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MULTIPLE MIXING RATIOS OF GAMMA RAY TRANSITIONS FROM ${}^{142-150}_{60}\mathrm{Nd}\,(\mathrm{n},\mathrm{n}'\gamma)^{142-150}_{60}\mathrm{Nd}$ REACTION USING a_2- RATIO METHOD

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Abstract

In the current work, the mixing ratios (δ) of gamma transitions were calculated from energy levels in the isotopes neodymium ${}^{142-150}_{60}Na$ populated in the ${}^{142-150}_{60}\mathrm{Nd}\,(\mathrm{n},\mathrm{n}'\gamma)^{142-150}_{60}\mathrm{Nd}$ using the a_2 ratio method. We used the experimental coefficient (a_2) for two γ-transitions from the initial state itself, the statistical tensor $\rho_2(J_i)$, associated with factor a_2, would be the same for the two transitions. The results obtained are in good agreement or within the experimental error with -those previously published. And existing contradictions resulting from inaccuracies in the empirical results of previous work. The current results confirm that the , a_2 – method is used to calculate the values of mixing ratios and the feasibility of this method in predicting errors in experimental results.

Keywords: Multiple Mxing Ratios, ${}^{142-150}_{60}\mathrm{Nd}\,(\mathrm{n},\mathrm{n}'\gamma)^{142-150}_{60}\mathrm{Nd}$; Gamma Transitions; a_2 –Ratio Method.

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1. Introduction

The mixing ratios are defined as the ratio between the matrix elements for electric Quadra pole E_2 and the magnetic dipole M_2 for the transition of gamma from the elementary to final level. The angular distribution measurements of gamma radiation are sensitive to interference between matrix elements for E_2 and M_2.There are different terms in the literature because of the different formulas proposed for the interpretation of angular distribution [1].Therefore, the definition used for the mixing ratio should be determined in the angular distribution measurements. The definition of the user in the current research is the definition of Steffen and Alder [2]:

$$\delta = \frac{\langle J_f | E_2 | J_i \rangle}{\langle J_f | M_1 | J_I \rangle} \dots \dots \dots \quad (1)$$

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Gamma rays are known to be electromagnetic radiation, for transmission of gamma radiation from the initial level of spin J_i and parity π_i to a final level of spin J_f and parity π_f , the transition by emission of single 2^L pole quantum is possible if the following condition is met:

$$|J_i - J_f| \leq L \leq (J_i + J_f) \ldots\ldots\ldots\ldots \quad (2)$$

Where L represents the angular momentum of the gamma rays. It is known that L for gamma irradiation is not equal to $L \neq 0$. In such transitions, the change in the parity of the electrical radiation (EL) is as follows:

$$\pi_i.\pi_f = (-1)^L \ldots\ldots\ldots\ldots \quad (3)$$

And for magnetic radiation (ML)

$$\pi_i.\pi_f = (-1)^{L+1} \ldots\ldots\ldots\ldots\ldots \quad (4)$$

If both the primary and the final levels are identical, the possible transitions are$E2$, M1, E4, M3, etc., but if the two levels are different, the transitions M2, E1, M4, E3, etc. are possible.

The wavelength of emitted radiation (λ) is usually much greater than that of the emitted radiated nucleus radius (R). The radiation intensity is reduced by increasing L by $(\lambda/R)^{2L}$ [3], and therefore:
$E_1 > E_2 > E_3 > etc.$ and $M_1 > M_2 > M_3 > etc.$ Therefore, large values of L values can be ignored and the smallest values taken into account. If the parity of the two levels is similar, mixing is only $(ML + E(L+1))$, if the parity of the two levels is different, mixing is only $(EL + M(L+1))$.

However, the magnetic transitions are usually slower than the electric transitions at about $(v/c)^2$ time at L value itself. Where (v) represents the speed of the charges and (c) the speed of light in the vacuum [3]. If we assume that:

$$R = 1.2A^{1/3}\, F \ldots\ldots\ldots\ldots \quad (5)$$

Where R is the radius of the nucleus excited with Fermi units (F) and (A) the mass number of the excited nucleus. The relationship between the wavelength of the magnetic radiation and the wavelength of the electrical radiation of the value of (L) itself is as follows [4]:

$$\lambda(ML) = 0.3A^{-2/3}\, \lambda\,(EL) \ldots\ldots\ldots\ldots \quad (6)$$

Thus, $E1 > M1$ and $E2 > M2$, thus, the first mixing $[ML + E\,(L + 1)]$ is more likely than the second mixing $[EL + M\,(L + 1)]$.

If δ is the mixing ratio, [3]

$$\delta^2 = \Gamma(L+1)/\,\Gamma(L) \ldots\ldots \quad (7)$$

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Where $\Gamma(L) + \Gamma(L+1) = \Gamma_\gamma \ldots\ldots\ldots..$ (8)

And Γ_γ represents the total gamma width and is linked to the average age of the primary level (τ) and the following relationship [3]:

$$\Gamma_\gamma . \tau = \hbar = \frac{h}{2\pi} \ldots .... \quad (9)$$

Where h represents Plank constant, $(\hbar)$ is Dirac constant.

Transitions where one of the spins (J_i orJ_f) is zero, are pure transitions ($\delta = 0$)

If both J_i and J_f are zero, the transition from the primary to the final level does not emit gamma rays because $(L = 0)$ but is usually done by Internal conversion or by Pair Production $(e^+ - e^-)$ when the difference between the two energies of the two levels is greater than twice rest mass energy of electron ($E_i - E_f > 2\, m_0 c^2$).

2. Theory

Angular distribution is defined as the distribution in angles relative to an experimentally specified direction, of the density of photons or particles resulting from nuclear reactions [5]. The angular expression of the transmission of gamma rays from the primary state of spin J_i (the magnetic Quantitative number m_i) can be expressed to the final state of spin J_f (the magnetic Quantitative number m_f) by the following relationship [6].

$$w(\theta) = \sum_k A_k P_k \text{Cos}\theta \ldots\ldots\ldots \ldots\ldots\ldots\ldots \quad (10)$$

$$w(\theta) = \sum_k \rho_k (J_k) F_k (J_i J_f \delta) P_k \text{Cos}\theta \ldots\ldots\ldots \quad (11)$$

Where

A_k == is the angular distribution coefficient
θ = is the angle between the direction of the γ- rays and the axis of alignment (beam direction).
$P_k \text{Cos}\theta$ = is the Legendre polynomial.
$\rho_k(J_k)$ =is statistical tensor which describe the alignment of the initial state
$F_k(J_i J_f \delta)$ =Coefficients which contain the information on angular momentum changes and the multipole mixing

$$F_k(J_i J_f \delta) = \frac{F_k(J_f L_1 L_1 J_i) + 2\delta\, F_k(J_f L_1 L_2 J_i) + \delta^2 F_k(J_f L_2 L_2 J_i)}{(1+\delta^2)} \ldots\ldots\ldots \; [7] \quad (12)$$

Where $L_2 = L_1 + 1 \ldots\ldots\ldots\ldots ....$ (13)

$F_k(J_f L_1 L_2 J_i) = (-1)^{J_f - J_i - 1} [(2L_1+1)(2L_2+1)(2J_i+1)]^{1/2} (L_1 1 L_2 - 1|K0)^* W(J_i J_i L_1 L_2, K J_f) \ldots (14)$

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Where
$(L_1 1 L_2 - 1|K0)$ = are Calabash –Gordon Coefficients and $W(J_i J_i L_1 L_2, KJ_f)$ are Racah Coefficients
The triangular condition on the Racah Coefficients limit k to [6]:

$$0 \leq K \leq \min(2L_1, 2L_2, 2J_i) \dots\dots\dots \quad (15)$$

Fork $= 0$,

$$F_0(J_f L_1 L_2 J_i) = \delta_{L_1 L_2} = \begin{cases} 1 & \text{if } L_1 = L_2 \\ 0 & \text{if } L_1 \neq L_2 \end{cases} \dots\dots\dots \quad (16)$$

The statistical tensor, $\rho_k(J_i)$ are given by a weighted sum over the population parameter, $P(m_i)$ of the $(2J_i + 1)$ magnetic substrates associated with (J_i)[6]:

$$\rho_k(J_i) = \sum_{\substack{m_i=0 \\ \text{or} \\ m_i=\frac{1}{2}}}^{J_i} \rho_k(J_i)\ (J_i\ m_i)P(m_i) \dots\dots\dots \quad (17)$$

With the normalization

$$\sum_{m_i=-J_i}^{J_i} P(m_i) = 1 \dots\dots \quad (18)$$

For an aligned and un polarized initial a state,
$P(m_i) = P(-m_i)$
So that $P(m_i)$ values are in the range

$$0 \leq P(m_i) \leq \frac{1}{2}\left(1 + \delta_{m,0}\right) \dots\dots\dots \quad (19)$$

Where

$$\delta_{m,0} = \begin{cases} 1 & \text{when } m = 0 \\ 0 & \text{when } m \neq 0 \end{cases}$$

And hence

$$\rho_k(J_i, m_i) = (2 - \delta_{m,0})\frac{(J_i m_i J_{i\_} m_i|K0)}{(J_i m_i J_{i\_} m_i|00)} \dots\dots\dots \quad (20)$$

The Clesch –Gordan coefficients$(J_i m_i J_{i_} m_i|K0)$, are zero for odd values of k and hence eq.(11) contains only even values of k ,(k=0,2,4,…..)

When k=0, the equation (20) becomes

$$\rho_k(J_i, m_i) = \left(2 - \delta_{m,0}\right) \dots\dots \quad (21)$$

Therefore

$$\rho_0(J_i) = 1 \dots\dots\dots \quad (22)$$

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Al-Zuhairi calculated the coefficients F_2, F_4 for the correct integer of spin from halves of multiples odd numbers from $J_i = \frac{3}{2}$ to $J_f = \frac{61}{2}$ and $J_i = 1$ to $J_f = 40$ .As outlined in the Appendix (A).

From eq.(22) its clear that $\rho_0(J_i) = F_0(J_f J_i \delta) = 1$ and $a_k = \frac{A_k}{A_0}$ then

$$a_k = \rho_k(J_i) \frac{F_k(J_f L_1 L_1 J_i) + 2\delta F_k(J_f L_1 L_2 J_i) + \delta^2 F_k(J_f L_2 L_2 J_i)}{(1+\delta^2)} \dots\dots\dots\dots\dots\dots \quad (23)$$

$a_2 - ratio$ Method depends only on the experimental a_2-coefficients obtained for at least two γ-transitions from the same level one of which is pure transition or may be considered as a pure transition.For gamma transition from level J_i to level J_{f_1}

$$a_2(J_i - J_{f_1}) = \rho_2(J_i) \frac{F_2(J_{f_1} L_1 L_1 J_i) + 2\delta_1 F_2(J_{f_1} L_1 L_2 J_i) + \delta_1^2 F_2(J_{f_1} L_2 L_2 J_i)}{(1+\delta_1^2)} \dots\dots.. \quad (24)$$

For gamma transition from level J_i to level J_{f_2}

$$a_2(J_i - J_{f_2}) = \rho_2(J_i) \frac{F_2(J_{f_2} L_1 L_1 J_i) + 2\delta_2 F_2(J_{f_2} L_1 L_2 J_i) + \delta_2^2 F_2(J_{f_2} L_2 L_2 J_i)}{(1+\delta_2^2)} \dots\dots.. \quad (25)$$

This method has been applied in previous studies [8, 9, 10, 11] if the second transition pure or can be considered its transition a pure, in which case $\delta_2 = zero$, so

$$\frac{a_2(J_i - J_{f_1})}{a_2(J_i - J_{f_2})} = \frac{F_2(J_{f_1} L_1 L_1 J_i) + 2\delta_1 F_2(J_{f_1} L_1 L_2 J_i) + \delta_1^2 F_2(J_{f_1} L_2 L_2 J_i)}{(1+\delta_1^2) F_2(J_{f_2} L_1 L_1 J_i)} \dots\dots.. \quad (26)$$

Where
$\rho_2(J_i)$ = is the same for both transitions

3. Results and Discussions

The tables (1, 2, 3, 4) show the energy levels in isotopes of neodymium (^{142}Na, ^{144}Na, ^{146}Na, ^{150}Na) , respectively, which have two transitions, one of which is pure $(2^+ - 0)$ and the other is mixed $(2^+ - 2^+)$. For isotope ^{148}Na, there is no level such as these transitions within the energy levels published in reference [12]. In these tables, pure $E2$ transitions represent transitions $(2^+ - 0)$, due to the following:

$$|J_i - J_f| \le L \le (J_i + J_f) \rightarrow |2-0| \le L \le (2+0) \rightarrow 2 \le L \le 2 \rightarrow L = 2\ only$$

$\pi_i . \pi_f = (-1)^L$ (The change in the parity of the electrical radiation (EL))
π_i = the parity of initial level= (+)
π_f== the parity of final level= (+)
$(+) \times (+) = (-1)^L \rightarrow L = even\ numbers = 2,4,6, \dots\dots, k \rightarrow EL = E2 \quad because\ L = 2\ only$
$\pi_i . \pi_f = (-1)^{L+1}$ (The change in the parity of the magnetice radiation (ML))

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$(+)\times(+)=(-1)^{L+1}\rightarrow L=odd\ numbers=1,2,3,5,\ldots\ldots,k\ \rightarrow\ ML=M1,M3,M5,\ldots$
$\rightarrow ML\ is\ not\ found\ \ because\ \ L=2\ only$

Therefore pure $E2$ transitions represent transitions $(2^{+}-0)$
While the transition $(2^{+}\ -\ 2^{+})$ is a mixed transition due to the following:

$$|J_i-J_f|\le L\le(J_i+J_f)\ \rightarrow\ |2-2|\le L\le(2+2)\rightarrow\ 0\le L\le 4\rightarrow L=0,1,2,3,4$$

For the electrical radiation

$(+)\times(+)=(-1)^{L}\rightarrow\ \ L=even\ numbers\ \rightarrow EL=\ E2\ ,E4\quad but\ EL\neq E0\ because\ L\neq 0$
$EL=E2\ only\ because\ \ E2>E3>\ E4\rightarrow E2\ >>\ E4$

For the magnetice radiation

$(+)\times(+)=(-1)^{L+1}\rightarrow\ L=odd\ numbers, ML=M1,M3$
$ML=M1\ because\ M1>M2>M3\rightarrow\ \ M1>>M3$

Table 1: mixing ratios of $\gamma-$ transitions of excited energy levels $(\ 2^{+}-\ 2^{+})$ for $^{142}_{60}$Nd − isotop using a_2-ratio method

E_i(KeV)	E_γ(KeV)	$\frac{a_2}{a_4}$[13]	$\delta-values$		
			Reference [13]	**Reference [14]**	**a_2-ratio (Present work)**
2384.3	2384	0.297(17) −0.063(24)	E_2	E_2	E_2
	808.5	0.329(37) 0.078(50)	0.16(6) … … ..	0.20(5) 1.3(2)	$(0.23^{+0.13}_{-0.09})$ 1.3(3)
2583.1	2583.1	0.214(19) −0.080(30)	E_2	E_2	E_2
	1007.3	0.030(22) 0.020(30)	−0 .28(3) … … ….	−0.28(2) $(6.5^{+1.3}_{-0.8})$	−0.26(5) $(6^{+2.5}_{-1.3})$
2845.8	2845.8	0.325(25) −0.090(30)	E_2	E_2	E_2
	1270	−0.220(90) −0.160(130)	−0.60(30) $-(6^{+29}_{-3})$	−0.82(8) −3.7(7)	$-(0.83^{+?}_{-0.27})$ $-(3.6^{+7.2}_{-?})$
3045 .1	3045.1	0.250(9) −0.096(25)	E_2	E_2	E_2
	1469.5	0.290(60) −0.030(80)	$0.1<\delta<1.5$	0.20(9) 1.4(3)	$(0.28^{+?}_{-0.17})$ $(1.2^{+0.5}_{-?})$
3128	3128	0.210(40) 0.030(50)	E_2	E_2	E_2
	1552.2	−0.120(24) −0.020(30)	−0.69(9) $-(\ 5.1^{+2.2}_{-1.4})$	−0.61(4) −5.8(14)	$-(0.71^{+0.19}_{-0.13})$ $-(5^{+4.7}_{-1.9})$
3358.7	3358.6	0.210(80) −0.080(100)	E_2	E_2	E_2
	1782.9	−0.200(40) 0.020(50)	$-5<\delta<-0.7$	$-(0.84^{+0.20}_{-0.10})$ $-(\ 3.4^{+1.3}_{-0.9})$	Imaginary roost

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It is clear from the table (1) that the values of mixing ratios (δ) obtained by the a_{2-} ratio method, in good agreement or within the experimental error with the results published in the reference [13], and adopted δ- values in reference [14]. The contradiction appears in γ −transition($1782.9\ KeV$) from level ($3358.7KeV$).The imaginary roots obtained in the calculation of values (δ) for this transition refer to the a_{2-}coefficient of γ −transition(3358.6 keV) or a_{2-}coefficient of γ −transition ($1782.9KeV$) incorrect. If the value of a_{2-}coefficient = 0.210 for the transition of ($3358.6\ keV$) is incorrect, the a_{2-}coefficient for transition ($2583.1\ keV$) ($a_2 = 0.214$) and the a_{2-}coefficient for transition ($3128.0\ keV$) ($a_2 = 0.210$) is also incorrect, although the values δ calculated for the two transitions (1007.3KeV) and ($1552.2\ keV$) of the same levels are agreement with the values δ of references[13 and 14].The reason for this agreement is that the value of a_{2-} coefficient for each of these transfers is relatively small and therefore not sensitive to a value δ calculation in this way.

Table 2: mixing ratios of γ − transitions of excited energy levels ($2^+ - 2^+$) for ${}^{144}_{60}$Nd − isotop using a_2-ratio method

E_i(KeV)	E_γ(KeV)	$\frac{a_2}{a_4}$[15]	δ − *values*		
			Reference [15]	**Reference [14]**	**a_2-ratio (Present work)**
1560.5	1560.5	0.363(67) −0.011(81)	E_2	E_2	E_2
	864.2	−0.165(30) −0.088(43)	−0.73(8) … … ..	−0.70(6) ($4.6^{+1.5}_{-0.9}$)	−0.61(10) −($7.8^{+8.2}_{-2.5}$)
2072.2	2072.1	0.417(52) 0.029(56)	E_2	E_2	E_2
	1375.9	0.309(38) −0.005(56)	0.13(7) 1.7(3)	0.12(4) 1.5(2)	0.02(6) 2.1(4)
2526.7	2526.5	0.466(52) 0.012(74)	E_2	E_2	E_2
	1830.5	0.393(59) −0.048(84)	0.50(25) … … ….	Imaginary roost	0.07(7) 1.9(4)

It is clear from the table (2) that the values of mixing ratios (δ) from two levels(1560.5 ,2072.2)KeV, which have been calculated by a_2-ratio method in the current work are agreement with published values-δ in the exporters [14,15].For the γ −transition($1830.5\ KeV$), none of the δ values calculated in the current search agree with the δ values published in the report [15]. This indicates that the a_2 −coefficient of transition ($2526.5\ KeV$)or a_2 −coefficient of transmission ($1830.5KeV$) is incorrect. This confirms what is stated in the reference [14] regarding the inaccuracy of the experimental results of the transitions (2526.5,1830.5)KeV from the level ($2526.7KeV$).

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Table 3: mixing ratios of $\gamma -$ transitions of excited energy levels ($2^+ - 2^+$) for $^{146}_{60}\mathrm{Nd} -$ isotop using a_2-ratio method

E_i(KeV)	E_γ(KeV)	$\frac{a_2}{a_4}$[16]	$\delta - values$		
			Reference [16]	Reference [14]	a_2-ratio (Present work)
1470.4	1470.4	0.312(34) −0.092(67)	E_2	E_2	E_2
	1016.5	0.050(25) −0.020(31)	−0.24(5) $(5.4^{+3.0}_{-2.3})$	−0.24(2) 5.7(7)	−0.25(4) $(5.7^{+1.6}_{-1.0})$
1787.2	1787.2	0.281(35) −0.013(44)	E_2	E_2	E_2
	1333.2	−0.111(37) 0.000(47)	−0.64(11) $-(10^{+70}_{-4})$	−0.58(7) $-(11^{+18}_{-2})$	$-(0.56^{+0.11}_{-0.09})$ $-(11^{+40}_{-5})$
1977.8	1977.4	0.322(50) −0.036(61)	E_2	E_2	E_2
	1523.7	0.177(29) −0.000(38)	−0.07(4) 2.8(4)	−0.05(2) 2.6(2)	−0.07(6) $(2.7^{+0.6}_{-0.4})$
2286.0	1831.7	0.083(14) −0.003(17)	−0.19(3) 4.4(5)	−0.19(2) 4.2(3)	−0.16(4) $(3.7^{+0.7}_{-0.5})$
	1243.2*	0.066(12) −0.047(15)	E_2	E_2	E_2

Where (*) represents a pure transition.

From the table (3), we observe that the (δ) values calculated in a_2-ratio method in the current search are agreement with (δ) values published in the two references[14,16] within the experimental error.

Table 4: mixing ratios of $\gamma -$ transitions of excited energy levels ($2^+ - 2^+$) for $^{150}_{60}\mathrm{Nd} -$ isotop using a_2-ratio method

E_i(KeV)	E_γ(KeV)	$\frac{a_2}{a_4}$[17]	$\delta - values$		
			Reference [17]	Reference [18]	a_2-ratio (Present work)
1061.6	1061.7	0.277(12) −0.005(14)	E_2	E_2	E_2
	931.6	−0.144(29) 0.006(35)	−0.75(10) … ….	$-(0.68^{+0.12}_{-0.09})$ $-(5.5^{+3.2}_{-1.7})$	$-(0.68^{+0.12}_{-0.09})$ $-(5.5^{+3.2}_{-1.7})$
2260.4	1584.0	0.305(79) −0.010(86)	E_2	E_2	E_2
	1198.5	−0.228(38) −0.051(46)	$-(1.6^{+?}_{-0.4})$ … ….	$-(1.3^{+?}_{-0.4})$ $-(1.8^{+1.4}_{-?})$	$-(1.3^{+?}_{-0.4})$ $-(1.8^{+1.4}_{-?})$

From the table (4), we can see that the (δ) values calculated in a_2-ratio methods in the current search are agreement with (δ) values published in the two references [17, 18].

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4. Conclusions

The empirical results published in the references[13,14,15,16,17,18]are correct and the results of the current study are agreement with them, Contradictions exist in the two transitions ($808.6\ and\ 1270KeV$) in the two levels ($2384.3 and\ 2845.9KeV$) in ^{142}Nd isotop due to the inaccuracy of the $a_{2,}, a_{4-}$coefficients measured in the reference [13] of these two transitions.

The possibility of $a_{2,}$-ratio method not only at the expense of (δ) values but also in predicting the existence of any error of empirical results was confirmed
The $a_{2,}$-ratio method was not used in the case of $^{148}_{60}Nd$ isotope because there were no two transition from level has spin 2^{+}, one of which is pure transition.

Appendix (A)

J_i	L_1	L_2	J_f	F_2	F_4
1	1	1	0	0.70711	0
1	1	1	1	-0.35355	0
1	1	2	1	-1.06067	0
1	2	2	1	-0.35355	0
1	1	1	2	0.07071	0
1	1	2	2	0.47434	0
1	2	2	2	0.35355	0
1	2	2	3	-0.10101	0
1	2	3	3	0.37796	0
1	3	3	3	0.53034	0
1	3	3	4	-0.17678	0
2	2	2	0	-0.59761	-1.06904
2	1	1	1	0.41833	0
2	1	2	1	-0.93542	0
2	2	2	1	-0.29881	0.71269
2	1	1	2	-0.41833	0
2	1	2	2	-0.61238	0
2	2	2	2	0.12806	-0.30544
2	1	1	3	0.11952	0
2	1	2	3	0.65466	0
2	2	2	3	0.34149	0.07636
2	2	2	4	-0.17075	-0.00848
2	2	3	4	0.50507	-0.06274
2	3	3	4	0.44822	-0.02970
2	3	3	5	-0.29881	0.00405
3	3	3	0	-0.86603	0.21320
3	2	2	1	-0.49487	-0.44670
3	2	3	1	-0.46290	1.04463
3	3	3	1	-0.64953	0.03553
3	1	1	2	0.34641	0

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3	1	2	2	-0.94869	0
3	2	2	2	-0.12372	0.67006
3	1	1	3	-0.43301	0
3	1	2	3	-0.43301	0
3	2	2	3	0.22682	-0.44670
3	1	1	4	0.14434	0
3	1	2	4	0.72169	0
3	2	2	4	0.30929	0.14890
3	2	2	5	-0.20620	-0.02030
3	2	3	5	0.54554	-0.13430
3	3	3	5	0.36085	-0.05492
3	3	3	6	-0.36085	0.00969
4	3	3	1	-0.78349	0.14527
4	2	2	2	-0.44770	-0.30438
4	2	3	2	-0.52972	0.90036
4	3	3	2	-0.47009	-0.04842
4	1	1	3	0.31339	0
4	1	2	3	-0.94018	0
4	2	2	3	-0.04477	0.60876
4	1	1	4	-0.43875	0
4	1	2	4	-0.33541	0
4	2	2	4	0.26455	-0.49807
4	1	1	5	0.15955	0
4	1	2	5	0.75679	0
4	2	2	5	0.28490	0.19370
4	2	2	6	-0.22792	-0.02980
4	2	3	6	0.56407	-0.184337
4	3	3	6	0.29915	-0.06874
4	3	3	7	-0.39887	0.01422
5	3	3	2	-0.73599	0.11589
5	2	2	3	-0.42056	-0.24281
5	2	3	3	-0.55634	0.80301
5	3	3	3	-0.36799	-0.07726
5	1	1	4	0.29439	0
5	1	2	4	-0.93095	0
5	2	2	4	0	0.56556
5	1	1	5	-0.44159	0
5	1	2	5	-0.27386	0
5	2	2	5	0.28307	-0.52297
5	1	1	6	0.16984	0
5	1	2	6	0.77832	0
5	2	2	6	0.26689	0.22413
5	2	2	7	-0.24263	-0.03736
5	2	3	7	0.57416	-0.22100
5	3	3	7	0.25476	-0.07726

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5	3	3	8	-0.42461	0.01783
6	3	3	3	-0.70510	0.09967
6	2	2	4	-0.40291	-0.20883
6	2	3	4	-0.56980	0.73833
6	3	3	4	-0.30219	-0.09018
6	1	1	5	0.28204	0
6	1	2	5	-0.92319	0
6	2	2	5	0.02878	0.53699
6	1	1	6	-0.44320	0
6	1	2	6	-0.23146	0
6	2	2	6	0.29355	-0.53699
6	1	1	7	0.17728	0
6	1	2	7	0.79283	0
6	2	2	7	0.25326	0.24613
6	2	2	8	-0.25326	-0.04343
6	2	3	8	0.58028	0.24879
6	3	3	8	0.22160	-0.08292
6	3	3	9	-0.44321	0.02073

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