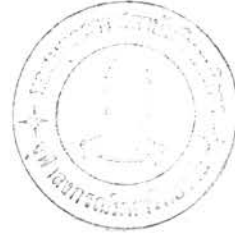


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APPENDIX A

THE DERIVATION OF EQUATION (2.19)

We will derive Eq. (2.19)

From Eq.(2.18) and Eq (2.3)

$$T \tanh^{-1} \langle S_0 \rangle = \sum_j J_{oj} \langle S_j \rangle - \beta \langle S_0 \rangle \sum_j J_{oj}^2 (1 - \langle S_j \rangle^2) \quad (2.18)$$

$$\langle S_0 \rangle = \tanh \left[\sum_{j=1}^Z \tanh^{-1} (t_j g_{oj}) \right] \quad (2.3)$$

We get

$$\begin{aligned} \tanh^{-1} \langle S_0 \rangle &= \sum_{j=1}^Z \tanh^{-1} (t_j g_{oj}) \\ &= \sum_{j=1}^Z \left(t_j g_{oj} + \frac{1}{3} t_j^3 g_{oj}^3 + \frac{1}{5} t_j^5 g_{oj}^5 + \dots \right) \\ &= \sum_{j=1}^Z \left[\beta J_{oj} t_j - \frac{1}{3} \beta^3 J_{oj}^3 t_j \right. \\ &\quad \left. + \frac{1}{3} \beta^3 J_{oj}^3 t_j^3 + 0 (J_{oj}^5) \right] \end{aligned}$$

Multiplying Eq.(2.18) by

$$\langle S_0 \rangle = \sum_j \beta J_{oj} t_j$$

and averaging over the t 's and J 's. The left hand side is

$$\begin{aligned} T \sum_j \beta J_{oj} t_j \tanh^{-1} \langle S_0 \rangle &= T \sum_j \sum_{j=1}^Z \left[\beta^2 J_{oj} J_{oj} \overline{t_j t_j} \right. \\ &\quad \left. - \frac{1}{3} \beta^4 J_{oj}^3 J_{oj} \overline{t_j t_j} + \frac{1}{3} \beta^4 J_{oj}^3 J_{oj} \overline{t_j^3 t_j} \right. \\ &\quad \left. + 0 (J_{oj}^6) \right] \\ &= T \sum_j \left[\beta^2 J_{oj}^2 \overline{t_j^2} - \frac{1}{3} \beta^4 J_{oj}^4 \overline{t_j^2} \right] \end{aligned}$$

$$\begin{aligned}
& + \frac{1}{3} \beta^4 J_{0j}^4 \overline{t_j^4} + \dots] \\
= & \tau [\beta^2 \widehat{J_j^2} \overline{t_j^2} - \frac{1}{3z} \beta^4 \widehat{J_j^4} \overline{t_j^2} \\
& + \frac{1}{3z} \beta^4 \widehat{J_j^4} \overline{t_j^4}]
\end{aligned}$$

look at the term $\sum_j J_{0j} \langle S_j \rangle$

$$\begin{aligned}
\langle S_j \rangle &= (1 - t_j^2 g_{0j}^2)^{-1} [t_j (1 - g_{0j}^2) \\
& + g_{0j} (1 - t_j^2) \langle S_0 \rangle] \\
&= t_j (1 - g_{0j}^2) + g_{0j} (1 - t_j^2) \langle S_0 \rangle \\
& + t_j^3 g_{0j}^2 (1 - g_{0j}^2) + t_j^2 g_{0j}^3 (1 - t_j^2) \langle S_0 \rangle
\end{aligned}$$

$$\begin{aligned}
\sum_j J_{0j} \langle S_j \rangle &= \sum_j t_j J_{0j} [1 - (\beta J_{0j} - \frac{1}{3} \beta^3 J_{0j}^3)^2] \\
& + \sum_j J_{0j} (\beta J_{0j} - \frac{1}{3} \beta^3 J_{0j}^3) (1 - t_j^2) \langle S_0 \rangle \\
& + \sum_j t_j^3 J_{0j} (\beta J_{0j} - \frac{1}{3} \beta^3 J_{0j}^3)^2 \\
& [1 - (\beta J_{0j} - \frac{1}{3} \beta^3 J_{0j}^3)^2] \\
& + \sum_j t_j^2 J_{0j} (\beta J_{0j} - \frac{1}{3} \beta^3 J_{0j}^3)^3 \\
& (1 - t_j^2) \langle S_0 \rangle
\end{aligned}$$

$$= I_1 + I_2 + I_3 + I_4$$

$$\begin{aligned}
I_1 &= \sum_j t_j J_{0j} [1 - (\beta J_{0j} - \frac{1}{3} \beta^3 J_{0j}^3)^2] \\
&= \sum_j t_j J_{0j} (1 - \beta^2 J_{0j}^2 + \frac{2}{3} \beta^4 J_{0j}^4 \\
& - \frac{1}{9} \beta^6 J_{0j}^6)
\end{aligned}$$

$$\sum_j \beta J_{0j} t_j I_1 = \sum_j \sum_j (\beta J_{0j} J_{0j} \overline{t_j t_j} - \beta^3 J_{0j}^3 J_{0j} \overline{t_j t_j})$$

$$\begin{aligned}
& + \frac{2}{3} \beta^5 J_{0j}^5 J_{0j} \overline{t_j t_j} - \frac{1}{9} \beta^7 J_{0j}^7 J_{0j} \overline{t_j t_j} \\
& = \sum_j (\beta J_{0j}^2 \overline{t_j^2} - \beta^3 J_{0j}^4 \overline{t_j^2} + \frac{2}{3} \beta^5 J_{0j}^6 \overline{t_j^2} \\
& \quad - \frac{1}{9} \beta^7 J_{0j}^8 \overline{t_j^2}) \\
& = (\beta J^2 - \frac{1}{3} \beta^3 J^4) \overline{t_j^2}
\end{aligned}$$

$$I_2 = \sum_j J_{0j} (\beta J_{0j} - \frac{1}{3} \beta^3 J_{0j}^3) (1 - t_j^2) \langle S_0 \rangle$$

$$\begin{aligned}
\langle S_0 \rangle & = \tanh [\sum_{j=1}^Z \tanh^{-1} (t_j g_{0j})] \\
& = \sum_{j=1}^Z \tanh^{-1} (t_j g_{0j}) \\
& \quad - \frac{1}{3} [\sum_{j=1}^Z \tanh^{-1} (t_j g_{0j})]^3 + \dots
\end{aligned}$$

$$= \sum_{j=1}^Z t_j g_{0j} + \sum_{j=1}^Z \frac{1}{3} t_j^3 g_{0j}^3$$

$$- \frac{1}{3} \sum_{i,j,k} g_i g_j g_k t_i t_j t_k$$

$$= \sum_{j=1}^Z t_j (\beta J_{0j} - \frac{1}{3} \beta^3 J_{0j}^3)$$

$$+ \frac{1}{3} \sum_{j=1}^Z t_j^3 (\beta J_{0j} - \frac{1}{3} \beta^3 J_{0j}^3)^3$$

$$- \frac{1}{3} \sum_{i,j,k} g_i g_j g_k t_i t_j t_k$$

$$= \sum_{j=1}^Z t_j (\beta J_{0j} - \frac{1}{3} \beta^3 J_{0j}^3)$$

$$+ \frac{1}{3} \sum_{j=1}^Z t_j^3 (\beta^3 J_{0j}^3 + \dots)$$

$$- \frac{1}{3} \sum_{i,j,k} g_i g_j g_k t_i t_j t_k$$

$$I_2 = I_2' + I_2''$$

Where

$$I_2' = \sum_l J_{0l} (\beta J_{0l} - \frac{1}{3} \beta^3 J_{0l}^3) \langle S_0 \rangle$$

$$\begin{aligned}
&= \sum_1 J_{01} (\beta J_{01} - \frac{1}{3} \beta^3 J_{01}^3) \\
&\quad [\sum_{j=1}^Z t_j (\beta J_{0j} - \frac{1}{3} \beta^3 J_{0j}^3) \\
&\quad + \frac{1}{3} \sum_{j=1}^Z t_j^3 (\beta^3 J_{0j}^3 + \dots) \\
&\quad - \frac{1}{3} \sum_{i,j,k} g_i g_j g_k t_i t_j t_k]
\end{aligned}$$

Multiply by $\sum_J \beta J_{0J} t_J$, We get

$$\begin{aligned}
\sum_J \beta J_{0J} t_J I_2' &= \sum_1 J_{01} (\beta J_{01} - \frac{1}{3} \beta^3 J_{01}^3) \\
&\quad [\sum_{J,j} (\beta^2 J_{0j} - \frac{1}{3} \beta^4 J_{0j}^3) \overline{t_j t_J} \\
&\quad + \frac{1}{3} \sum_{J,j} (\beta^4 J_{0j}^3 J_{0J} + \dots) \overline{t_j^3 t_J} \\
&\quad - \frac{1}{3} \sum_{J,i,j,k} \beta J_{0J} g_i g_j g_k \overline{t_i t_j t_k t_J}] \\
&= (\beta J^2 - \frac{1}{3z} \beta^3 J^4) [\sum_J (\beta^2 J_{0J}^2 - \frac{1}{3} \beta^4 J_{0J}^4) \overline{t_J^2} \\
&\quad + \frac{1}{3} \sum_J (\beta^4 J_{0J}^4 + \dots) \overline{t_J^4} \\
&\quad - \frac{1}{3} \sum_{J,i,j,k} \beta J_{0J} g_i g_j g_k \overline{t_i t_j t_k t_J}] \\
&= (\beta J^2 - \frac{1}{3z} \beta^3 J^4) [(\beta^2 J^2 - \frac{1}{3z} \beta^4 J^4) \overline{t_J^2} \\
&\quad + \frac{1}{3z} \beta^4 J^4 \overline{t_J^4} + 0 (\frac{1}{z^2}) - \frac{1}{3} \sum_J \beta J_{0J} g_J^3 \overline{t_J^4} \\
&\quad - \sum_{J,j} \beta J_{0J} g_J g_j^2 \overline{t_j^2 t_J^2}] \\
&= (\beta J^2 - \frac{1}{3z} \beta^3 J^4) [(\beta^2 J^2 - \frac{1}{3z} \beta^4 J^4) \overline{t_J^2} \\
&\quad + \frac{1}{3z} \beta^4 J^4 \overline{t_J^4} - \frac{1}{3z} \beta^4 J^4 \overline{t_J^4} \\
&\quad - (\beta^2 J^2 - \frac{1}{3z} \beta^4 J^4) (\beta^2 J^2 - \frac{2}{3z} \beta^4 J^4) \overline{t_j^2 t_J^2}] \\
&= (\beta J^2 - \frac{1}{3z} \beta^3 J^4) [(\beta^2 J^2 - \frac{1}{3z} \beta^4 J^4) \overline{t_J^2}
\end{aligned}$$

$$\begin{aligned}
& - \left(\beta^4 (\widehat{J^2})^2 - \frac{1}{2} \beta^6 \widehat{J^2} \widehat{J^4} \right) \overline{t_j^2} \overline{t_j^2}] \\
& = \left[\beta^3 (\widehat{J^2})^2 - \frac{2}{3z} \beta^5 \widehat{J^2} \widehat{J^4} \right] \overline{t_j^2} \\
& - \left[\beta^5 (\widehat{J^2})^3 - \frac{4}{3z} \beta^7 (\widehat{J^2})^2 \widehat{J^4} \right] \overline{t_j^2} \overline{t_j^2} \\
I_2'' & = - \sum_j J_{oj} \left(\beta J_{oj} - \frac{1}{3} \beta^3 J_{oj}^3 \right) t_j^2 \langle S_o \rangle \\
\sum_j \beta J_{oj} t_j I_2'' & = - \sum_j \sum_{j_1} \sum_{j_2} \left(\beta J_{oj} - \frac{1}{3} \beta^3 J_{oj}^3 \right) t_j^2 \beta J_{oj} t_{j_1} J_{oj_2} \\
& \quad \left[t_{j_1} \left(\beta J_{o1} - \frac{1}{3} \beta^3 J_{o1}^3 \right) + 0 (t^3) \right] \\
& = - \sum_j \sum_{j_1} \sum_{j_2} \left(\beta J_{oj}^2 - \frac{1}{3} \beta^3 J_{oj}^4 \right) \overline{t_j^2} \overline{t_{j_1}} \overline{t_{j_2}} \beta J_{oj} \\
& \quad \left(\beta J_{o1} - \frac{1}{3} \beta^3 J_{o1}^3 \right) + 0 (t^6) \\
& = - \sum_j \left(\beta J_{oj}^2 - \frac{1}{3} \beta^3 J_{oj}^4 \right) \left(\beta^2 J_{oj}^2 - \frac{1}{3} \beta^4 J_{oj}^4 \right) \overline{t_j^4} \\
& - \sum_j \sum_{j_1} \left(\beta J_{oj}^2 - \frac{1}{3} \beta^3 J_{oj}^4 \right) \left(\beta^2 J_{oj}^2 - \frac{1}{3} \beta^4 J_{oj}^4 \right) \\
& \quad \overline{t_j^2} \overline{t_{j_1}^2} \\
& = - \left[\frac{1}{2} \beta^3 J^4 + 0 \left(\frac{1}{z^2} \right) \right] \overline{t_j^4} \\
& - \left(\beta \widehat{J^2} - \frac{1}{3z} \beta^3 \widehat{J^4} \right) \left(\beta^2 \widehat{J^2} - \frac{1}{3z} \beta^4 \widehat{J^4} \right) \overline{t_j^2} \overline{t_j^2} \\
& = - \frac{1}{z} \beta^3 \widehat{J^4} \overline{t_j^4} - \left[\beta^3 (\widehat{J^2})^2 - \frac{2}{3z} \beta^5 \widehat{J^2} \widehat{J^4} \right] \overline{t_j^2} \overline{t_j^2} \\
\sum_j \beta J_{oj} t_j I_2 & = \sum_j \beta J_{oj} t_j (I_2' + I_2'') \\
& = \left[\beta^3 (\widehat{J^2})^2 - \frac{2}{3z} \beta^5 \widehat{J^2} \widehat{J^4} \right] \overline{t_j^2} \\
& - \left[\beta^3 (\widehat{J^2})^2 - \frac{2}{3z} \beta^5 \widehat{J^2} \widehat{J^4} + \beta^5 (\widehat{J^2})^3 \right. \\
& \quad \left. - \frac{4}{3z} \beta^7 (\widehat{J^2})^2 \widehat{J^4} \right] \overline{t_j^2} \overline{t_j^2} - \frac{1}{z} \beta^3 \widehat{J^4} \overline{t_j^4} \\
I_3 & = \sum_j J_{oj} t_j^3 \left(\beta J_{oj} - \frac{1}{3} \beta^3 J_{oj}^3 \right)^2
\end{aligned}$$

$$\begin{aligned}
& [1 - (\beta_{0j} - \frac{1}{3}\beta^3 J_{0j}^3)^2] \\
\sum_j \beta_{0j} t_j I_3 &= \sum_j \sum_j \beta_{0j} J_{0j} (\beta_{0j}^2 J_{0j}^2 - \frac{2}{3}\beta^4 J_{0j}^4 + \frac{1}{9}\beta^6 J_{0j}^6) \\
& (1 - \beta^2 J_{0j}^2 + \frac{2}{3}\beta^4 J_{0j}^4 - \frac{1}{9}\beta^6 J_{0j}^6) \overline{t_j^3 t_j} \\
&= \sum_j \beta_{0j}^2 J_{0j}^2 (\beta_{0j}^2 J_{0j}^2 - \frac{5}{3}\beta^4 J_{0j}^4 + \dots) \overline{t_j^4} \\
&= \frac{1}{z} \beta^3 \widehat{J^4} \overline{t_j^4} + 0 \left(\frac{1}{z^2}\right)
\end{aligned}$$

$$I_4 = \sum_j J_{0j} t_j^2 (\beta_{0j} - \frac{1}{3}\beta^3 J_{0j}^3)^3 (1 - t_j^2) \langle S_0 \rangle$$

$$\langle S_0 \rangle = \sum_1 (\beta_{01} - \frac{1}{3}\beta^3 J_{01}^3) t_1 + 0 (t^3)$$

$$\begin{aligned}
\sum_j \beta_{0j} t_j I_4 &= \sum_j \sum_j \sum_1 J_{0j} (\beta_{0j} - \frac{1}{3}\beta^3 J_{0j}^3)^3 \\
& \beta_{0j} (\beta_{01} - \frac{1}{3}\beta^3 J_{01}^3) \overline{t_j^2 (1 - t_j^2) t_j t_1} \\
&= \sum_j J_{0j} (\beta_{0j} - \frac{1}{3}\beta^3 J_{0j}^3)^3 (\beta_{0j}^2 J_{0j}^2 - \frac{1}{3}\beta^4 J_{0j}^4) \overline{t_j^4} \\
&+ \sum_j \sum_j J_{0j} (\beta_{0j} - \frac{1}{3}\beta^3 J_{0j}^3)^3 (\beta_{0j}^2 J_{0j}^2 - \frac{1}{3}\beta^4 J_{0j}^4) \\
& \overline{t_j^2} \overline{t_j^2} \\
&= 0 \left(\frac{1}{z^2}\right) + \left(\frac{1}{z} \beta^3 \widehat{J^4}\right) (\beta^2 \widehat{J^2} - \frac{1}{3z} \beta^4 \widehat{J^4}) \overline{t_j^2} \overline{t_j^2} \\
&= \frac{1}{z} \beta^5 \widehat{J^2} \widehat{J^4} \overline{t_j^2} \overline{t_j^2}
\end{aligned}$$

$$\begin{aligned}
\sum_j \beta_{0j} t_j \sum_j J_{0j} \langle S_j \rangle &= [\beta \widehat{J^2} - \frac{1}{z} \beta^3 \widehat{J^4} + \beta^3 (\widehat{J^2})^2 - \frac{2}{3z} \beta^5 \widehat{J^2} \widehat{J^4}] \overline{t_j^2} \\
&- [\beta^3 (\widehat{J^2})^2 - \frac{5}{3z} \beta^5 \widehat{J^2} \widehat{J^4} + \beta^5 (\widehat{J^2})^3] \\
&- \frac{4}{3z} \beta^7 (\widehat{J^2})^2 \widehat{J^4}] \overline{t_j^2} \overline{t_j^2}
\end{aligned}$$

The second term of the right hand side of Eq. (2.18) is

$$\begin{aligned}
\beta \langle S_0 \rangle \sum_j J_{0j}^2 (1 - \langle S_j \rangle^2) &= \beta \langle S_0 \rangle \sum_j J_{0j}^2 - \beta \langle S_0 \rangle \sum_j J_{0j}^2 \langle S_j \rangle^2 \\
&= A - B'
\end{aligned}$$

Where

$$A = \beta \langle S_0 \rangle \sum_j J_{0j}^2$$

$$= \beta \langle S_0 \rangle J^2$$

$$\begin{aligned} \sum_j \beta J_{0j} t_j A &= \beta^2 \hat{J}^2 \sum_j J_{0j} t_j \langle S_0 \rangle \\ &= \beta^2 \hat{J}^2 \sum_j J_{0j} t_j \left[\sum_{j=1}^z t_j (\beta J_{0j} - \frac{1}{3} \beta^3 J_{0j}^3) \right. \\ &\quad \left. + \frac{1}{3} \sum_{j=1}^z t_j^3 (\beta^3 J_{0j}^3 + \dots) \right. \\ &\quad \left. - \frac{1}{3} \sum_{i,j,k} g_i g_j g_k t_i t_j t_k \right] \\ &= \beta^2 \hat{J}^2 \left[\sum_j \overline{t_j t_j} J_{0j} (\beta J_{0j} - \frac{1}{3} \beta^3 J_{0j}^3) \right. \\ &\quad \left. + \frac{1}{3} \sum_j \overline{t_j t_j^3} J_{0j} (\beta^3 J_{0j}^3 + \dots) \right. \\ &\quad \left. - \frac{1}{3} \sum_{j,i,k} J_{0j} g_i g_j g_k \overline{t_i t_j t_k t_j} \right] \\ &= \beta^2 \hat{J}^2 \left[\sum_j \overline{t_j^2} (\beta J_{0j}^2 - \frac{1}{3} \beta^3 J_{0j}^4) \right. \\ &\quad \left. + \frac{1}{3} \sum_j \overline{t_j^4} (\beta^3 J_{0j}^4 + \dots) - \frac{1}{3} \sum_j J_{0j} g_j^3 \overline{t_j^4} \right. \\ &\quad \left. - \sum_j \overline{J_{0j} g_j g_j^2 t_j^2 t_j^2} \right] \\ &= \beta^2 \hat{J}^2 \left[\overline{t_j^2} (\beta \hat{J}^2 - \frac{1}{3z} \beta^3 \hat{J}^4) + \frac{1}{3z} \overline{t_j^4} \beta^3 \hat{J}^4 \right. \\ &\quad \left. + 0 \left(\frac{1}{z^2} \right) - \frac{1}{3z} \beta^3 \hat{J}^4 \overline{t_j^4} \right. \\ &\quad \left. - (\beta \hat{J}^2 - \frac{1}{3z} \beta^3 \hat{J}^4) (\beta^2 \hat{J}^2 - \frac{2}{3z} \beta^4 \hat{J}^4) \overline{t_j^2 t_j^2} \right] \\ &= \beta^2 \hat{J}^2 \left[\overline{t_j^2} (\beta \hat{J}^2 - \frac{1}{3z} \beta^3 \hat{J}^4) + \frac{1}{3z} \overline{t_j^4} \beta^3 \hat{J}^4 \right. \\ &\quad \left. - \frac{1}{3z} \beta^3 \hat{J}^4 \overline{t_j^4} \right. \\ &\quad \left. - [(\hat{J}^2)^2 \beta^3 - \frac{1}{z} \beta^5 \hat{J}^2 \hat{J}^4] \overline{t_j^2 t_j^2} \right] \\ &= \beta^2 \hat{J}^2 \left[\overline{t_j^2} (\beta \hat{J}^2 - \frac{1}{3z} \beta^3 \hat{J}^4) \right. \\ &\quad \left. - (\beta^3 (\hat{J}^2)^2 - \frac{1}{z} \beta^5 \hat{J}^2 \hat{J}^4) \overline{t_j^2 t_j^2} \right] \end{aligned}$$

$$\begin{aligned}
B' &= \beta \langle S_0 \rangle \sum_j J_{0j}^2 \langle S_j \rangle^2 \\
&= \beta \langle S_0 \rangle \sum_j J_{0j}^2 [t_j^2 (1 - 2g_{0j}^2 + g_{0j}^4) \\
&\quad + 2g_{0j} (1 - g_{0j}^2) (t_j - t_j^3) \langle S_0 \rangle \\
&\quad + g_{0j}^2 (1 - t_j^2) \langle S_0 \rangle^2] \\
&= \sum_j \beta J_{0j}^2 (1 - 2g_{0j}^2 + g_{0j}^4) \langle S_0 \rangle t_j^2 \\
&\quad + 2 \sum_j \beta J_{0j}^2 g_{0j} (1 - g_{0j}^2) \langle S_0 \rangle^2 (t_j - t_j^3) \\
&\quad + \sum_j \beta J_{0j}^2 g_{0j}^2 \langle S_0 \rangle^3 (1 - t_j^2)^2 \\
\sum_J \beta J_{0J} t_J B' &= \sum_J \sum_j \beta^2 J_{0J} J_{0j}^2 (1 - 2g_{0j}^2 + g_{0j}^4) \langle S_0 \rangle t_j^2 t_J \\
&\quad + 2 \sum_J \sum_j \beta^2 J_{0J} J_{0j}^2 g_{0j} (1 - g_{0j}^2) t_J t_j \langle S_0 \rangle^2 \\
&\quad + \sum_J \sum_j \beta^2 J_{0J} J_{0j}^2 g_{0j}^2 \langle S_0 \rangle^3 t_J
\end{aligned}$$

Only the leading order term of $\langle S_0 \rangle$ has to be considered here since all the other terms will give rise to t^6 terms.

$$\begin{aligned}
\sum_J \beta J_{0J} t_J B' &= B_1' + B_2' + B_3' \\
B_1' &= \sum_J \sum_j \beta^2 J_{0J} J_{0j}^2 (1 - 2g_{0j}^2 + g_{0j}^4) S_0 t_j^2 t_J \\
&= \sum_J \sum_j \beta^2 J_{0J} J_{0j}^2 (1 - 2g_{0j}^2 + g_{0j}^4) \sum_1 g_1 t_j^2 t_J t_1 \\
&= \sum_J \beta^2 J_{0J}^3 g_J (1 - 2g_J^2 + g_J^4) \overline{t_J^4} \\
&\quad + \sum_J \sum_j \beta^2 J_{0J} J_{0j}^2 g_J (1 - 2g_{0j}^2 + g_{0j}^4) \overline{t_j^2} \overline{t_J^2} \\
&= \frac{1}{2} \beta^3 J^4 \overline{t_J^4} + (\sum_J \beta^2 J_{0J} g_J) \\
&\quad [\sum_j J_{0j}^2 (1 - 2g_{0j}^2 + g_{0j}^4)] \overline{t_j^2} \overline{t_J^2}
\end{aligned}$$

B₂

$$\begin{aligned}
&= \frac{1}{z} \beta^3 \widehat{J^4} \overline{t_J^4} + (\beta^3 \widehat{J^2} - \frac{1}{3z} \beta^5 \widehat{J^4}) (\widehat{J^2} - \frac{2}{z} \beta^2 \widehat{J^4}) \\
&\quad \cdot \overline{t_j^2} \overline{t_j^2} \\
&= \frac{1}{z} \beta^3 \widehat{J^4} \overline{t_J^4} + [\beta^3 (\widehat{J^2})^2 - \frac{7}{3z} \beta^5 \widehat{J^2} \widehat{J^4}] \overline{t_j^2} \overline{t_j^2} \\
&= 2 \sum_J \sum_j \beta^2 J_{0j} J_{0j}^2 g_{0j} (1 - g_{0j}^2) \langle S_0 \rangle^2 t_j t_j \\
&= 2 \sum_J \sum_j \beta^2 J_{0j} J_{0j}^2 g_{0j} (1 - g_{0j}^2) t_j t_j \sum_{k, l} g_{kj} g_{lj} t_k t_l \\
&= 2 \sum_J \beta^2 J_{0j}^3 g_{0j}^3 (1 - g_{0j}^2) \overline{t_J^4} \\
&\quad + 2 \sum_J \beta^2 J_{0j}^3 g_{0j} (1 - g_{0j}^2) \overline{t_J^2} \sum_k g_k^2 \overline{t_k^2} \\
&\quad + 4 \sum_J J_{0j} g_J \overline{t_J^2} \sum_j \beta^2 g_{0j}^2 J_j^2 \overline{t_j^2} \\
&= 0(\frac{1}{z^2}) + \frac{2}{z} \beta^3 \widehat{J^4} (\beta^2 \widehat{J^2} - \frac{2}{3z} \beta^4 \widehat{J^4}) \overline{t_J^2} \overline{t_k^2} \\
&\quad + 4 (\beta \widehat{J^2} - \frac{1}{3z} \beta^3 \widehat{J^4}) (\frac{1}{z} \beta^4 \widehat{J^4}) \overline{t_J^2} \overline{t_j^2} \\
&= \frac{2}{z} \beta^5 \widehat{J^2} \widehat{J^4} \overline{t_J^2} \overline{t_k^2} + \frac{4}{z} \beta^5 \widehat{J^2} \widehat{J^4} \overline{t_J^2} \overline{t_j^2} \\
&= \sum_J \sum_j \beta^2 J_{0j} J_{0j}^2 g_{0j}^2 \langle S_0 \rangle^3 t_j \\
&= \beta^2 \sum_J \sum_j J_{0j} J_{0j}^2 g_{0j}^2 t_j \sum_{1,2,3} g_1 g_2 g_3 t_1 t_2 t_3 \\
&= \beta^2 \sum_j J_{0j}^2 g_{0j}^2 \sum_{J,1,2,3} J_{0j} g_1 g_2 g_3 t_1 t_2 t_3 t_j \\
&= \frac{1}{z} \beta^4 \widehat{J^4} \sum_{J,1,2,3} J_{0j} g_1 g_2 g_3 t_1 t_2 t_3 t_j \\
&= \frac{1}{z} \beta^4 \widehat{J^4} [\sum_J J_{0j} g_J^3 \overline{t_J^4} + 3 \sum_{J,1} J_{0j} g_J g_1^2 \overline{t_J^2} \overline{t_1^2}] \\
&= \frac{1}{z} \beta^4 \widehat{J^4} [\frac{1}{z} \beta^3 \widehat{J^4} \overline{t_J^4} \\
&\quad + 3(\beta \widehat{J^2} - \frac{1}{3z} \beta^3 \widehat{J^4}) (\beta^2 \widehat{J^2} - \frac{2}{3z} \beta^4 \widehat{J^4}) \overline{t_J^2} \overline{t_1^2}] \\
&= \frac{3}{z} \beta^7 (\widehat{J^2})^2 \widehat{J^4} \overline{t_J^2} \overline{t_1^2}
\end{aligned}$$

B₃

$$\begin{aligned}
\sum_j \beta J_{0j} t_j B' &= B'_1 + B'_2 + B'_3 \\
&= \frac{1}{z} \beta^3 \widehat{J^4} \overline{t_j^4} \\
&\quad + [\beta^3 (\widehat{J^2})^2 + \frac{11}{3z} \beta^5 \widehat{J^2} \widehat{J^4}] \\
&\quad + \frac{3}{z} \beta^7 (\widehat{J^2})^2 \widehat{J^4} \overline{t_j^2} \overline{t_j^2}
\end{aligned}$$

$$\begin{aligned}
\sum_j \beta J_{0j} t_j \beta \langle S_0 \rangle \sum_j J_{0j}^2 (1 - \langle S_j \rangle^2) &= \sum_j \beta J_{0j} t_j (A - B') \\
&= [\beta^3 (\widehat{J^2})^2 - \frac{1}{3z} \beta^5 \widehat{J^2} \widehat{J^4}] \overline{t_j^2} \\
&\quad - \frac{1}{z} \beta^3 \widehat{J^4} \overline{t_j^4} \\
&\quad + [-\beta^5 (\widehat{J^2})^3 - \beta^3 (\widehat{J^2})^2 - \frac{11}{3z} \beta^5 \widehat{J^2} \widehat{J^4}] \\
&\quad - \frac{2}{z} \beta^7 (\widehat{J^2})^2 \widehat{J^4} \overline{t_j^2} \overline{t_j^2}
\end{aligned}$$

Finally after collecting every terms we obtain

$$\overline{t_j^4} + (-1 - \frac{1}{2} \beta^2 \widehat{J^2}) \overline{t_j^2} + [8\beta^2 \widehat{J^2} + 5\beta^4 (\widehat{J^2})^2] \overline{t_j^2} \overline{t_j^2} = 0 \quad (2.18')$$

where

$$\begin{aligned}
\overline{t} &= \int_{-\infty}^{\infty} P(H) t \, dH \\
\widehat{J} &= \int_{-\infty}^{\infty} P(J) J \, dJ \\
\overline{t_j^2} &= \int_{-\infty}^{\infty} [c \delta(H - mzJ_1) \\
&\quad + (1 - c) \delta(H - mzJ_2)] t^2 \, dH \\
&= c \cdot \tanh^2(\beta mzJ_1) + (1 - c) \tanh^2(\beta mzJ_2) \\
&= cq_1^2 + (1 - c) q_2^2 \\
\overline{t_j^4} &= c \tanh^4(\beta mzJ_1) + (1 - c) \tanh^4(\beta mzJ_2) \\
&= cq_1^4 + (1 - c) q_2^4
\end{aligned}$$

$$\begin{aligned}
\overline{t_j^2} \overline{t_j^2} &= [cq_1^2 + (1-c)q_2^2]^2 \\
\widehat{j^2} &= [c\delta(J-J_1) + (1-c)\delta(J-J_2)]J^2 dJ \\
&= cJ_1^2 + (1-c)J_2^2 \\
\widehat{j^4} &= cJ_1^4 + (1-c)J_2^4 \\
(\widehat{j^2})^2 &= [cJ_1^2 + (1-c)J_2^2]^2
\end{aligned}$$

Substitute these terms in Eq. (2.18) we get

$$\begin{aligned}
&[cq_1^4 + (1-c)q_2^4] - [1 + \frac{1}{2}\beta^2 (cJ_1^2 + (1-c)J_2^2)] [cq_1^2 + (1-c)q_2^2] \\
&+ [8\beta^2 (cJ_1^2 + (1-c)J_2^2) + 5\beta^4 (cJ_1^2 + (1-c)J_2^2)^2] \\
&[cq_1^2 + (1-c)q_2^2]^2 = 0 \quad (2.18'')
\end{aligned}$$

$$\text{let } J_2 = aJ_1$$

$$(J_1/k_B T)^2 = X$$

Rearrange Eq. (2.18'') we get

$$\begin{aligned}
&[cq_1^4 + (1-c)q_2^4] - [1 + \frac{1}{2}(c + (1-c)a^2)X] [cq_1^2 + (1-c)q_2^2] \\
&+ [8(c + (1-c)a^2)X + 5(c + (1-c)a^2)^2 X^2] [cq_1^2 + (1-c)q_2^2]^2 \\
&= 0 \quad (2.19)
\end{aligned}$$

From Eq. (2.11) we get

$$m - cq_1 - (1-c)q_2 = 0 \quad (2.19')$$

$$\text{where } q_1 = \tanh(m z x)$$

$$q_2 = \tanh(m z x a)$$

APPENDIX B
COMPUTER PROGRAM

B1 PROGRAM FOR EVALUATING THE APPROXIMATE VALUE X AND M WITH C = 0

B1.1 PROGRAM FOR EVALUATING X WHEN Z, A AND M ARE GIVEN

```
10 PRINT CHR$(15)
20 PRINT
30 INPUT "Z= ";Z
40 INPUT "A= ";A
50 PRINT : PRINT
60 PRINT "M", "X"
70 PRINT
80 FOR MM = 1 TO 9
90 M = MM / 10
100 X = ( LOG ((1 + M) / (1 - M))) / (2 * A * Z * M)
110 PRINT M, X
120 NEXT MM
130 END
```

B1.2 PROGRAM FOR EVALUATING M WHEN Z, A AND X ARE GIVEN

```
10 PRINT CHR$(15)
20 PRINT
30 INPUT "A = ";A
40 INPUT "Z = ";Z
50 INPUT "X1 = ";X1
60 INPUT "X2 = ";X2
70 PRINT : PRINT
80 PRINT "X", "M"
90 PRINT
100 FOR XX = (X1 * 100) TO (X2 *
    100)
110 X = XX / 100
120 P = SQR ((1 + 0.5 * A * A *
    X) / (1 + B * A * A * X + 5 *
    A * A * A * A * X * X))
130 M = ( LOG ((1 + P) / (1 - P))
    ) / (2 * A * Z * X)
140 PRINT X, M
150 NEXT XX
160 END
```

B2 NEWTON-RAPHSON METHOD PROGRAM

```

1 PRINT CHR$(15)
2 PRINT
3 POKE 1657,80
10 INPUT "A=" ;A
20 INPUT "Z=" ;Z
30 INPUT "M=" ;M
40 INPUT "X=" ;X
41 PRINT : PRINT
42 PRINT " C";
43 HTAB (13): PRINT "M";
44 HTAB (27): PRINT "X";
45 HTAB (38): PRINT "SOR(X)"
46 PRINT
50 FOR CC = 0 TO 100:
55 C = CC / 100
60 REM PRINT "C","M","X","SOR(X)"
100 E1 = EXP (X * M * Z)
110 E2 = EXP (- X * M * Z)
120 F1 = EXP (X * M * Z * A)
130 F2 = EXP (- X * M * Z * A)
140 Q1 = (E1 - E2) / (E1 + E2)
150 Q2 = (F1 - F2) / (F1 + F2)
160 S1 = 2 / (E1 + E2)
170 S2 = 2 / (F1 + F2)
180 C1 = C + ((1 - C) * A * A)
190 Q3 = (C * Q1 * Q1) + ((1 - C) * Q2 * Q2)
200 Z2 = M * Z * S1 * S1
210 Z1 = M * Z * A * S2 * S2
220 P = (C * Q1 * Q1 * Q1 * Q1) + (Q2 * Q2 * Q2 * Q2 * (1 - C)) - ((1 + (.5 * C1 * X)) * Q3) + (((8 * C1 * X) + (5 * C1 * C1 * X * X)) * Q3 * Q3)
230 B = M - (C * Q1) - (Q2 * (1 - C))
240 GX = (- C * Z * M * S1 * S1) - ((1 - C) * Z * A * M * S2 * S2)
250 GM = 1 - (C * Z * X * S1 * S1) - ((1 - C) * Z * A * X * S2 * S2)
260 P1 = (4 * C * Q1 * Q1 * Q1 * Z2) + ((1 - C) * 4 * Q2 * Q2 * Q2 * Z1) - ((1 + (.5 * C1 * X)) * ((2 * C * Q1 * Z2) + (2 * (1 - C) * Q2 * Z1)))
270 P2 = - (.5 * Q3 * C1) + (((8 * C1 * X) + (5 * C1 * C1 * X * X)) * 2 * Q3 + ((2 * C * Q1 * Z2) + (2 * (1 - C) * Q2 * Z1))) + (Q3 * Q3 * ((8 * C1) + (16 * C1 * C1 * X)))
280 PX = P1 + P2
290 P3 = (4 * C * Q1 * Q1 * Q1 * Z * X * S1 * S1) + ((1 - C) * 4 * Q2 * Q2 * Q2 * A * Z * X * S2 * S2) - ((1 + (.5 * C1 * X)) * ((2 * C * Q1 * Z * X * S1 * S1) + ((1 - C) * 2 * Q2 * A * Z * X * S2 * S2)))
300 P4 = (((8 * C1 * X) + (5 * C1 * C1 * X * X)) * 2 * Q3 + ((2 * C * Q1 * Z * X * S1 * S1) + ((1 - C) * 2 * Q2 * A * Z * X * S2 * S2)))
310 PM = P3 + P4
320 D = (PX * GM) - (PM * GX)
330 H = ((8 * PM) - (P * GM)) / D
340 K = ((P * GX) - (G * PX)) / D
350 X = X + H
360 M = M + K
380 IF ABS (H) > .000000001 THEN GOTO 100
390 IF ABS (K) > .000000001 THEN GOTO 100
395 PRINT C:
396 HTAB (6): PRINT M;
397 HTAB (22): PRINT X;
398 HTAB (36): PRINT SQR (X)
410 NEXT CC
415 PR# 0
420 END

```


B3 LEAST SQUARES METHOD PROGRAM FOR CURVE FITTING

```

1 PRINT CHR$(15)
2 PRINT
3 POKE 1657,80
5 C1 = 0.1
10 C2 = 0.2
15 C3 = 0.3
20 C4 = 0.4
25 C5 = 0.5
30 C6 = 0.6
35 C7 = 0.7
40 C8 = 0.8
45 C9 = 0.9
50 INPUT "Y1 = ";Y1
55 INPUT "Y2 = ";Y2
60 INPUT "Y3 = ";Y3
65 INPUT "Y4 = ";Y4
70 INPUT "Y5 = ";Y5
75 INPUT "Y6 = ";Y6
80 INPUT "Y7 = ";Y7
85 INPUT "Y8 = ";Y8
90 INPUT "Y9 = ";Y9
95 P0 = 9
100 P1 = C1 + C2 + C3 + C4 + C5 + C6 + C7 + C8 + C9
105 P2 = (C1 ^ 2) + (C2 ^ 2) + (C3 ^ 2) + (C4 ^ 2) + (C5 ^ 2) + (C6 ^ 2) +
(C7 ^ 2) + (C8 ^ 2) + (C9 ^ 2)
110 P3 = (C1 ^ 3) + (C2 ^ 3) + (C3 ^ 3) + (C4 ^ 3) + (C5 ^ 3) + (C6 ^ 3) +
(C7 ^ 3) + (C8 ^ 3) + (C9 ^ 3)
115 P4 = (C1 ^ 4) + (C2 ^ 4) + (C3 ^ 4) + (C4 ^ 4) + (C5 ^ 4) + (C6 ^ 4) +
(C7 ^ 4) + (C8 ^ 4) + (C9 ^ 4)
120 V1 = Y1 + Y2 + Y3 + Y4 + Y5 + Y6 + Y7 + Y8 + Y9
125 V2 = (C1 * Y1) + (C2 * Y2) + (C3 * Y3) + (C4 * Y4) + (C5 * Y5) + (C6 *
Y6) + (C7 * Y7) + (C8 * Y8) + (C9 * Y9)
130 V3 = Y1 * (C1 ^ 2) + Y2 * (C2 ^ 2) + Y3 * (C3 ^ 2) + Y4 * (C4 ^ 2) +
Y5 * (C5 ^ 2) + Y6 * (C6 ^ 2) + Y7 * (C7 ^ 2) + Y8 * (C8 ^ 2) + Y9 *
(C9 ^ 2)
135 D1 = P0 * (P2 * P4 - P3 * P3) - P1 * (P1 * P4 - P2 * P3) + P2 * (P1 *
P3 - P2 * P2)
140 D2 = V1 * (P2 * P4 - P3 * P3) - P1 * (V2 * P4 - V3 * P3) + P2 * (V2 *
P3 - V3 * P2)
145 D3 = P0 * (V2 * P4 - V3 * P3) - V1 * (P1 * P4 - P2 * P3) + P2 * (P1 *
V3 - P2 * V2)
150 D4 = P0 * (P2 * V3 - P3 * V2) - P1 * (P1 * V3 - P2 * V2) + V1 * (P1 *
P3 - P2 * P2)
155 E = D1 / D4
160 F = D2 / D4
165 B = P3 / D4
170 PRINT "E", "F", "B"
175 PRINT E, F, B
180 END

```

A = 2
Z = 6

<p>A = .5 Z = 6</p> <p>Y1 = .624218128 Y2 = .594912309 Y3 = .567886197 Y4 = .543715886 Y5 = .522250866 Y6 = .503109198 Y7 = .485880136 Y8 = .470254264 Y9 = .456019235 E .654553354 F -.320166999 G .111628855</p>	<p>A = 1.5 Z = 6</p> <p>Y1 = .350935971 Y2 = .368031129 Y3 = .375540936 Y4 = .383503903 Y5 = .391961908 Y6 = .400958804 Y7 = .410535745 Y8 = .42072419 Y9 = .43154372 E .354652822 F .0412607598 G .0267340651</p>	<p>A = 2 Z = 6</p> <p>Y1 = .311638343 Y2 = .321037672 Y3 = .321318189 Y4 = .342621899 Y5 = .355122613 Y6 = .369037848 Y7 = .384629767 Y8 = .402170829 Y9 = .42175459 E .307933001 F .0584000743 G .0810839157</p>
--	--	---

A = 2
Z = 7

<p>A = .5 Z = 7</p> <p>Y1 = .584702198 Y2 = .557348923 Y3 = .531858374 Y4 = .508942905 Y5 = .48860498 Y6 = .470482567 Y7 = .454216242 Y8 = .439494871 Y9 = .426079408 E .613455743 F -.3018031176 G .104844633</p>	<p>A = 1.5 Z = 7</p> <p>Y1 = .336705523 Y2 = .343376148 Y3 = .350438558 Y4 = .357925392 Y5 = .365888116 Y6 = .374355225 Y7 = .383367585 Y8 = .392950184 Y9 = .403101711 E .330785416 F .0576746205 G .0256994406</p>	<p>A = 2 Z = 7</p> <p>Y1 = .290424256 Y2 = .299252242 Y3 = .306910901 Y4 = .31953536 Y5 = .331293477 Y6 = .344394768 Y7 = .359091442 Y8 = .375427185 Y9 = .394018506 E .284015262 F .0597380567 G .0653822973</p>
--	--	---

A = .5
Z = 8

A = 1.5
Z = 8

A = 2
Z = 8

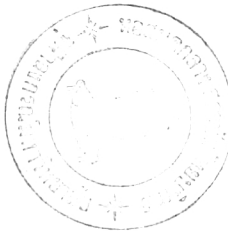
Y1 = .552715333	Y1 = .31710442	Y1 = .273346229
Y2 = .526996038	Y2 = .323511238	Y2 = .281711446
Y3 = .502790905	Y3 = .330211605	Y3 = .290566807
Y4 = .480096103	Y4 = .337320592	Y4 = .300942661
Y5 = .46144659	Y5 = .344875609	Y5 = .312102135
Y6 = .44415429	Y6 = .352913594	Y6 = .324549784
Y7 = .429660486	Y7 = .361467725	Y7 = .338528523
Y8 = .414660666	Y8 = .3705579366	Y8 = .35421267
Y9 = .401916999	Y9 = .380162049	Y9 = .37166076
E F G	E F G	E F G
.550168296 -.286549122 .0990153842	.311554443 .054798639 .0237253449	.267554317 .0565626243 .0650527865

A = .5
Z = 9

A = 1.5
Z = 9

A = 2
Z = 9

Y1 = .526100531	Y1 = .301015093	Y1 = .259211791
Y2 = .501777032	Y2 = .307056209	Y2 = .267191859
Y3 = .47868115	Y3 = .313455685	Y3 = .275928802
Y4 = .457646247	Y4 = .320247421	Y4 = .285549473
Y5 = .438932361	Y5 = .327466985	Y5 = .296213712
Y6 = .422317239	Y6 = .335148603	Y6 = .308122357
Y7 = .40759463	Y7 = .343319649	Y7 = .321502979
Y8 = .394056636	Y8 = .351989941	Y8 = .336553621
Y9 = .381871098	Y9 = .361140718	Y9 = .35313066
E F G	E F G	E F G
.552419459 -.273300066 .0937027693	.295623009 .0524335703 .0225551957	.253675356 .0539536201 .0622953636



A = .5
Z = 10

A = 1.5
Z = 10

A = 2
Z = 10

Y1 = .503480172	Y1 = .287332483	Y1 = .247259705
Y2 = .480369933	Y2 = .293130368	Y2 = .25491248
Y3 = .458248509	Y3 = .299274336	Y3 = .263294345
Y4 = .437957374	Y4 = .305796926	Y4 = .272529597
Y5 = .419864427	Y5 = .312731794	Y5 = .282775778
Y6 = .403616592	Y6 = .320110276	Y6 = .294230683
Y7 = .389492966	Y7 = .327654809	Y7 = .307117938
Y8 = .376593862	Y8 = .336268876	Y8 = .321582971
Y9 = .364881192	Y9 = .345026599	Y9 = .33743865
E F G	E F G	E F G
.528865367 -.262018 .0891219436	.282139441 .9504454852 .0215322255	.241931805 .0518000884 .0596791664

Z= 6 A= .5		Z= 6 A= 1		Z= 6 A= 1.5		Z= 6 A= 2	
M	X	M	X	M	X	M	X
.1	.334451159	.1	.167225579	.1	.11148372	.1	.9836127897
.2	.33788759	.2	.168943795	.2	.112629197	.2	.9844718975
.3	.343910671	.3	.171995336	.3	.11463689	.3	.9859776678
.4	.353040775	.4	.176520387	.4	.117680258	.4	.9882601937
.5	.366204096	.5	.183102048	.5	.122068032	.5	.9915510241
.6	.385081767	.6	.192540883	.6	.128360589	.6	.9962704418
.7	.413000251	.7	.206500126	.7	.13766675	.7	.103250063
.8	.45775512	.8	.22887756	.8	.15258504	.8	.11443878
.9	.545266477	.9	.272633239	.9	.181755493	.9	.136316619

Z= 7 A= .5		Z= 7 A= 1		Z= 7 A= 1.5		Z= 7 A= 2	
M	X	M	X	M	X	M	X
.1	.286672422	.1	.145336211	.1	.0955574739	.1	.0716681055
.2	.289617934	.2	.144808967	.2	.0965393115	.2	.0724044836
.3	.294780575	.3	.147390288	.3	.0982601918	.3	.0736951438
.4	.302606379	.4	.151303199	.4	.100868793	.4	.0756515947
.5	.313889225	.5	.156944613	.5	.104629742	.5	.0784723063
.6	.330070086	.6	.165035043	.6	.110023362	.6	.0825175215
.7	.354000215	.7	.177800108	.7	.118000072	.7	.0885000538
.8	.392361532	.8	.196180766	.8	.130787177	.8	.098090383
.9	.467371266	.9	.233685633	.9	.155790422	.9	.116842817

Table 22

Z= 8 A= .5		Z= 8 A= 1		Z= 8 A= 1.5		Z= 8 A= 2	
M	X	M	X	M	X	M	X
.1	.250838369	.1	.125419185	.1	.0836127897	.1	.0627095923
.2	.253415693	.2	.126707846	.2	.0844718975	.2	.0633539232
.3	.257933004	.3	.128966502	.3	.0859776678	.3	.0644832509
.4	.264780581	.4	.132390291	.4	.0882601937	.4	.0661951453
.5	.274653072	.5	.137326536	.5	.0915510241	.5	.0686632681
.6	.289811325	.6	.144405663	.6	.0962704418	.6	.0722028313
.7	.309750188	.7	.154875094	.7	.103250063	.7	.0774375471
.8	.34331634	.8	.17165817	.8	.11443878	.8	.0858290851
.9	.408949858	.9	.204474929	.9	.136316619	.9	.102237465

Z= 9 A= .5		Z= 9 A= 1		Z= 9 A= 1.5		Z= 9 A= 2	
M	X	M	X	M	X	M	X
.1	.222967439	.1	.11148372	.1	.0743224798	.1	.0557418598
.2	.225258393	.2	.112629197	.2	.0750861311	.2	.0563145984
.3	.229273781	.3	.11463669	.3	.0764245936	.3	.0573184452
.4	.235360517	.4	.117680258	.4	.0784533056	.4	.0588401292
.5	.244136064	.5	.122068032	.5	.0813786881	.5	.061034016
.6	.256721178	.6	.128360589	.6	.085573726	.6	.0641802945
.7	.275333501	.7	.13766675	.7	.0917778337	.7	.0688333752
.8	.30517009	.8	.15258504	.8	.10172336	.8	.07629252
.9	.363510985	.9	.181755493	.9	.121170328	.9	.0908777463

Z= 10 A= .5		Z= 10 A= 1		Z= 10 A= 1.5		Z= 10 A= 2	
M	X	M	X	M	X	M	X
.1	.200670695	.1	.100335348	.1	.0668902318	.1	.0501676738
.2	.202732554	.2	.101366277	.2	.067577518	.2	.0506831385
.3	.206346403	.3	.103173201	.3	.0687821343	.3	.0515866007
.4	.211824465	.4	.105912233	.4	.070608155	.4	.0529561163
.5	.219722458	.5	.109861229	.5	.0732408193	.5	.0549306145
.6	.23104906	.6	.11552453	.6	.0770163534	.6	.057762265
.7	.247809151	.7	.123900075	.7	.0826000503	.7	.0619500377
.8	.274653072	.8	.137326536	.8	.0915510241	.8	.0686632681
.9	.327159686	.9	.163579943	.9	.109053295	.9	.0817899716

Z= 6 A= .5 X1= .30 X2= .50		Z= 6 A= 1 X1= .10 X2= .30		Z= 6 A= 1.5 X1= .06 X2= .26		Z= 6 A= 2 X1= .04 X2= .24	
X	M	X	M	X	M	X	M
.3	1.21536332	.1	1.63450784	.06	1.61047435	.04	1.68793394
.31	1.16196451	.11	1.43125914	.07	1.29461986	.05	1.22683356
.32	1.1124154	.12	1.26714582	.08	1.07016599	.06	.943057575
.33	1.06633424	.13	1.13231457	.09	.903839699	.07	.753801243
.34	1.02338696	.14	1.01990082	.1	.776503973	.08	.620158909
.35	.98328008	.15	.924987308	.11	.676440079	.09	.521660304
.36	.945754799	.16	.843966969	.12	.596106759	.1	.446605041
.37	.91058209	.17	.774138884	.13	.530451335	.11	.387867463
.38	.877558585	.18	.713443993	.14	.475973344	.12	.340884364
.39	.846503143	.19	.660287516	.15	.430178307	.13	.302611727
.4	.817253919	.2	.613416778	.16	.391245227	.14	.270948998
.41	.789665911	.21	.571835372	.17	.35781672	.15	.24440467
.42	.763408844	.22	.534741719	.18	.328862354	.16	.221893501
.43	.73896538	.23	.501484337	.19	.303587214	.17	.20260899
.44	.715629568	.24	.471528788	.2	.281369248	.18	.185940608
.45	.693505521	.25	.444432998	.21	.261715413	.19	.171418588
.46	.672506262	.26	.41982802	.22	.244230397	.2	.158676206
.47	.652552729	.27	.397404506	.23	.228593932	.21	.147423452
.48	.633572907	.28	.376900622	.24	.21454408	.22	.137428292
.49	.615501973	.29	.358093732	.25	.201864753	.23	.128503114
		.3	.34075339			.24	.120494765

Table 23

Z= 7 A= .5 X1= .25 X2= .45		Z= 7 A= 1 X1= .10 X2= .30		Z= 7 A= 1.5 X1= .06 X2= .26		Z= 7 A= 2 X1= .04 X2= .24	
X	M	X	M	X	M	X	M
.25	1.33549786	.1	1.49100672	.06	1.38040659	.04	1.44680052
.26	1.26626169	.11	1.22679355	.07	1.10967417	.05	1.05157162
.27	1.20290368	.12	1.08612498	.08	.917285133	.06	.808335064
.28	1.14473973	.13	.970555347	.09	.774719742	.07	.646115351
.29	1.09118571	.14	.874200703	.1	.665574834	.08	.531564779
.3	1.04173999	.15	.792846264	.11	.579895782	.09	.447137403
.31	.995969576	.16	.723400259	.12	.510948651	.1	.382804321
.32	.953498918	.17	.663547615	.13	.454672573	.11	.332457825
.33	.914000779	.18	.611523423	.14	.407977152	.12	.292186598
.34	.877188823	.19	.565960728	.15	.368724263	.13	.25938148
.35	.842811497	.2	.52578581	.16	.335353052	.14	.232241999
.36	.810646971	.21	.490144605	.17	.306709046	.15	.209489717
.37	.780498934	.22	.458350045	.18	.281882018	.16	.19019443
.38	.752193074	.23	.429943718	.19	.260217612	.17	.173664849
.39	.725574123	.24	.404167532	.2	.241173642	.18	.159377664
.4	.70050336	.25	.380942493	.21	.224327497	.19	.146930218
.41	.676856496	.26	.359852589	.22	.209340341	.2	.136008177
.42	.654521867	.27	.340632454	.23	.195937656	.21	.126362959
.43	.633398897	.28	.323057674	.24	.183894926	.22	.117795679
.44	.613396773	.29	.306937465	.25	.173026931	.23	.110145526
.45	.594133304	.3	.29210062			.24	.103281227

Z= 8 A= .5 X1= .25 X2= .45		Z= 8 A= 1 X1= .10 X2= .30		Z= 8 A= 1.5 X1= .05 X2= .25		Z= 8 A= 2 X1= .04 X2= .24	
X	M	X	M	X	M	X	M
.25	1.15856063	.1	1.22588088	.05	1.56038742	.04	1.26595045
.26	1.10797896	.11	1.07344435	.06	1.20785576	.05	.920125167
.27	1.05254072	.12	.950359362	.07	.970964995	.06	.707293181
.28	1.00164727	.13	.849235928	.08	.802624492	.07	.565350933
.29	.954787495	.14	.764925615	.09	.677879775	.08	.465119182
.3	.911522488	.15	.693740481	.1	.58237798	.09	.391245228
.31	.871473379	.16	.632975227	.11	.50733906	.1	.334953781
.32	.834311554	.17	.580604163	.12	.447089069	.11	.290900597
.33	.799750682	.18	.535062995	.13	.397838501	.12	.255663273
.34	.767540221	.19	.495215637	.14	.356980008	.13	.226958795
.35	.73746006	.2	.460062583	.15	.32263373	.14	.203211749
.36	.7093161	.21	.428876529	.16	.293433921	.15	.183303502
.37	.682936568	.22	.40105625	.17	.26836254	.16	.166420126
.38	.658166939	.23	.376113253	.18	.246646765	.17	.151956743
.39	.634877357	.24	.353646591	.19	.227690411	.18	.139455456
.4	.61294044	.25	.333324681	.2	.211026937	.19	.128563941
.41	.592249434	.26	.314871015	.21	.19628656	.2	.119007155
.42	.572706634	.27	.29805338	.22	.183172798	.21	.110567589
.43	.554224035	.28	.282675466	.23	.171445449	.22	.103071219
.44	.536722177	.29	.268570299	.24	.16090806	.23	.0963773356
.45	.520129141	.3	.255595042	.25	.151398565	.24	.0903710735

Z= 9 A= .5 X1= .20 X2= .40		Z= 9 A= 1 X1= .10 X2= .30		Z= 9 A= 1.5 X1= .05 X2= .25		Z= 9 A= 2 X1= .03 X2= .23	
X	M	X	M	X	M	X	M
.2	1.40321144	.1	1.08967189	.05	1.38701104	.03	1.68952775
.21	1.31429963	.11	.954172758	.06	1.07364957	.04	1.12528929
.22	1.23458137	.12	.844763877	.07	.863079906	.05	.817889037
.23	1.16276071	.13	.754876381	.08	.713443993	.06	.62870505
.24	1.09776964	.14	.67993388	.09	.6025598	.07	.502534162
.25	1.03872056	.15	.616658206	.1	.517669316	.08	.413439272
.26	.984870206	.16	.562644646	.11	.450960053	.09	.347773536
.27	.935591747	.17	.516092589	.12	.397404506	.1	.297736694
.28	.890353126	.18	.475629329	.13	.353634224	.11	.258578308
.29	.848699996	.19	.440191678	.14	.317315563	.12	.227256243
.3	.810242211	.2	.408944518	.15	.286785538	.13	.201741151
.31	.774643004	.21	.381223581	.16	.260830152	.14	.180632666
.32	.74161027	.22	.35649448	.17	.23854448	.15	.162936446
.33	.710889495	.23	.334322892	.18	.219241569	.16	.147929001
.34	.682257974	.24	.314352525	.19	.202391476	.17	.13507266
.35	.655520054	.25	.296288605	.2	.187579499	.18	.123960405
.36	.6305032	.26	.279885347	.21	.174476942	.19	.114279058
.37	.607054727	.27	.264936337	.22	.162820265	.2	.105784138
.38	.585039057	.28	.251267081	.23	.152395955	.21	.0982823016
.39	.564335429	.29	.238729155	.24	.143029387	.22	.0916188614
.4	.544835946	.3	.227195593	.25	.134576502		

Z= 10 A= .5 X1= .20 X2= .40		Z= 10 A= 1 X1= .10 X2= .30		Z= 10 A= 1.5 X1= .05 X2= .25		Z= 10 A= 2 X1= .03 X2= .23	
X	M	X	M	X	M	X	M
.2	1.26289029	.1	.990704704	.05	1.24830994	.03	1.52057498
.21	1.18286967	.11	.858755482	.06	.96628461	.04	1.01276036
.22	1.11112323	.12	.76028749	.07	.776771916	.05	.736100133
.23	1.04648464	.13	.679389743	.08	.642099594	.06	.565834545
.24	.987992675	.14	.611940492	.09	.54230382	.07	.452280746
.25	.934848505	.15	.554992385	.1	.465902384	.08	.372095345
.26	.886383185	.16	.506380182	.11	.405864048	.09	.312996182
.27	.842032572	.17	.46448333	.12	.357664056	.1	.267963025
.28	.801317813	.18	.428066396	.13	.318270801	.11	.232720477
.29	.763829996	.19	.39617251	.14	.285584006	.12	.204530618
.3	.72921799	.2	.368050067	.15	.258106984	.13	.181567036
.31	.697178703	.21	.343101223	.16	.234747137	.14	.162569399
.32	.667449243	.22	.320845032	.17	.214690032	.15	.146642802
.33	.639800545	.23	.300890602	.18	.197317412	.16	.133136101
.34	.614032177	.24	.282917272	.19	.182152329	.17	.121565394
.35	.589969048	.25	.266659745	.2	.168821549	.18	.111564364
.36	.56745288	.26	.251896812	.21	.157029246	.19	.102851152
.37	.546349254	.27	.238442704	.22	.146538238	.2	.0952057238
.38	.526535152	.28	.226140373	.23	.137156359	.21	.0884540715
.39	.507901896	.29	.214856239	.24	.128726448	.22	.0824569752
.4	.490352352	.3	.204476034	.25	.121118852		

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