l_2} [\,l_1\ l_2\,]\ (-1)^{J_a + J_p + J_q + J_c + l_2 + 2J_s} \begin{Bmatrix} l_1 & k_1 & k_3 \\ J_r & J_a & J_p \end{Bmatrix} \begin{Bmatrix} l_1 & k_2 & l_2 \\ J_q & J_b & J_c \end{Bmatrix} \begin{Bmatrix} l_1 & J_c & J_b \\ J_s & k_3 & k_1 \end{Bmatrix}$$



25.



$$= \sum_{l_1\ l_2} [\,l_1\ l_2\,]\ (-1)^{J_a + J_p + J_s + J_b + 2J_q + k_1 + k_2 + k_3} \begin{Bmatrix} l_1 & k_1 & k_3 \\ J_r & J_a & J_p \end{Bmatrix} \begin{Bmatrix} J_s & J_q & l_1 \\ k_3 & k_1 & J_c \end{Bmatrix} \begin{Bmatrix} k_2 & l_2 & l_1 \\ J_q & J_s & J_b \end{Bmatrix}$$

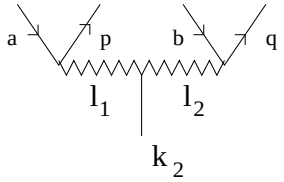
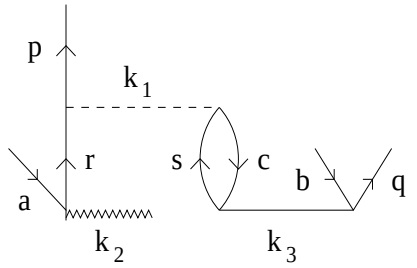
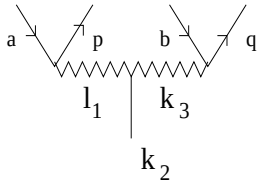


Figure 36: Cluster amplitude diagrams arising from the (particle-particle, particle-hole) form of V_N

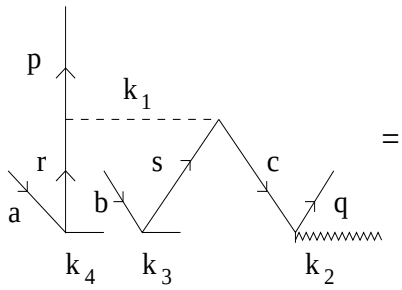
26.



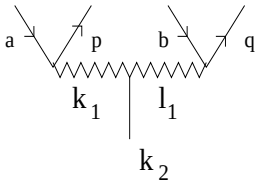
$$= \sum_{l_1} [l_1] \frac{\delta(k_3, k_1)}{[k_1]} (-1)^{J_a + J_p + J_c + J_s + 2J_r + l_1 + k_1} \begin{Bmatrix} l_1 & k_1 & k_2 \\ J_r & J_a & J_p \end{Bmatrix}$$



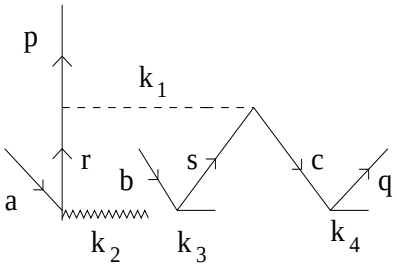
27.



$$= \delta(J_r, J_a)\, \delta(J_s, J_b)\, [J_r J_s]^{-1/2} \sum_{l_1} [l_1]\, (-1)^{J_b + J_q + l_1} \begin{Bmatrix} l_1 & k_2 & k_1 \\ J_c & J_b & J_q \end{Bmatrix}$$



28.



$$= \delta(J_s, J_b)\, \delta(J_c, J_q)\, [J_q J_s]^{-1/2} \sum_{l_1} [l_1]\, (-1)^{J_a + J_p + l_1} \begin{Bmatrix} l_1 & k_1 & k_2 \\ J_r & J_a & J_p \end{Bmatrix}$$

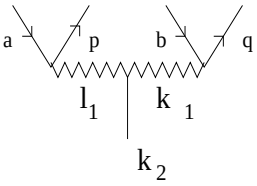
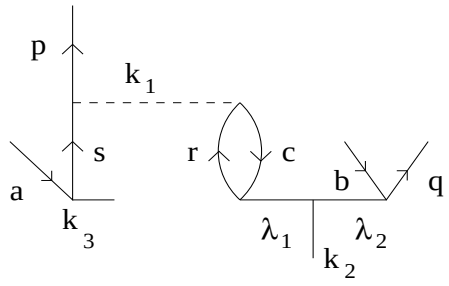
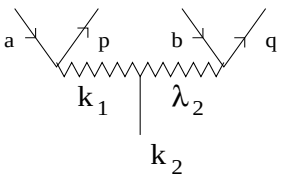


Figure 37: Cluster amplitude diagrams arising from the (particle-particle, particle-hole) form of V_N

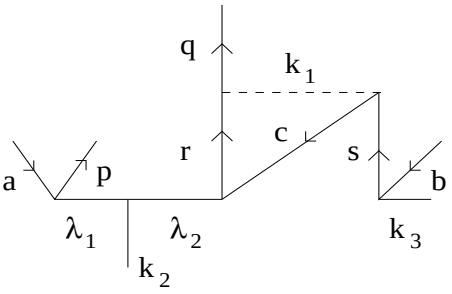
29.



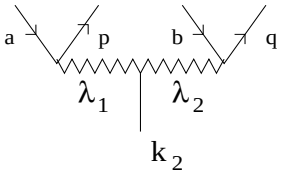
$$= \frac{\delta(k_1, \lambda_1)}{[k_1]} \, \delta(J_s, J_a) \, (-1)^{J_r + J_c + k_1 + 2J_c} \, [J_s]^{-1/2}$$



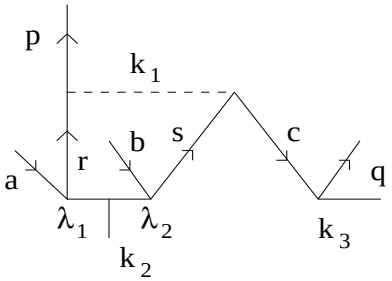
30.



$$= \delta(J_s, J_b) \, [J_s]^{-1/2} \, (-1)^{J_r + J_c + \lambda_2} \, \begin{Bmatrix} J_q & J_b & \lambda_2 \\ J_c & J_r & k_1 \end{Bmatrix}$$



31.



$$= \delta(J_c, J_q) \sum_{l_1 \, l_2} [l_1 \, l_2] \, (-1)^{J_q + J_b + J_a + J_p + k_1 + l_2 + \lambda_2 + k_2} \, [J_q]^{-1/2} \, \begin{Bmatrix} k_1 & \lambda_1 & l_1 \\ J_a & J_p & J_r \end{Bmatrix} \, \begin{Bmatrix} l_1 & l_2 & k_2 \\ \lambda_2 & \lambda_1 & k_1 \end{Bmatrix} \, \begin{Bmatrix} k_1 & l_2 & \lambda_2 \\ J_b & J_s & J_q \end{Bmatrix}$$

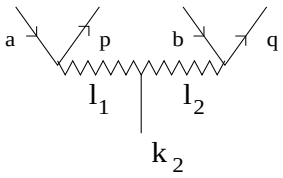
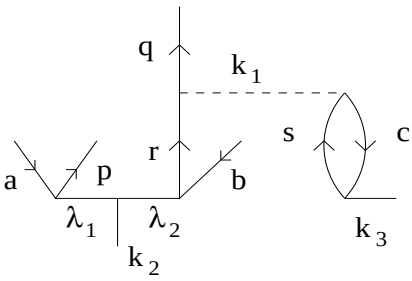
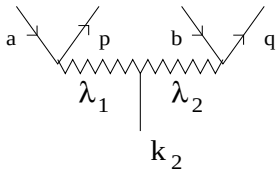


Figure 38: Cluster amplitude diagrams arising from the (particle-particle, particle-hole) form of V_N

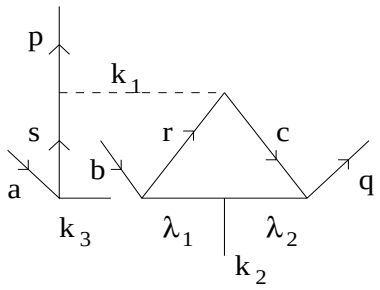
32.



$$= \delta(J_r, J_q)\,[J_r]^{-1/2}\,\delta(J_s, J_c)\;\delta(k_1, 0)$$

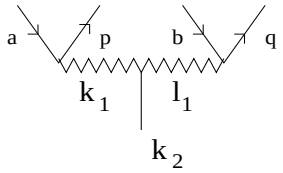


33.

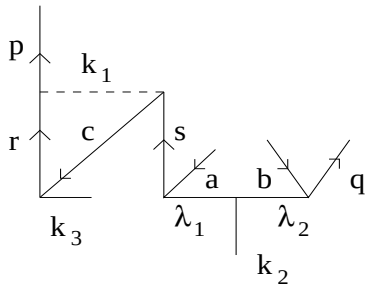


$$= \delta(J_c, J_a)\,[J_a]^{-1/2} \sum_{l_1} [l_1]\,(-1)^{J_r + J_b + 2J_c + \lambda_2 + k_1 + l_1}$$

$$\begin{Bmatrix} J_b & J_r & \lambda_1 \\ J_q & J_c & \lambda_2 \\ l_1 & k_1 & k_2 \end{Bmatrix}$$



34.



$$= \delta(J_r, J_c) \quad [J_r]^{-1/2} \quad \frac{\delta(J_s, J_p)}{[J_s]}$$

$$(-1)^{J_r + J_p + k_1 + 2J_s}$$

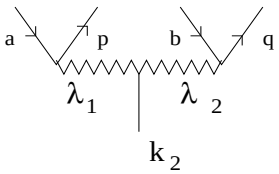
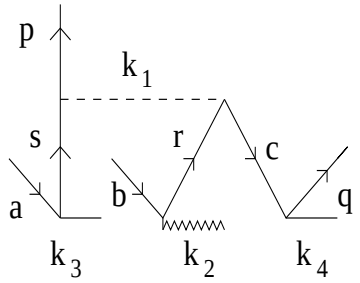
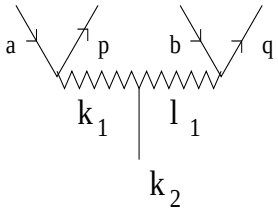


Figure 39: Cluster amplitude diagrams arising from the (particle-particle, particle-hole) form of V_N

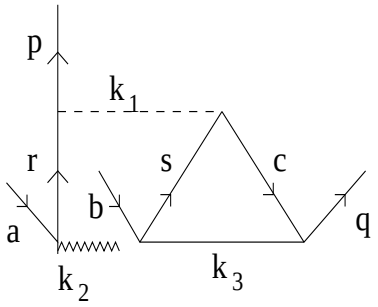
35.



$$= \sum_{l_1} [l_1]\, \delta(J_s, J_a)\, [J_a]^{-1/2}\, \delta(J_c, J_q)\, [J_q]^{-1/2}\, (-1)^{J_b + J_q + k_1 + k_2} \begin{Bmatrix} k_1 & l_1 & k_2 \\ J_b & J_r & J_q \end{Bmatrix}$$



36.



$$= \sum_{l_1} [l_1]\, (-1)^{J_c + J_s + k_1 + J_a + J_p + l_1} \begin{Bmatrix} k_1 & J_q & J_b \\ k_3 & J_s & J_c \end{Bmatrix} \begin{Bmatrix} l_1 & k_1 & k_2 \\ J_r & J_a & J_p \end{Bmatrix}$$

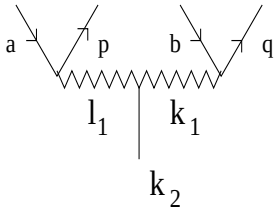
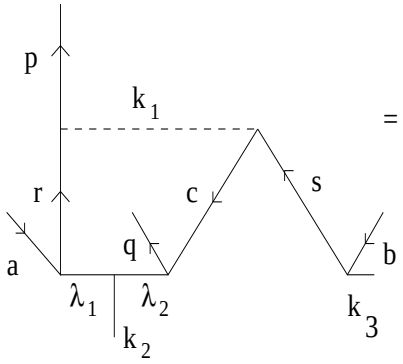


Figure 40: Cluster amplitude diagrams arising from the (particle-particle, particle-hole) form of V_N

37.



$$= \delta(J_b J_s)[J_b]^{-1/2} \sum_{l_1 l_2} [l_1 l_2] (-1)^{J_a + J_p + J_b + J_q + 2J_q + \lambda_2 + k_2} \begin{Bmatrix} k_1 & \lambda_1 & l_1 \\ J_a & J_p & J_r \end{Bmatrix} \begin{Bmatrix} l_1 & l_2 & k_2 \\ \lambda_2 & \lambda_1 & k_1 \end{Bmatrix} \begin{Bmatrix} k_1 & l_2 & \lambda_2 \\ J_q & J_c & J_b \end{Bmatrix}$$

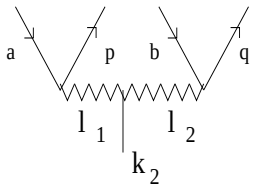


Figure 41: Cluster amplitude diagrams arising from the (particle-particle, particle-hole) form of V_N

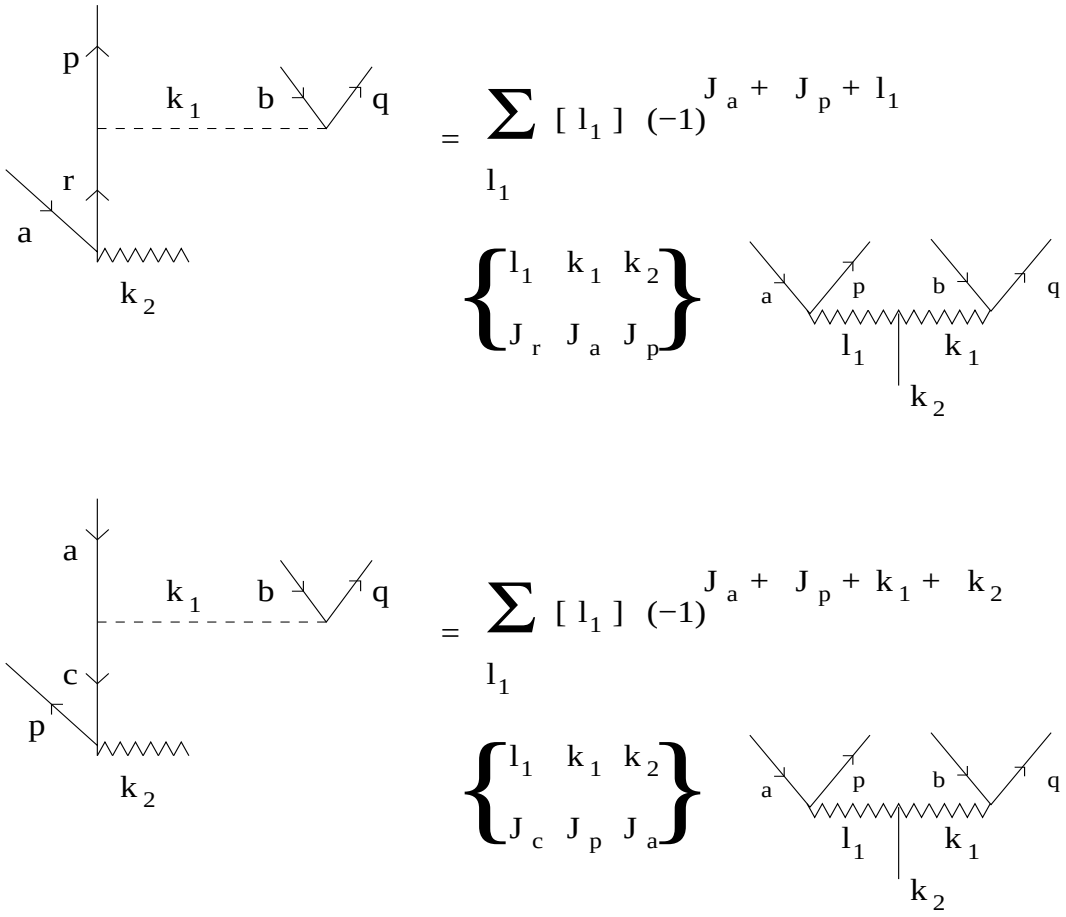
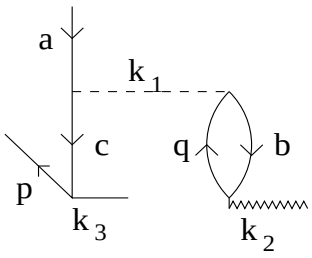
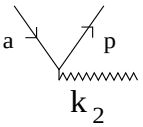


Figure 42: Cluster amplitude diagrams arising from the (particle-particle, hole-particle) form of V_N

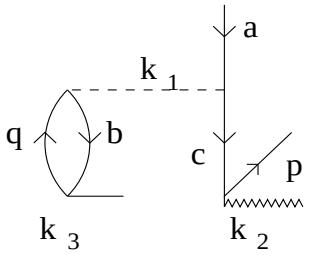
1.



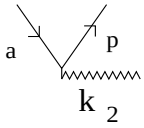
$$= \delta(J_p, J_c)\,[J_c]^{-1/2}\,\frac{\delta(k_1, k_2)}{[k_1]}\,(-1)^{J_q + J_b + k_2 + 2J_q}$$



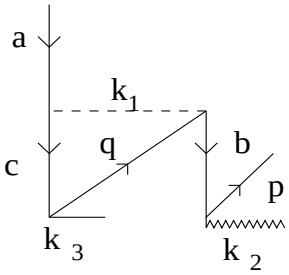
2.



$$= \frac{\delta(k_1, k_3)}{[k_1]}\,\delta(J_a, J_c)\,[J_a]^{-1/2}\,(-1)^{J_q + J_b + k_1 + 2J_b}\,\delta(J_q, J_b)$$



3.



$$= \delta(J_q, J_c)\,[J_q]^{-1/2}\,\frac{\delta(J_a, J_b)}{[J_b]}\,(-1)^{3J_a + J_q + k_1}$$

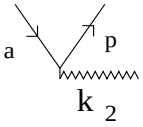
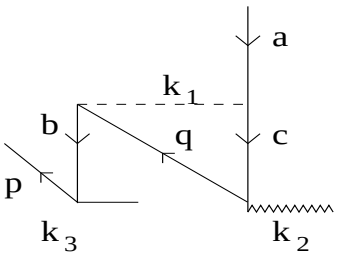
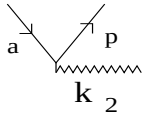


Figure 43: Cluster amplitude diagrams arising from the (hole-hole, particle-hole) form of V_N

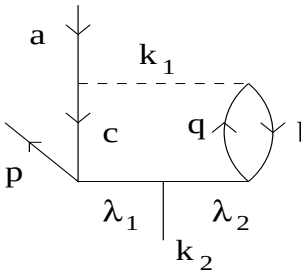
4.



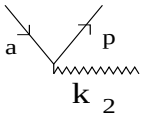
$$= \delta(J_b, J_p)\,[J_p]^{-1/2}\,(-1)^{J_c + J_q + k_2} \begin{Bmatrix} J_a & J_p & k_2 \\ J_q & J_c & k_1 \end{Bmatrix}$$



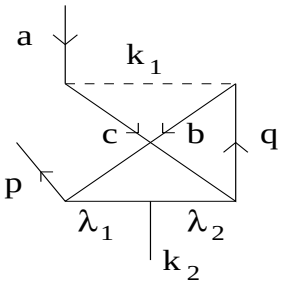
5.



$$= \frac{\delta(k_1, \lambda_2)}{[k_1]}\,(-1)^{J_a + J_p + k_2 + J_q + J_b + k_1 + 2J_b} \begin{Bmatrix} k_2 & J_a & J_p \\ J_c & \lambda_1 & \lambda_2 \end{Bmatrix}$$



6.



$$= (-1)^{J_a + J_p + J_q + J_c + \lambda_2 + k_2} \begin{Bmatrix} J_b & \lambda_2 & J_a \\ J_c & k_1 & J_q \end{Bmatrix} \begin{Bmatrix} J_a & k_2 & J_p \\ \lambda_1 & J_b & \lambda_2 \end{Bmatrix}$$

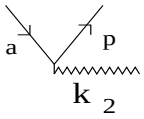


Figure 44: Cluster amplitude diagrams arising from the (hole-hole, particle-hole) form of V_N

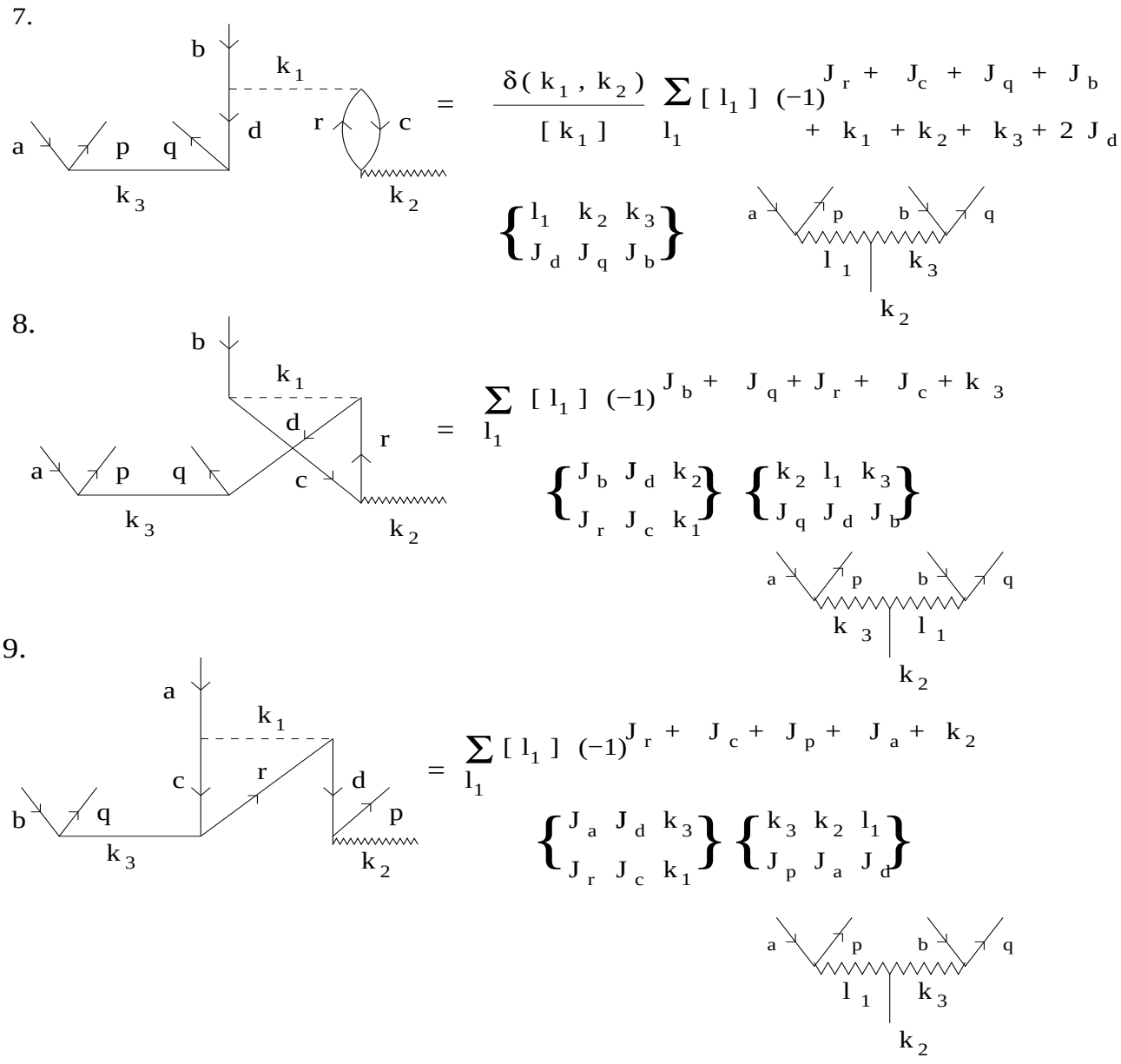
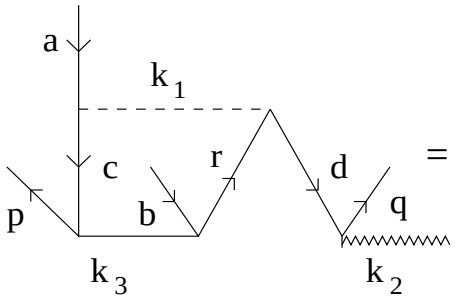


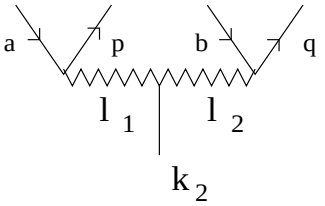
Figure 45: Cluster amplitude diagrams arising from the (hole-hole, particle-hole) form of V_N

10.

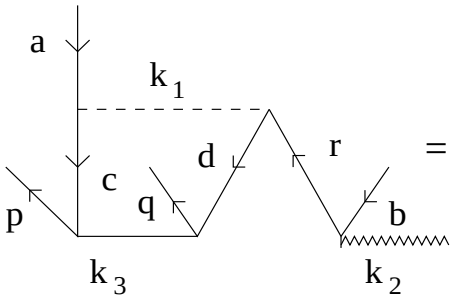


$$= \sum_{l_1\, l_2} [\, l_1\, l_2\,]\, (-1)^{J_a + J_d + J_q + J_p + l_1 + k_1 + 2J_c + l_2 + k_3} \begin{Bmatrix} l_1 & k_1 & k_3 \\ J_c & J_p & J_a \end{Bmatrix} \begin{Bmatrix} l_1 & k_2 & l_2 \\ J_q & J_b & J_d \end{Bmatrix}$$

$$\begin{Bmatrix} l_1 & J_d & J_b \\ J_r & k_3 & k_1 \end{Bmatrix}$$



11.



$$= \sum_{l_1\, l_2} [\, l_1\, l_2\,]\, (-1)^{J_a + J_p + J_r + J_b + 2J_r + k_2 + l_1} \begin{Bmatrix} l_1 & k_1 & k_3 \\ J_c & J_p & J_a \end{Bmatrix} \begin{Bmatrix} J_r & J_q & l_1 \\ k_3 & k_1 & J_d \end{Bmatrix}$$

$$\begin{Bmatrix} k_2 & l_2 & l_1 \\ J_q & J_r & J_b \end{Bmatrix}$$

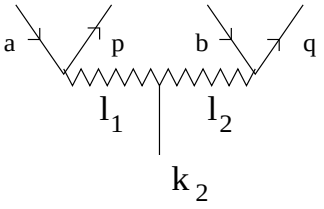
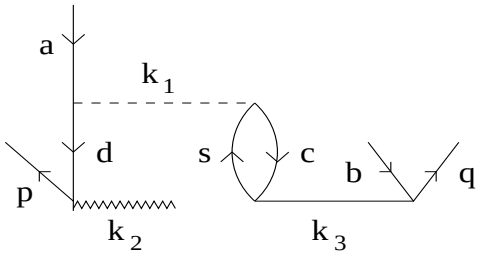
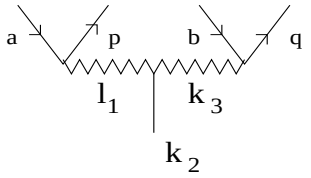


Figure 46: Cluster amplitude diagrams arising from the (hole-hole, particle-hole) form of V_N

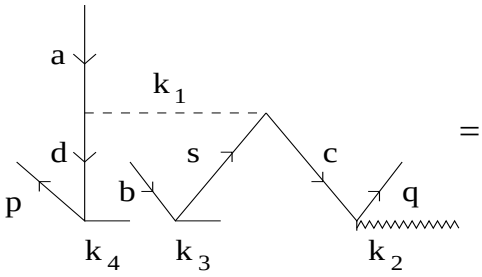
12.



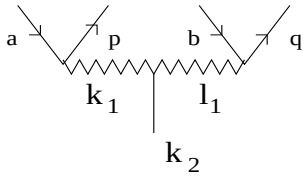
$$= \sum_{l_1} [\, l_1 \,] \quad (-1)^{J_a + J_p + J_c + J_s + 2J_d + k_2} \begin{Bmatrix} l_1 & k_1 & k_2 \\ J_d & J_p & J_a \end{Bmatrix} \frac{\delta(k_3, k_1)}{[\, k_1 \,]}$$



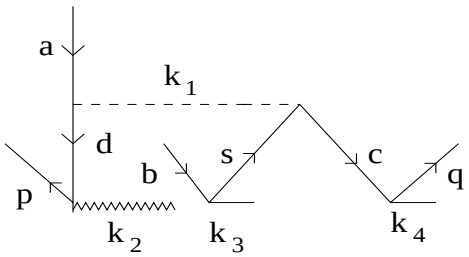
13.



$$= \delta(J_p, J_d)\, \delta(J_b, J_s) \sum_{l_1} [\, l_1 \,] \, [\, J_b J_d \,]^{-1/2} \, (-1)^{J_b + J_q + l_1} \begin{Bmatrix} l_1 & k_2 & k_1 \\ J_c & J_b & J_q \end{Bmatrix}$$



14.



$$= \delta(J_s, J_b)\, \delta(J_c, J_q)\, [\, J_q J_s \,]^{-1/2} \sum_{l_1} [\, l_1 \,] \, (-1)^{J_a + J_p + k_1 + k_2} \begin{Bmatrix} l_1 & k_1 & k_2 \\ J_d & J_p & J_a \end{Bmatrix}$$

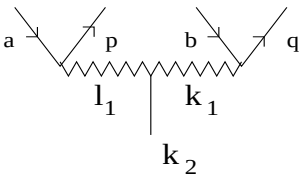
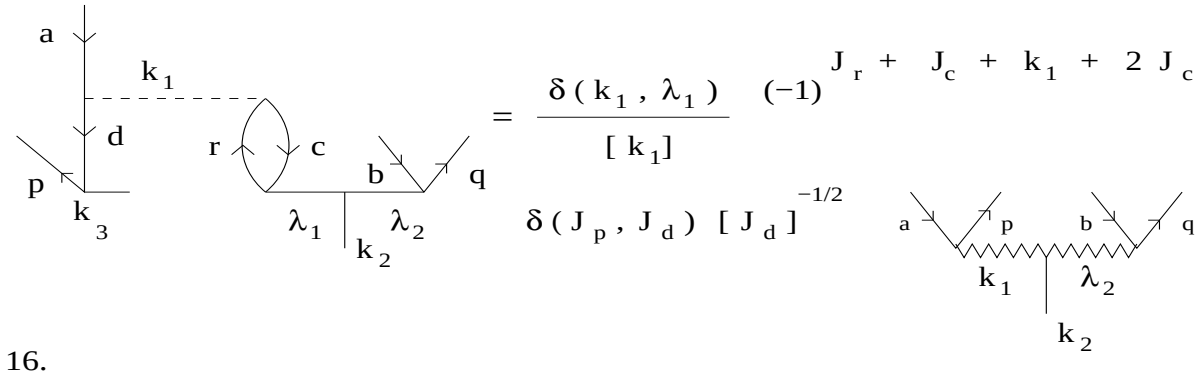
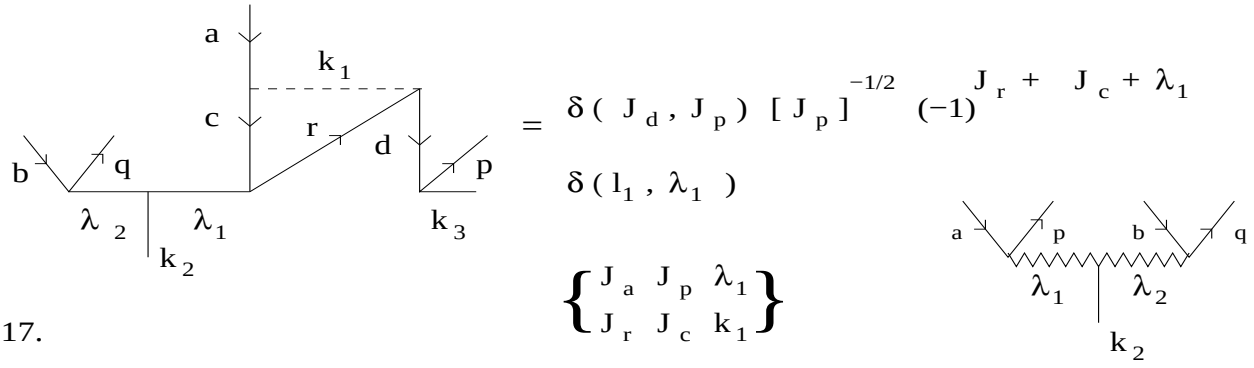


Figure 47: Cluster amplitude diagrams arising from the (hole-hole, particle-hole) form of V_N

15.



16.



17.

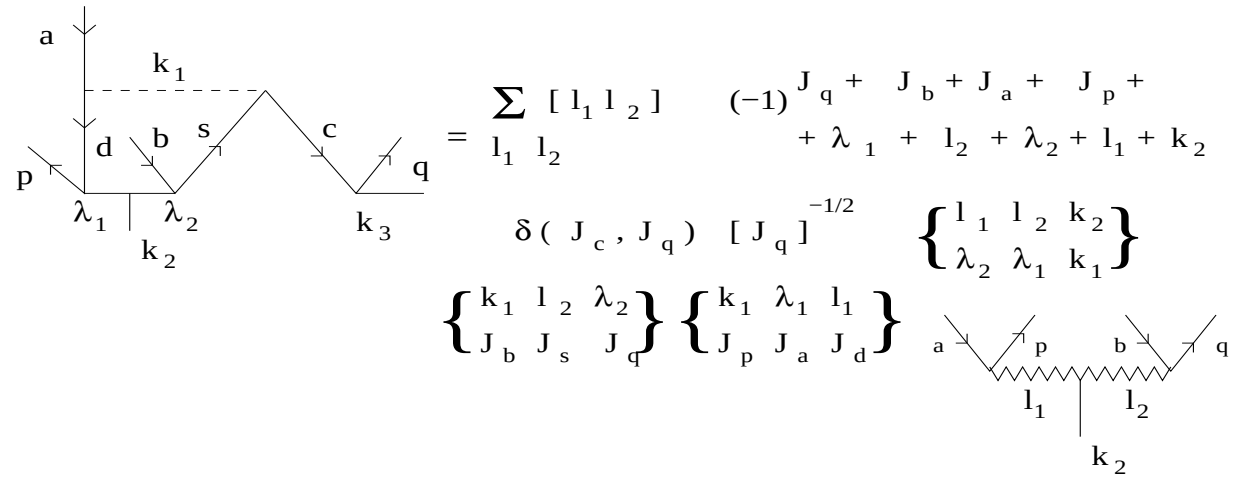
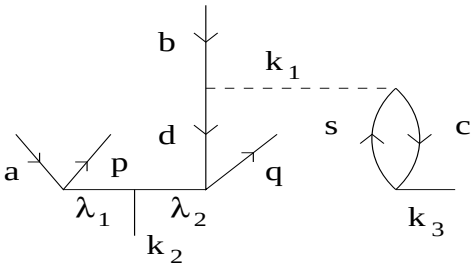


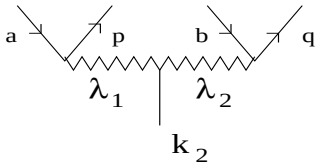
Figure 48: Cluster amplitude diagrams arising from the (hole-hole, particle-hole) form of V_N

18.

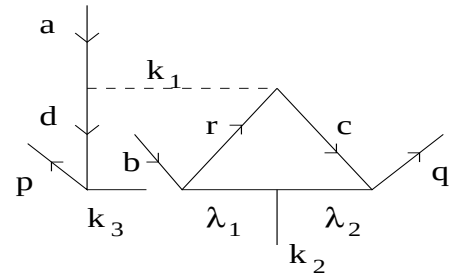


$$= \delta(J_b, J_d)\,(-1)^{J_s + J_c + 2J_c}\,\delta(J_r, J_c)$$

$$\delta(k_1, 0)\;\;[J_d]^{-1/2}$$



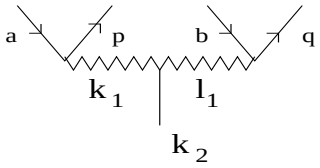
19.

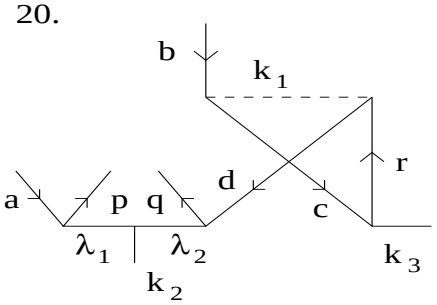


$$= \delta(J_p, J_d) \sum_{l_1} [l_1]\,(-1)^{J_q + J_c + 2J_b + \lambda_1 + k_2}$$

$$[J_d]^{-1/2} \quad \begin{Bmatrix} k_1 & k_2 & l_1 \\ J_r & \lambda_1 & J_b \\ J_c & \lambda_2 & J_q \end{Bmatrix}$$

20.





$$= \delta(J_r, J_c)\,[J_r]^{-1/2}\,\frac{\delta(J_b, J_d)}{[J_d]}$$

$$(-1)^{J_b + J_c + k_1 + 2J_b}$$

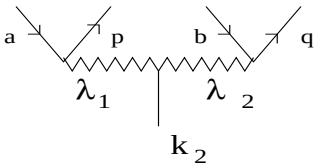
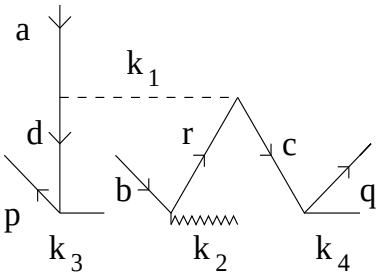


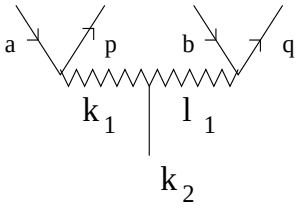
Figure 49: Cluster amplitude diagrams arising from the (hole-hole, particle-hole) form of V_N

21.

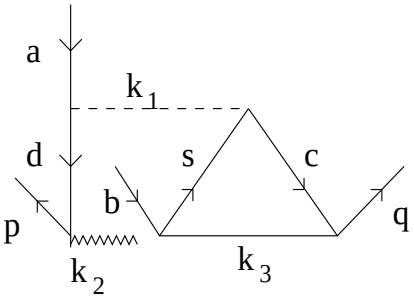


$$= \sum_{l_1} [l_1]\, \delta(J_p, J_d)\, [J_p]^{-1/2}\ \delta(J_c, J_q)$$

$$(-1)^{J_b + J_q + k_1 + k_2} \begin{Bmatrix} k_1 & l_1 & k_2 \\ J_b & J_r & J_q \end{Bmatrix} [J_q]^{-1/2}$$



22.



$$= \sum_{l_1\ l_2} [l_1\, l_2]\ (-1)^{J_c + J_s + k_2 + J_a + J_p}$$

$$\frac{\delta(k_1, l_2)}{[k_1]} \begin{Bmatrix} l_1 & k_1 & k_2 \\ J_d & J_p & J_a \end{Bmatrix} \begin{Bmatrix} k_1 & J_q & J_b \\ k_3 & J_s & J_c \end{Bmatrix}$$

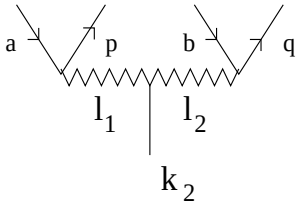


Figure 50: **Cluster amplitude diagrams arising from the (hole-hole, particle-hole) form of V_N

23.

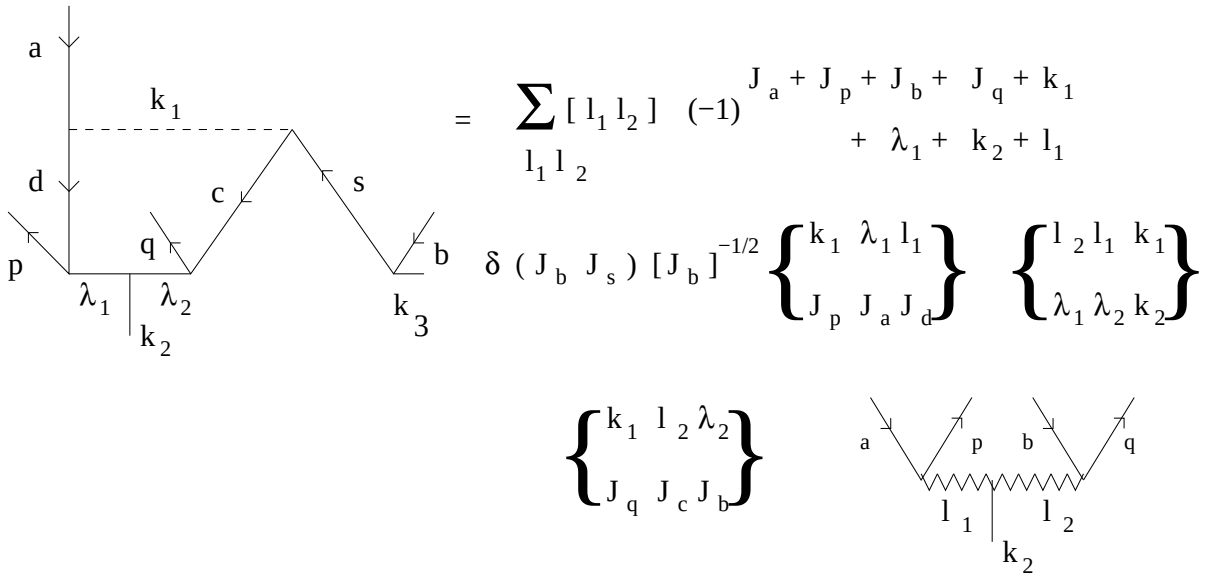
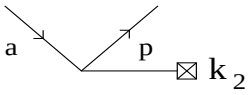
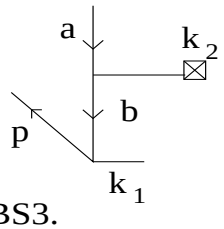


Figure 51: Cluster amplitude diagrams arising from the (hole-hole, particle-hole) form of V_N

BS1.

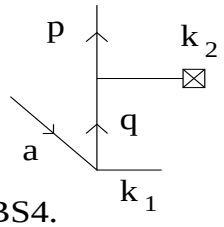


BS2.



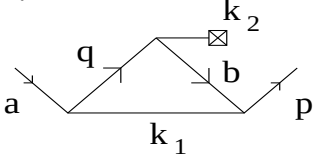
$$= \delta\,(J_p, J_b)\;[J_b]^{-1/2}$$

BS3.



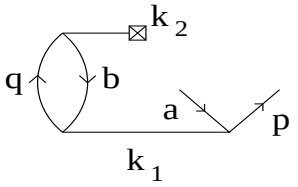
$$= \delta\,(J_a, J_q)\;[J_a]^{-1/2}$$

BS4.



$$= \begin{Bmatrix} J_a & k_2 & J_p \\ J_b & k_1 & J_q \end{Bmatrix} (-1)^{J_q + J_b + k_2}$$

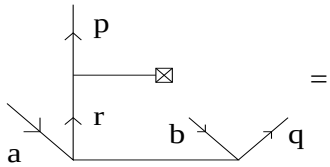
BS5.



$$= (-1)^{J_q + J_b + k_2 + 2J_b}\;\frac{\delta\,(k_2, k_1)}{[k_2]}$$

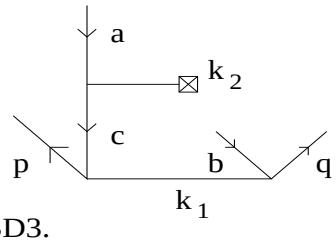
Figure 52: Diagrams contributing to the RHS of CCEDM equation - Singles

BD1.



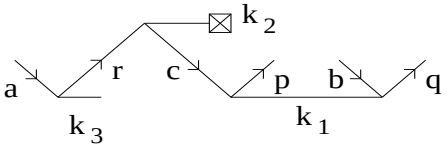
$$= \sum_{l_1} [l_1] \; (-1)^{J_a + J_p + k_1 + k_2} \begin{Bmatrix} l_1 & k_2 & k_1 \\ J_r & J_a & J_p \end{Bmatrix}$$

BD2.



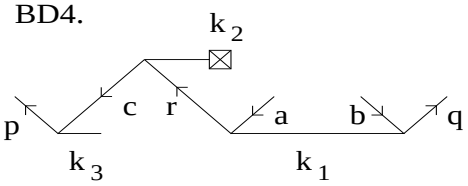
$$= \sum_{l_1} [l_1] \; (-1)^{J_a + J_p + l_1} \begin{Bmatrix} l_1 & k_2 & k_1 \\ J_c & J_p & J_a \end{Bmatrix}$$

BD3.



$$= \delta(J_a, J_p) \, [J_a]^{-1/2} \sum_{l_1} [l_1] \; (-1)^{J_a + J_p + l_1} \begin{Bmatrix} l_1 & k_2 & k_1 \\ J_c & J_p & J_a \end{Bmatrix}$$

BD4.



$$= \delta(J_c, J_p) \, [J_p]^{-1/2} \sum_{l_1} [l_1] \; (-1)^{J_a + J_p + k_1 + k_2} \begin{Bmatrix} l_1 & k_2 & k_1 \\ J_r & J_a & J_p \end{Bmatrix}$$

Figure 53: Diagrams contributing to RHS of CCEDM equation - Doubles

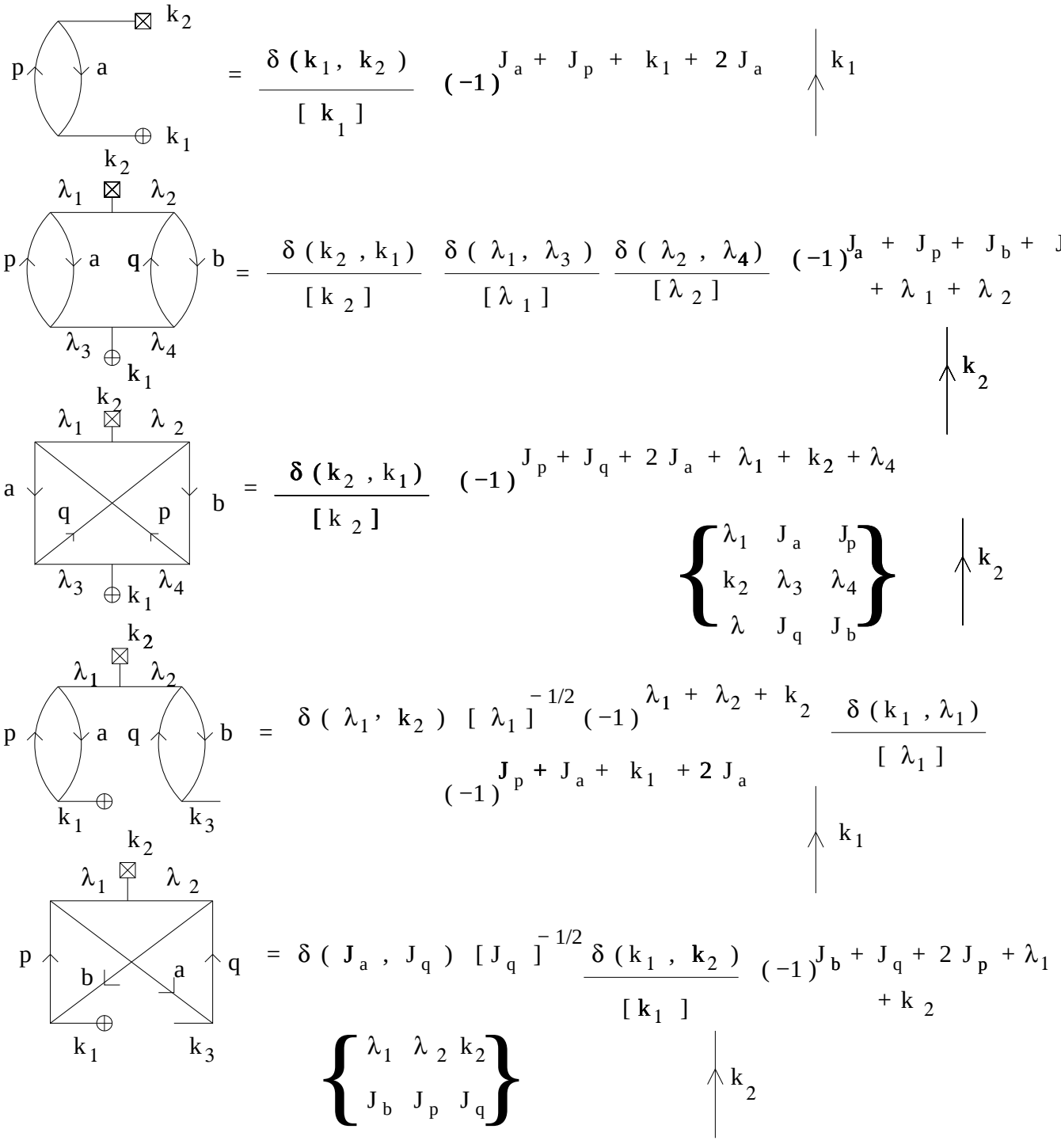


Figure 54: Diagrams contributing EDM at zeroth order

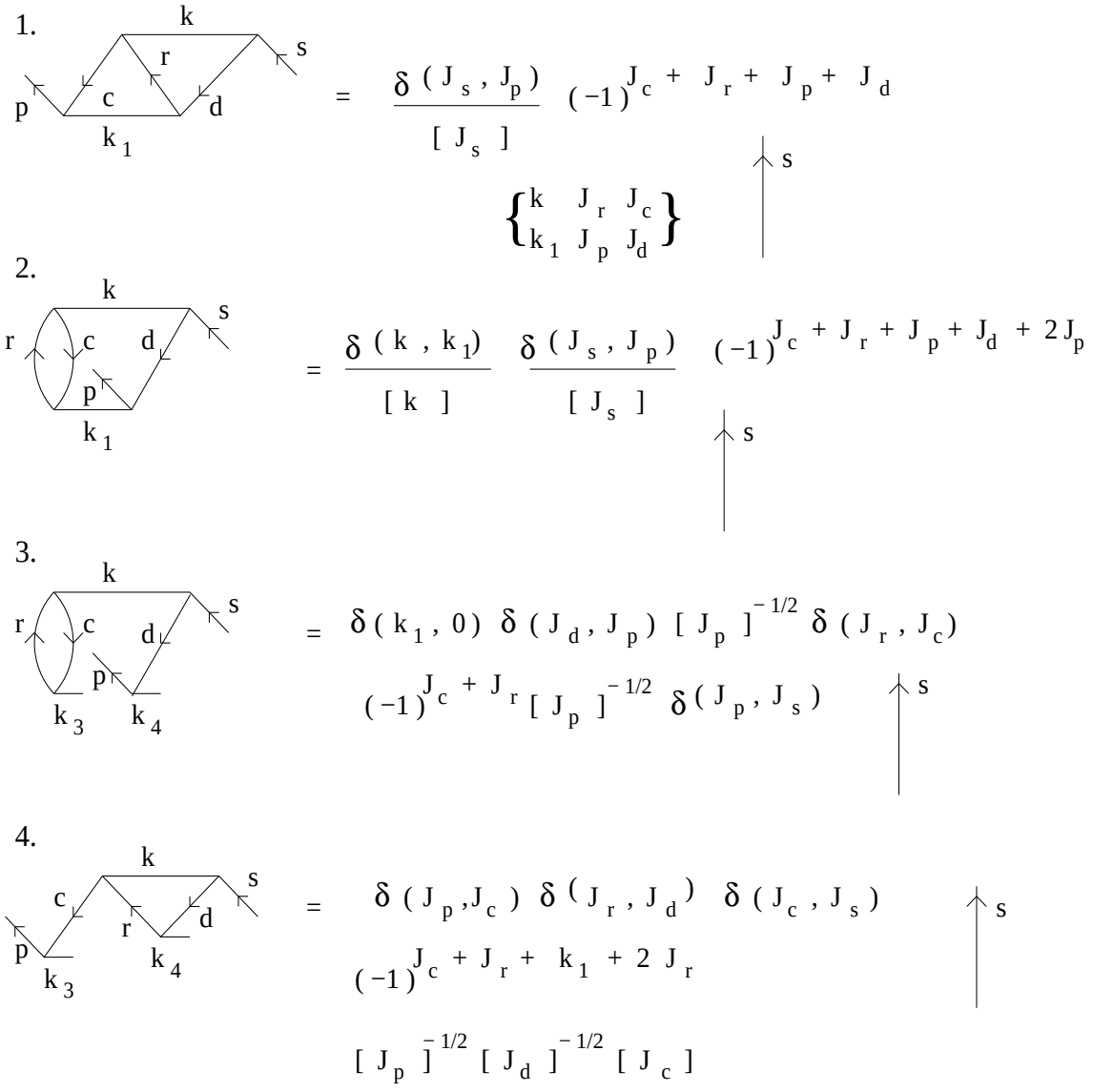
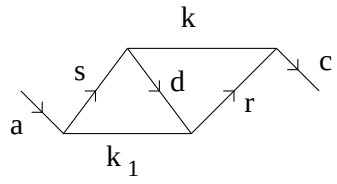


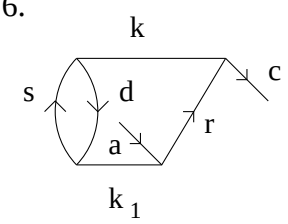
Figure 55: Angular factors for IMS diagrams arising form $V_N T^{(0)}$ - particle-particle

5.



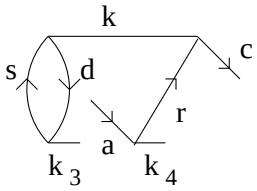
$$= \frac{\delta(J_c, J_a)}{[J_c]} (-1)^{J_c + J_r + J_s + J_d} \begin{Bmatrix} J_a & J_s & k_1 \\ J_d & J_r & k \end{Bmatrix} \downarrow c$$

6.



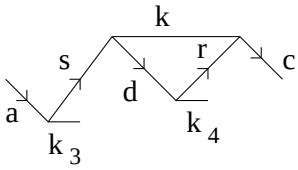
$$= \frac{\delta(k, k_1)}{[k]} \frac{\delta(J_c, J_a)}{[J_c]} (-1)^{J_s + J_d + J_r + J_c + 2J_c} \downarrow c$$

7.



$$= \delta(J_r, J_a)\ \delta(J_s, J_d)\ \delta(k, 0)\ [J_r]^{-1/2} (-1)^{J_s + J_d + 2J_d}\ [J_r]^{-1/2} \downarrow c$$

8.



$$= \delta(J_a, J_s)\ [J_a]^{-1/2} \delta(J_d, J_r)\ [J_d]^{-1/2} \frac{\delta(J_c, J_s)}{[J_c]} (-1)^{J_c + J_r + k + 2J_c} \downarrow c$$

Figure 56: Angular factors for IMS diagrams arising form $V_N T^{(0)}$ - hole-hole

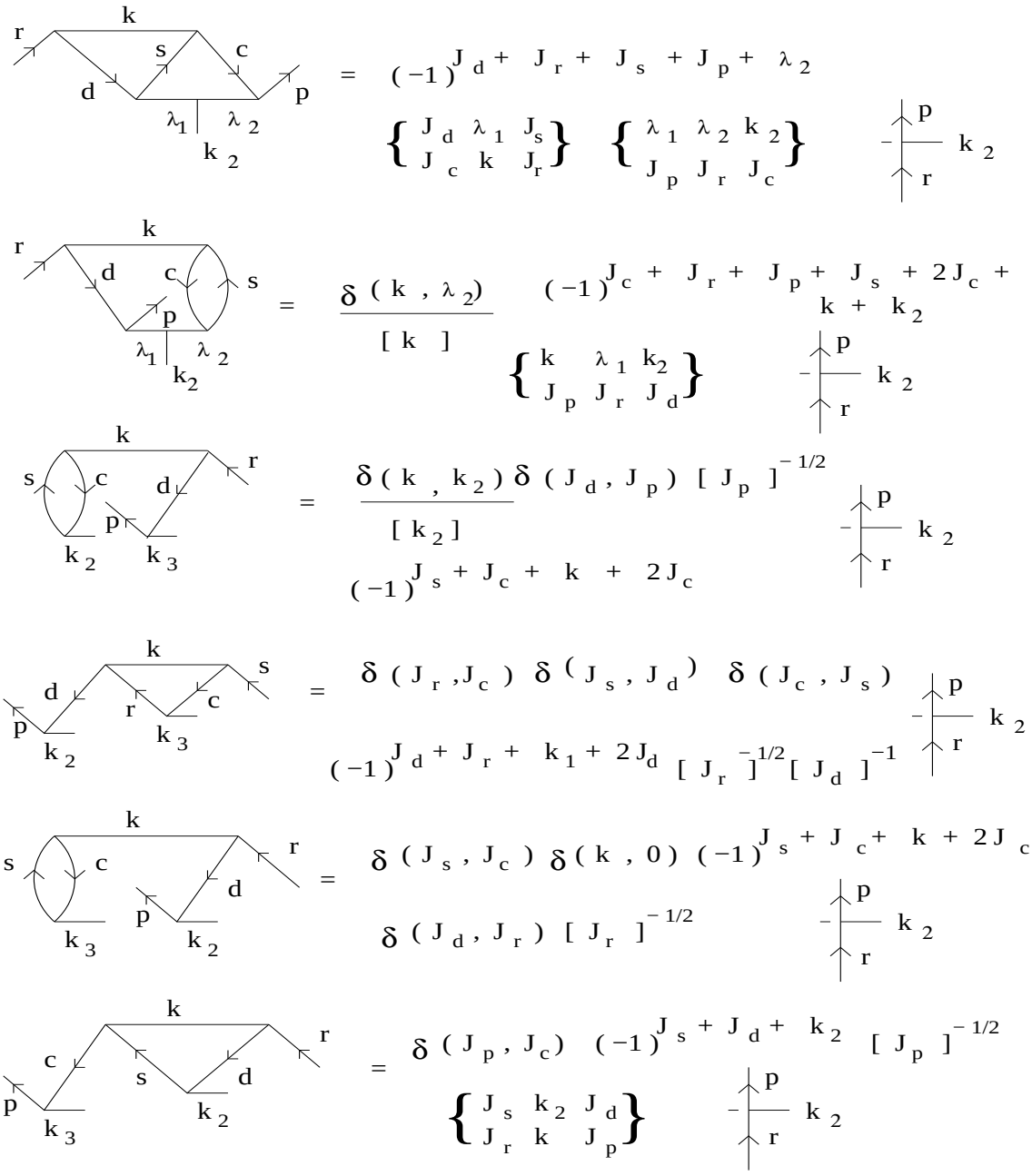


Figure 57: Angular factors for EDM perturbed IMS diagrams - particle-particle

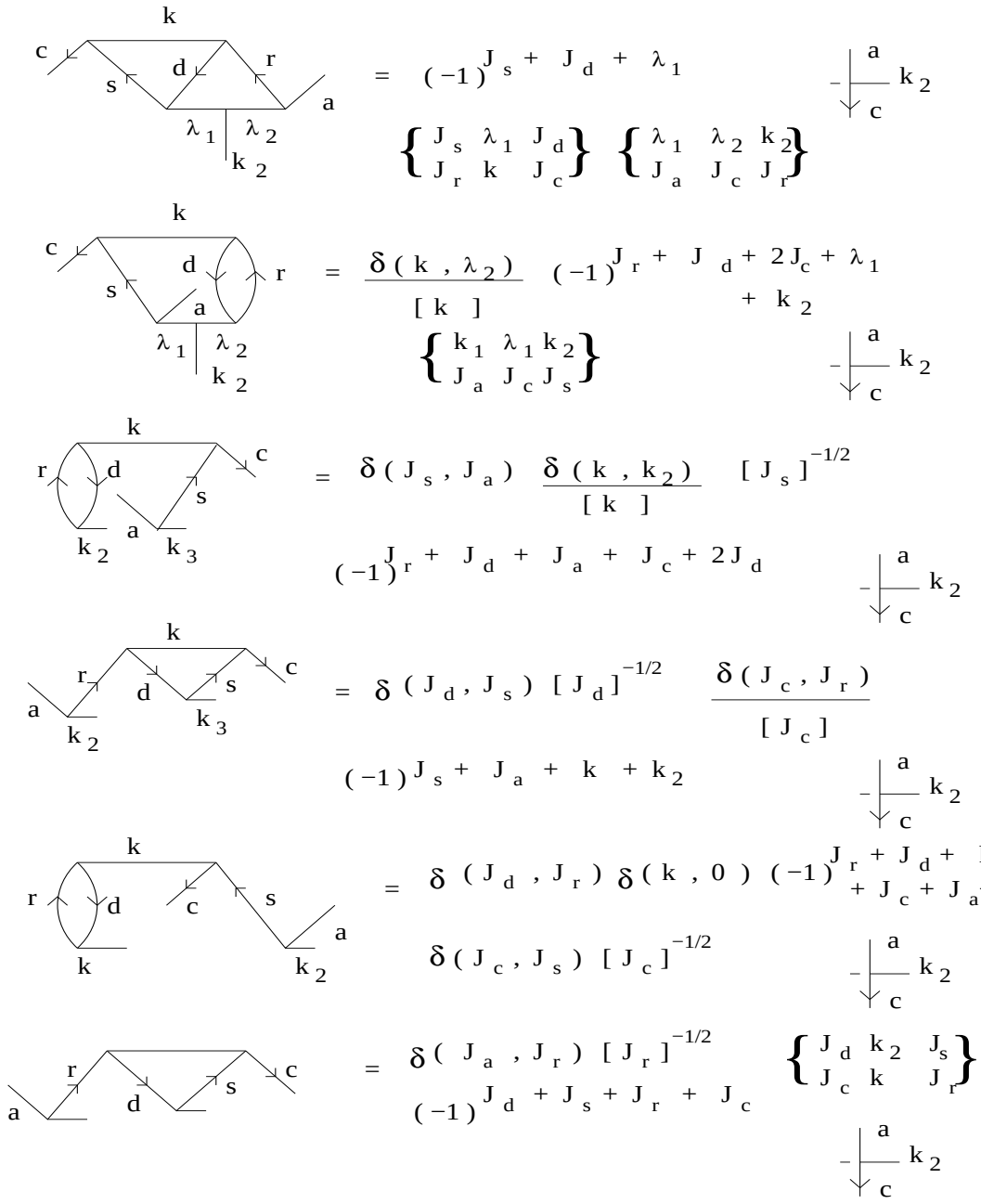
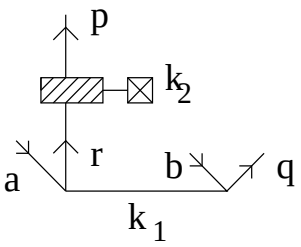


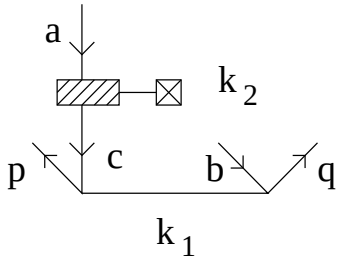
Figure 58: Angular factors for EDM perturbed IMS diagrams - hole-hole

BD1.



$$= \sigma_{l_1} [l_1] (-1)^{J_a + J_p + k_1 + k_2} \begin{Bmatrix} l_1 & k_2 & k_1 \\ J_r & J_a & J_p \end{Bmatrix}$$

BD2.



$$= \sigma_{l_1} [l_1] (-1)^{J_a + J_p + l_1} \begin{Bmatrix} l_1 & k_2 & k_1 \\ J_c & J_p & J_a \end{Bmatrix}$$

Figure 59: Angular factors for cluster diagrams arising from H_{EDM} perturbed IMS diagrams

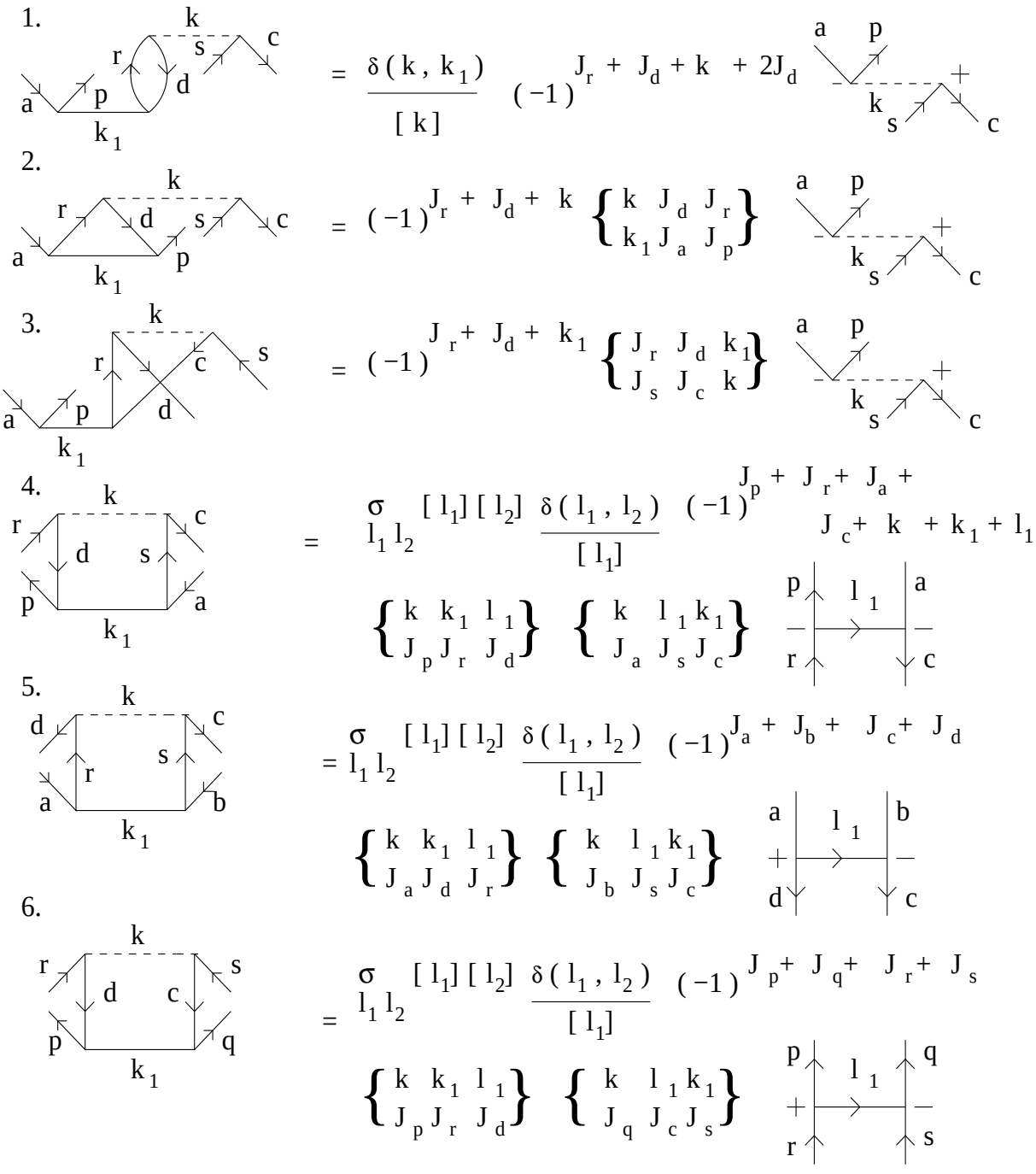


Figure 60: Angular factors for Coulomb IMS diagrams

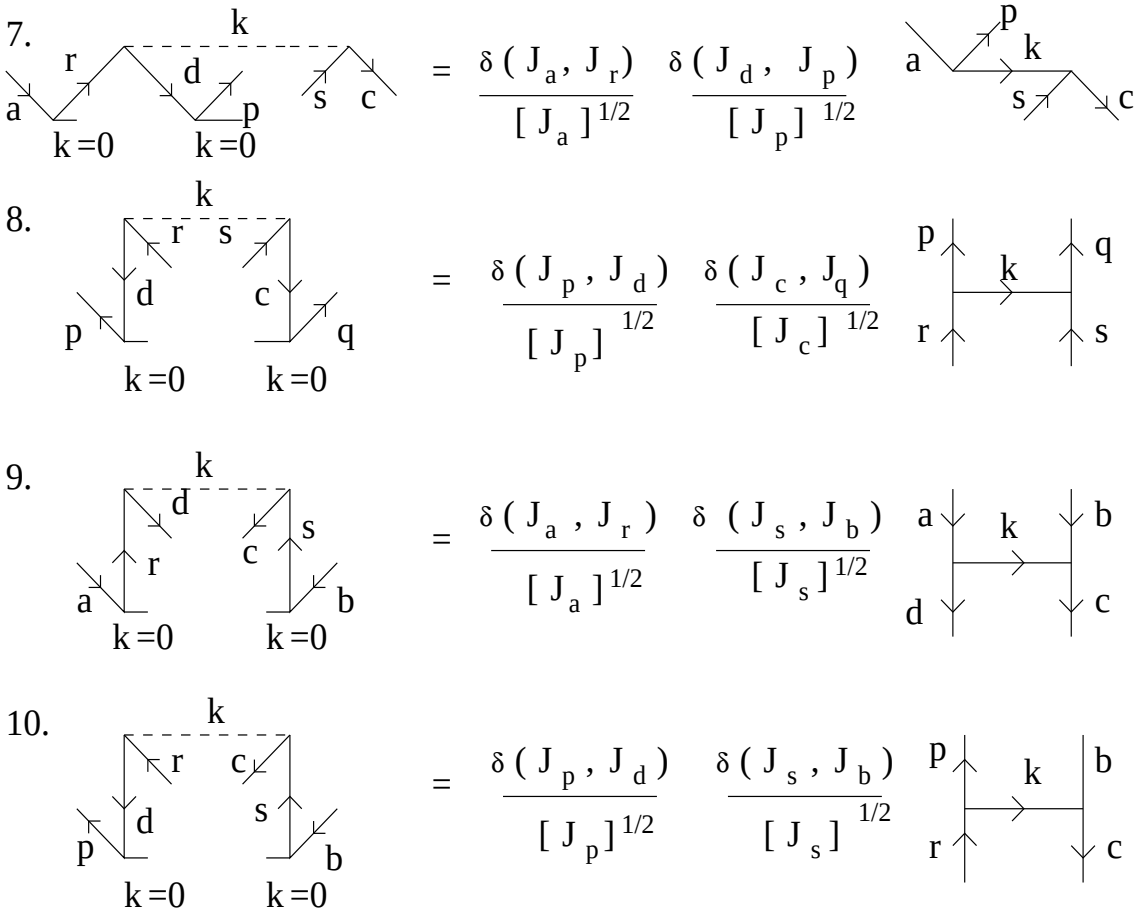


Figure 61: Angular factors for Coulomb IMS diagrams

1 Transformation rule for diagrams

We obtain a general rule for transforming a given diagram into a diagram with all the arrows reversed and vertex phase altered accordingly.

The phase change in the transformation is given by,

$$\mathrm{p}hase = (-1)^{\left(\sum_{free} J_{free} + \sum_{in} 2J_{in}\right)} \tag{2}$$

where J_{free} = the free lines present in the diagram, J_{in} = incoming line. This is illustrated using an example shown in Fig.62, where J_1, J_5 are the free lines and J_5 is the incoming line.

For the case of a diagram representing $T_2^{(1)}$ operator, this rule does not hold, as by convention there is no arrow on the rank K_2.

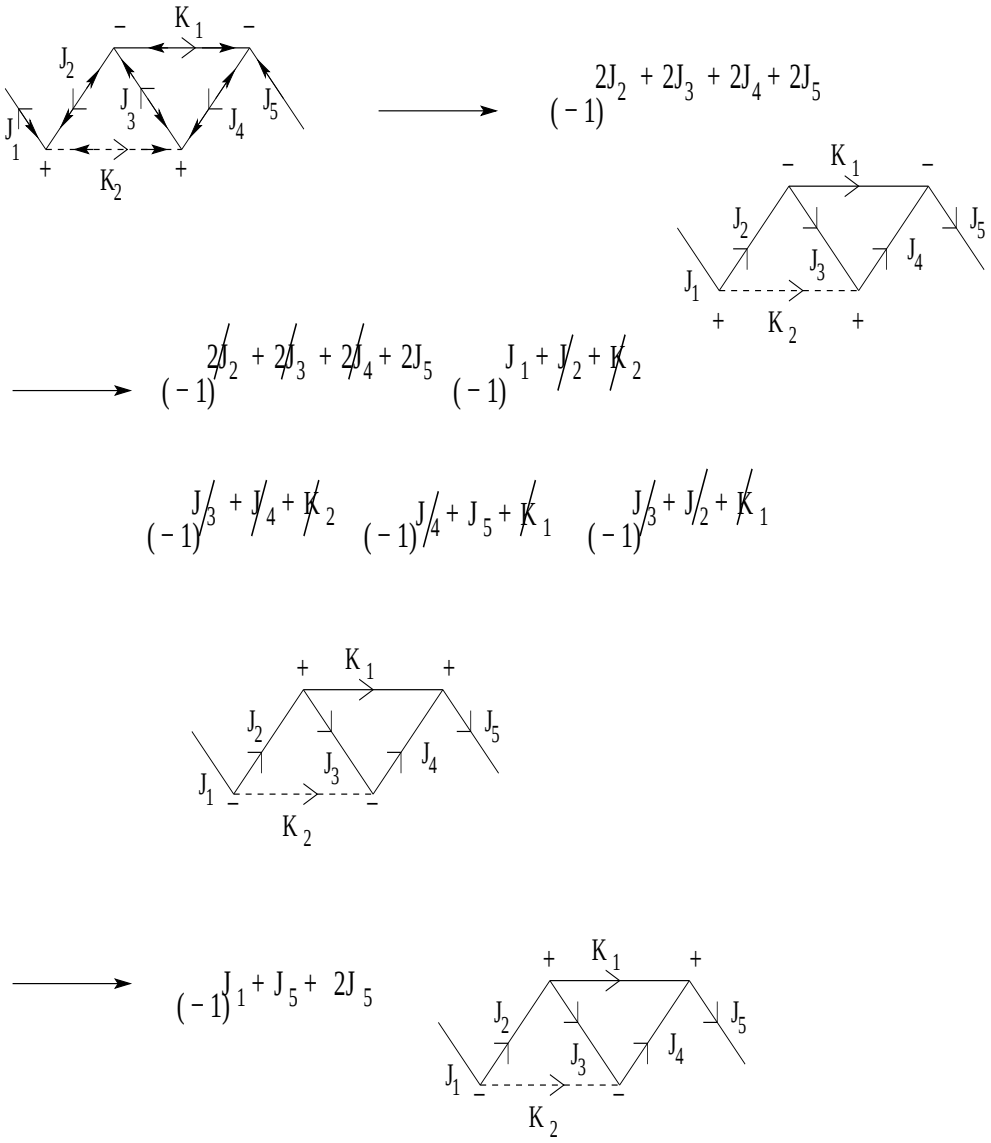


Figure 62: Figure illustrating the conversion of a given diagram to a diagram with direction of arrows reversed