

Part 4 : “New Advanced Study of Magic Squares and Cubes”

Chapter 6 : Fundamental Study of Multi-Dimensional Extra-Cubic Forms and their Decomposed Ones: Kanji Setsuda

Section 1 : Study of Four-Dimensional Extra-Cubic Forms of Order 3 and their Developed Ones

#1. Dimensions of Magic Squares and Cubes

Let's try to make some experiments and enhance our insight of looking through the whole fundamental structures of magic figures.

Say. I would like to build some extra-cubic magic objects by increasing the dimensions up to 4.

Isn't it visible? No, it isn't. Is it possible? Yes, it is.

Every magic square and cube is built in the regular array N^m ($N=3, 4, 5, 6, \dots$; $m=2$ or 3). We know that we can make any memory array, for instance, of 3^4 , or 2^6 in our computer space. The array of 3^4 is denoted by the four coordinates as: $n(0,0,0,0)$, $n(0,0,0,1)$, \dots , $n(1,1,1,1)$, \dots , $n(2,2,2,2)$. We can store any data into any position $n(i, j, k, l)$. Of course $i, j, k, l=0, 1, 2$.

If you could not make such a memory array as of 3^4 in your computer, you should have given up your wish to make such a crazy thing.

But you can really make such a memory array 3^4 in your computer space. Then you are able to make such a magic form as 4-Dimensional Extra-Cubic Object of Order 3.

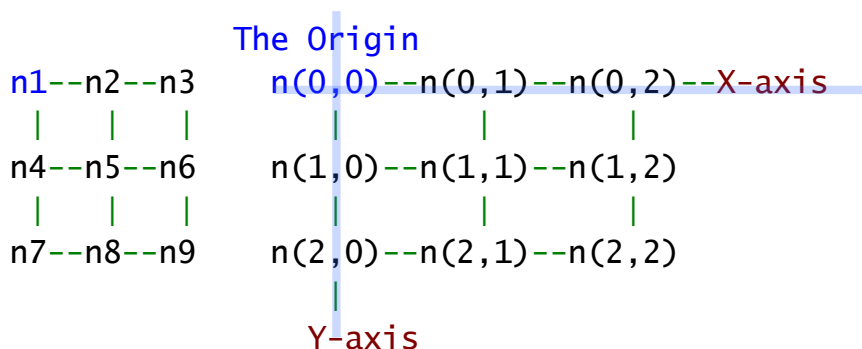
How does it look like? No one can draw a single picture of that object.

But we do not deal with the problem of appearance. The essential problem is how we should have the whole consecutive integer 1, 2, 3, 4, 5, \dots , 80, 81 stored into the array 3^4 . Instead of drawing pictures we must think how we can rearrange them and what conditions we must give to it first of all.

Dimension itself is difficult to explain, but I tried to make some figures for you to understand it easily. Take a look at the next figures full of axes.

Suppose n_1 as the Origin $n(0,0,0,0)$, and you will see four axes: **x-**, **y-**, **z-** and **w-axis** meet on the same Origin. Each axis directly stands for each dimension of the object. Four-dimensional objects must have four axes meeting on the same Origin.

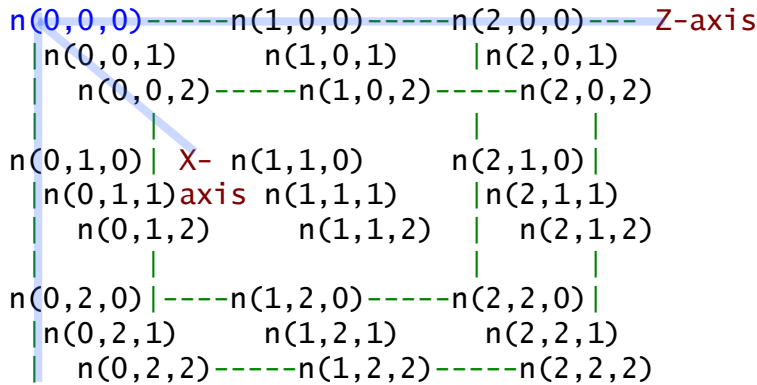
[Figure 1: 2-Dimensional Square built in the Regular Array 3^2]



[3-dimensional Cube built in the Regular Array $3*3*3$]

X-axis

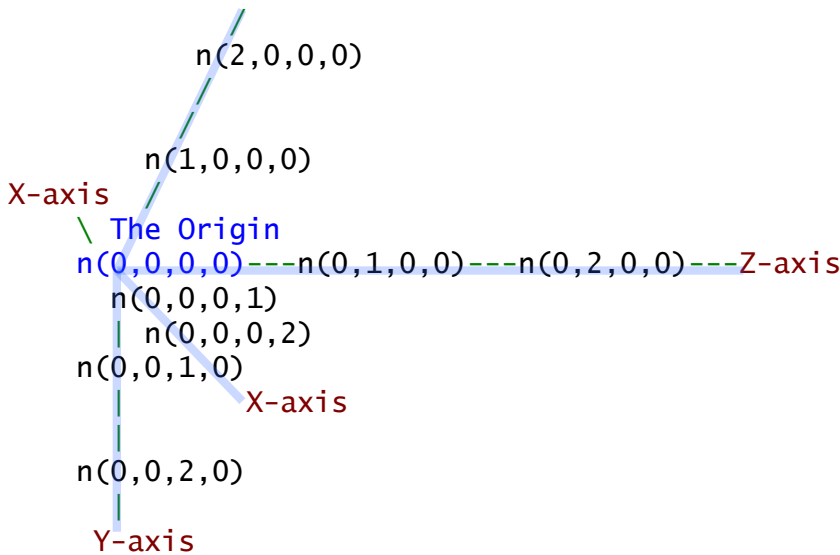
The Origin



Y-axis

[The Concept of 4-Dimensional Extra-Cube built in the Regular Array 3*3*3*3]

W-axis: the 4th axis



#2. Preparation for Making our Extra-Cubic Object 3⁴

We are going to make our object in such a structural array as shown above. I tried even to invent a new complete 'Developed Patterns.'

The three cubes below indicate a single 4-Dimensional Extra-Cubic Object all together.

[Figure 2: Four-Dimensional Extra Cubic Form of Order 3]

*** Development by 3 x(3 x 3 x 3) ***

1-----10-----19	28-----37-----46	55-----64-----73
2 11 20	29 38 47	56 65 74
4 3--13--12--22--21	31 30--40--39--49--48	58 57--67--66--76--75
5 14 23	32 41 50	59 68 77
7--6--16--15--25 24	34--33--43--42--52 51	61--60--70--69--79 78
8 17 26	35 44 53	62 71 80
9-----18-----27	36-----45-----54	63-----72-----81
[No.1]	[No.2]	[No.3]

[Notation by the 3rd Increment Number System]

0000	0100	0200	1000	1100	1200	2000	2100	2200
0001	0101	0201	1001	1101	1201	2001	2101	2201
0002	0102	0202	1002	1102	1202	2002	2102	2202
0010	0110	0210	1010	1110	1210	2010	2110	2210
0011	0111	0211	1011	1111	1211	2011	2111	2211
0012	0112	0212	1012	1112	1212	2012	2112	2212
0020	0120	0220	1020	1120	1220	2020	2120	2220
0021	0121	0221	1021	1121	1221	2021	2121	2221
0022	0122	0222	1022	1122	1222	2022	2122	2222
	[No.1]			[No.2]			[No.3]	

You must combine them into a whole thing in your brain. Although you cannot see it, you can imagine such a structural data-storage in your memory array 3^4 .

Though you may take the position names $n(0,0,0,0)$, $n(0,0,0,1)$, $n(0,0,0,2)$, ... , $n(2,2,2,1)$, $n(2,2,2,2)$, I like to call them as $n1$ (the Origin), $n2$, $n3$, $n4$, ... , $n80$, $n81$ in the old classical style, just because I am used to it.

As a single magic cube the sum of every line, every row and every column must be equal to the same constant $K=123$:

$$\begin{aligned}
 &n1+n2+n3=K; \quad n4+n5+n6=K; \quad n7+n8+n9=K; \quad n1+n4+n7=K; \quad n2+n5+n8=K; \quad n3+n6+n9=K; \\
 &n10+n11+n12=K; \quad n13+n14+n15=K; \quad n16+n17+n18=K; \quad n10+n13+n16=K; \quad n11+n14+n17=K; \\
 &n12+n15+n18=K; \quad n19+n20+n21=K; \quad n22+n23+n24=K; \quad n25+n26+n27=K; \quad n19+n22+n25=K; \\
 &n20+n23+n26=K; \quad n21+n24+n27=K; \quad n1+n10+n19=K; \quad n2+n11+n20=K; \quad n3+n12+n21=K; \\
 &n4+n13+n22=K; \quad n5+n14+n23=K; \quad n6+n15+n24=K; \quad n7+n16+n25=K; \quad n8+n17+n26=K; \\
 &n9+n18+n27=K; \\
 &n28+n29+n30=K; \quad n31+n32+n33=K; \quad n34+n35+n36=K; \quad n28+n31+n34=K; \quad n29+n32+n35=K; \\
 &n30+n33+n36=K; \quad n37+n38+n39=K; \quad n40+n41+n42=K; \quad \dots \\
 &n55+n56+n57=K; \quad n58+n59+n60=K; \quad n61+n62+n63=K; \quad n55+n58+n61=K; \quad \dots
 \end{aligned}$$

But these 81 simultaneous equations are not enough to define our object. The next 27 equations are also required. They are necessary for defining the relations in the 4th direction. Yes. Every position must be defined in the 4 directions.

$$\begin{aligned}
 &n1+n28+n55=K; \quad n2+n29+n56=K; \quad n3+n30+n57=K; \quad n4+n31+n58=K; \quad n5+n32+n59=K; \\
 &n6+n33+n60=K; \quad n7+n34+n61=K; \quad n8+n35+n62=K; \quad n9+n36+n63=K; \quad n10+n37+n64=K; \\
 &n11+n38+n65=K; \quad n12+n39+n66=K; \quad n13+n40+n67=K; \quad n14+n41+n68=K; \quad n15+n42+n69=K; \quad \dots
 \end{aligned}$$

You can easily understand this, if you take your careful look at the following figure. It shows another view-form of the same Extra-Cubic Object.

[Figure 3: Another View of Development by $3 \times (3 \times 3 \times 3)$]

1	2	3	4	5	6	7	8	9
10	11	12	13	14	15	16	17	18
28	19-29	20-30	31	22-32	23-33	34	25-35	26-36
37	38	39	40	41	42	43	44	45
55	46-56	47-57	48	58-49-59	50-60	51	61-52-62	53-63
64	65	66	67	68	69	70	71	72
73	74	75	76	77	78	79	80	81
	[No.1]			[No.2]			[No.3]	

How about the Complementary Pairs of C? Are they located symmetrically? Should we take them for the necessary conditions?

$$n1+n81=n2+n80=n3+n79=n4+n78=n5+n77=\dots=n39+n43=n40+n42=n41+n41=C$$

All Complementary Pairs of C(=82) are so reasonably placed that we might call them as 'symmetrically located'. The unique position $n41(=C/2=41)$ exists on the geometric center of our object. We can add them to the basic conditions to make our

object for a Self-Complementary type.

What do we think of the quart-agonals? In the case of Self-complementary type, each primary quart-agonal consists of one Complementary Pair and n_1 .

$$n_1+n_41+n_81=K; \quad n_3+n_41+n_79=K; \quad n_7+n_41+n_75=K; \quad n_9+n_41+n_73=K;$$

All these 4 equations are quite natural and acceptable, because each equation is calculated as $C+n_41=82+41=123=K$. If you accept the constant sum of Complementary Pairs of C, you must also accept them at the same time.

#3. What do we think about the Pan-quartagonals?

In this case I don't want to make it for a Pan-quartagonal type. You may skip to the next step, but I think it isn't useless for us to study about the problem of pan-quartagonals. Where do they appear in the diagram of Developed patterns?

If you consider the figure above as a 'prototype' form, you could find many pan-quartagonals exist in it and add up to the same constant 123.

Where and how do we find them? Remember the pan-quartagonal with n_2 runs 'parallel' to the primary quartagonal with n_1 in any usual cases.

Give your careful glance at the next diagrams below. They are invented for the extended forms of Figure 2 to find out pan-quartagonals easily.

For instance, the first primary quartagonal $1+41+81=123$ runs straight from No.1 cube through No.2 up to No.3 taking each representative. In reality $2+42+79=123$ seems to run 'parallel' to the primary quartagonal $1+41+81=123$, and $3+40+80=123$ runs also parallel to the same. We may accept them as the examples of real pan-quartagonals.

I found 8 pan-quartagonals with n_1 . There are as many pan-quartagonals as 8×9 in all. They are determined to be reused and rearranged for the object. Every line, every row and every column of the object consists of the same entries with the ones on any pan-quartagonal of the 'prototype'.

[Figure 4: Development by 3 x(3 x 3 x 3)]
[Extended Form and Pan-quartagonals]

[No.1]										$n_1+n_41+n_81 = K;$										
	9		18		27		9			$n_1+n_42+n_80 = K;$										
	7		16		25		7			$n_1+n_44+n_78 = K;$										
	3	8	12	17	21	26	3	8		$n_1+n_45+n_77 = K;$										
	1	---	9	---	10	---	18	---	19	---	27	---	1	9	$n_1+n_50+n_72 = K;$					
	6		2	7	15		11	16	24		20	25	6		2	7	$n_1+n_51+n_71 = K;$			
	4	3	---	13	---	12	---	22	---	21	---	4	---	3			$n_1+n_54+n_68 = K;$			
	9		5		1	18		14		10	27		23		9		5		1	$n_1+n_53+n_69 = K$
	7	---	6	---	16	---	15	---	25	---	24	---	7	6					(PT1)
	3	8		4	12	17		13	21	26		22	3	8		4				$n_2+n_42+n_79 = K;$
	1	9	---	10	---	18	---	19	---	27	---	1	---	9						$n_2+n_40+n_81 = K;$
		2	7		11	16		20	25		2	7								$n_2+n_45+n_76 = K;$
		3			12			21			3									$n_2+n_43+n_78 = K;$
			1		10			19			1									$n_2+n_51+n_70 = K;$
																				$n_2+n_49+n_72 = K;$
																				$n_2+n_54+n_67 = K;$
																				$n_2+n_52+n_69 = K;$
[No.2]	36		45		54		36												(PT2)

34	43	52	34	$n3+n40+n80 = K;$
30 35	39 44	48 53	30 35	$n3+n41+n79 = K;$
28--36-----	37--45-----	46--54-----	28 36	$n3+n43+n77 = K;$
33 29 34 42 38 43 51 47 52 33 29 34				$n3+n44+n76 = K;$
31 30-----	40--39-----	49--48-----	31--30	$n3+n49+n71 = K;$
36 32 28 45 41 37 54 50 46 36 32 28				$n3+n50+n70 = K;$
34--33-----	43--42-----	52--51-----	34 33	$n3+n52+n68 = K;$
30 35 31 39 44 40 48 53 49 30 35 31				$n3+n53+n67 = K;$
28 36-----	37--45-----	46--54-----	28--36	$..... (PT3)$
29 34	38 43	47 52	29 34	$n4+n44+n75 = K;$
30	39	48	30	$n4+n45+n74 = K;$
28	37	46	28	$n4+n38+n81 = K;$

[No. 3]

63	72	81	63	$n4+n39+n80 = K;$
61	70	79	61	$n4+n53+n66 = K;$
57 62	66 71	75 80	57 62	$n4+n54+n65 = K;$
55--63-----	64--72-----	73--81-----	55 63	$n4+n47+n72 = K;$
60 56 61 69 65 70 78 74 79 60 56 61				$n4+n48+n71 = K;$
58 57-----	67--66-----	76--75-----	58--57	$..... (PT4)$
63 59 55 72 68 64 81 77 73 63 59 55				$n5+n45+n73 = K;$
61--60-----	70--69-----	79--78-----	61 60	$n5+n44+n75 = K;$
57 62 58 66 71 67 75 80 76 57 62 58				$n5+n37+n81 = K;$
55 63-----	64--72-----	73--81-----	55--63	$n5+n39+n79 = K;$
56 61	65 70	74 79	56 61	$n5+n54+n64 = K;$
57	66	75	57	$n5+n52+n66 = K;$
55	64	73	55	$n5+n46+n72 = K;$
				$n5+n48+n70 = K;$
				$..... (PT5)$
				$.....$

#4. Making the 4-Dimensional Magic Object of Order 3

We use the basic names after the Figure 2. The conditions we give to the object are:

(1) Complementary pairs of C must be located 'symmetrically.'

$$n1+n81=n2+n80=n3+n79=n4+n78=n5+n77= \dots =n39+n43=n40+n42=n41+n41=C$$

(2) About every line, row and column 81+27 simultaneous equations are taken for the necessary conditions.

$$\begin{aligned}
 &n1+n2+n3=K; \quad n4+n5+n6=K; \quad n7+n8+n9=K; \quad n1+n4+n7=K; \quad n2+n5+n8=K; \quad n3+n6+n9=K; \\
 &n10+n11+n11=K; \quad n13+n14+n15=K; \quad n16+n17+n18=K; \quad n10+n13+n16=K; \quad n11+n14+n17=K; \\
 &n12+n15+n18=K; \quad n19+n20+n21=K; \quad n22+n23+n24=K; \quad n25+n26+n27=K; \quad n19+n22+n25=K; \\
 &n20+n23+n26=K; \quad n21+n24+n27=K; \quad n1+n10+n19=K; \quad n2+n11+n20=K; \quad n3+n12+n21=K; \\
 &n4+n13+n22=K; \quad n5+n14+n23=K; \quad n6+n15+n24=K; \quad n7+n16+n25=K; \quad n8+n17+n26=K; \\
 &n9+n18+n27=K; \\
 &n28+n29+n30=K; \quad n31+n32+n33=K; \quad n34+n35+n36=K; \quad n28+n31+n34=K; \quad n29+n32+n35=K; \\
 &n30+n33+n36=K; \quad n37+n38+n39=K; \quad n40+n41+n42=K; \quad \dots \\
 &n55+n56+n57=K; \quad n58+n59+n60=K; \quad n61+n62+n63=K; \quad n55+n58+n61=K; \quad \dots \\
 &n1+n28+n55=K; \quad n2+n29+n56=K; \quad n3+n30+n57=K; \quad n4+n31+n58=K; \quad n5+n32+n59=K; \\
 &n6+n33+n60=K; \quad n7+n34+n61=K; \quad n8+n35+n62=K; \quad n9+n36+n63=K; \quad n10+n37+n64=K; \\
 &n11+n38+n65=K; \quad n12+n39+n66=K; \quad n13+n40+n67=K; \quad n14+n41+n68=K; \quad n15+n42+n69=K; \\
 &\dots \quad n27+n54+n81=K
 \end{aligned}$$

But if you take (1), you don't have to deal with all of (2) equations.

$$n81=C-n1; \quad n80=C-n2; \quad n79=C-n3; \quad n78=C-n4; \quad \dots \quad n42=C-n40;$$

Therefore you may well take care of half of (2) equations at least.

**** Essential 56 Simultaneous Equations for our Object ****

$n_1+n_2+n_3=S \dots(1);$ $n_1+n_4+n_7=S \dots(2);$ $n_1+n_{10}+n_{19}=S \dots(3);$
 $n_1+n_{28}+n_{55}=S \dots(4);$ $n_2+n_5+n_8=S \dots(5);$ $n_2+n_{11}+n_{20}=S \dots(6);$
 $n_2+n_{29}+n_{56}=S \dots(7);$ $n_3+n_6+n_9=S \dots(8);$ $n_3+n_{12}+n_{21}=S \dots(9);$
 $n_3+n_{30}+n_{57}=S \dots(10);$ $n_4+n_5+n_6=S \dots(11);$ $n_4+n_{13}+n_{22}=S \dots(12);$
 $n_4+n_{31}+n_{58}=S \dots(13);$ $n_5+n_{14}+n_{23}=S \dots(14);$ $n_5+n_{32}+n_{59}=S \dots(15);$
 $n_6+n_{15}+n_{24}=S \dots(16);$ $n_6+n_{33}+n_{60}=S \dots(17);$ $n_7+n_8+n_9=S \dots(18);$
 $n_7+n_{16}+n_{25}=S \dots(19);$ $n_7+n_{34}+n_{61}=S \dots(20);$ $n_8+n_{17}+n_{26}=S \dots(21);$
 $n_8+n_{35}+n_{62}=S \dots(22);$ $n_9+n_{18}+n_{27}=S \dots(23);$ $n_9+n_{36}+n_{63}=S \dots(24);$
 $n_{10}+n_{11}+n_{12}=S \dots(25);$ $n_{10}+n_{13}+n_{16}=S \dots(26);$ $n_{10}+n_{37}+n_{64}=S \dots(27);$
 $n_{11}+n_{14}+n_{17}=S \dots(28);$ $n_{11}+n_{38}+n_{65}=S \dots(29);$ $n_{12}+n_{15}+n_{18}=S \dots(30);$
 $n_{12}+n_{39}+n_{66}=S \dots(31);$ $n_{13}+n_{14}+n_{15}=S \dots(32);$ $n_{13}+n_{40}+n_{67}=S \dots(33);$
 $n_{14}+n_{41}+n_{68}=S \dots(34);$ $n_{16}+n_{17}+n_{18}=S \dots(35);$ $n_{19}+n_{20}+n_{21}=S \dots(36);$
 $n_{19}+n_{22}+n_{25}=S \dots(37);$ $n_{20}+n_{23}+n_{26}=S \dots(38);$ $n_{21}+n_{24}+n_{27}=S \dots(39);$
 $n_{22}+n_{23}+n_{24}=S \dots(40);$ $n_{25}+n_{26}+n_{27}=S \dots(41);$ $n_{28}+n_{29}+n_{30}=S \dots(42);$
 $n_{28}+n_{31}+n_{34}=S \dots(43);$ $n_{28}+n_{37}+n_{46}=S \dots(44);$ $n_{29}+n_{32}+n_{35}=S \dots(45);$
 $n_{29}+n_{38}+n_{47}=S \dots(46);$ $n_{30}+n_{33}+n_{36}=S \dots(47);$ $n_{30}+n_{39}+n_{48}=S \dots(48);$
 $n_{31}+n_{32}+n_{33}=S \dots(49);$ $n_{31}+n_{40}+n_{49}=S \dots(50);$ $n_{32}+n_{41}+n_{50}=S \dots(51);$
 $n_{34}+n_{35}+n_{36}=S \dots(52);$ $n_{37}+n_{38}+n_{39}=S \dots(53);$ $n_{37}+n_{40}+n_{43}=S \dots(54);$
 $n_{38}+n_{41}+n_{44}=S \dots(55);$ $n_{40}+n_{41}+n_{42}=S \dots(56);$

(3) We don't give any conditions about pan-quartagonals this time.

Under these conditions I tried to permute all entries and calculate. I have got something like the result object set.

But are they really the '4-Dimensional Extra-Cubic Form'? How do you recognize it? How do you examine them?

Step back to Figure 1-4 and find the next four axes:

$$n_1+n_2+n_3=K; \quad n_1+n_4+n_7=K; \quad n_1+n_{10}+n_{19}=K; \quad n_1+n_{28}+n_{55}=K$$

What values do they take? Do they exchange their values with one another always in the equal manner? They might imply something four-dimensional.

I picked some examples out of the largest 'Mother Set' of solutions and listed the values of 4 axes:

[Figure 5: The Values of Four Axes]

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{ $n_1, n_2, n_3$ }, { $n_1, n_4, n_7$ }, { $n_1, n_{10}, n_{19}$ }, { $n_1, n_{28}, n_{55}$ }
[ 1] (1, 80, 42), (1, 78, 44), (1, 72, 50), (1, 54, 68)
[ 2] (1, 80, 42), (1, 78, 44), (1, 54, 68), (1, 72, 50)
[ 3] (1, 80, 42), (1, 77, 45), (1, 71, 51), (1, 53, 69)
[ 4] (1, 80, 42), (1, 77, 45), (1, 53, 69), (1, 71, 51)
[ 5] (1, 80, 42), (1, 72, 50), (1, 78, 44), (1, 54, 68)
[ 6] (1, 80, 42), (1, 72, 50), (1, 54, 68), (1, 78, 44)
[ 7] (1, 80, 42), (1, 71, 51), (1, 77, 45), (1, 53, 69)
[ 8] (1, 80, 42), (1, 71, 51), (1, 53, 69), (1, 77, 45)
[ 9] (1, 80, 42), (1, 54, 68), (1, 78, 44), (1, 72, 50)
[10] (1, 80, 42), (1, 54, 68), (1, 72, 50), (1, 78, 44)
[11] (1, 80, 42), (1, 53, 69), (1, 77, 45), (1, 71, 51)
[12] (1, 80, 42), (1, 53, 69), (1, 71, 51), (1, 77, 45)
[13] (1, 78, 44), (1, 80, 42), (1, 72, 50), (1, 54, 68)
[14] (1, 78, 44), (1, 80, 42), (1, 54, 68), (1, 72, 50)
[15] (1, 78, 44), (1, 77, 45), (1, 69, 53), (1, 51, 71)
[16] (1, 78, 44), (1, 77, 45), (1, 51, 71), (1, 69, 53)
[17] (1, 78, 44), (1, 72, 50), (1, 80, 42), (1, 54, 68)
[18] (1, 78, 44), (1, 72, 50), (1, 54, 68), (1, 80, 42)

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[19] (1, 78, 44), (1, 69, 53), (1, 77, 45), (1, 51, 71)
 [20] (1, 78, 44), (1, 69, 53), (1, 51, 71), (1, 77, 45)
 [21] (1, 78, 44), (1, 54, 68), (1, 80, 42), (1, 72, 50)
 [22] (1, 78, 44), (1, 54, 68), (1, 72, 50), (1, 80, 42)
 [23] (1, 78, 44), (1, 51, 71), (1, 77, 45), (1, 69, 53)
 [24] (1, 78, 44), (1, 51, 71), (1, 69, 53), (1, 77, 45)
 [25] (1, 77, 45), (1, 80, 42), (1, 71, 51), (1, 53, 69)
 [26] (1, 77, 45), (1, 80, 42), (1, 53, 69), (1, 71, 51)
 [27] (1, 77, 45), (1, 78, 44), (1, 69, 53), (1, 51, 71)
 [28] (1, 77, 45), (1, 78, 44), (1, 51, 71), (1, 69, 53)
 [29] (1, 77, 45), (1, 71, 51), (1, 80, 42), (1, 53, 69)
 [30] (1, 77, 45), (1, 71, 51), (1, 53, 69), (1, 80, 42)
 [31] (1, 77, 45), (1, 69, 53), (1, 78, 44), (1, 51, 71)
 [32] (1, 77, 45), (1, 69, 53), (1, 51, 71), (1, 78, 44)
 [33] (1, 77, 45), (1, 53, 69), (1, 80, 42), (1, 71, 51)
 [34] (1, 77, 45), (1, 53, 69), (1, 71, 51), (1, 80, 42)
 [35] (1, 77, 45), (1, 51, 71), (1, 78, 44), (1, 69, 53)
 [36] (1, 77, 45), (1, 51, 71), (1, 69, 53), (1, 78, 44)
 [37] (1, 72, 50), (1, 80, 42), (1, 78, 44), (1, 54, 68)
 [38] (1, 72, 50), (1, 80, 42), (1, 54, 68), (1, 78, 44)
 [39] (1, 72, 50), (1, 78, 44), (1, 80, 42), (1, 54, 68)
 [40] (1, 72, 50), (1, 78, 44), (1, 54, 68), (1, 80, 42)
 [41] (1, 72, 50), (1, 71, 51), (1, 69, 53), (1, 45, 77)
 [42] (1, 72, 50), (1, 71, 51), (1, 45, 77), (1, 69, 53)
 [43] (1, 72, 50), (1, 69, 53), (1, 71, 51), (1, 45, 77)
 [44] (1, 72, 50), (1, 69, 53), (1, 45, 77), (1, 71, 51)
 [45] (1, 72, 50), (1, 54, 68), (1, 80, 42), (1, 78, 44)
 [46] (1, 72, 50), (1, 54, 68), (1, 78, 44), (1, 80, 42)
 [47] (1, 72, 50), (1, 45, 77), (1, 71, 51), (1, 69, 53)
 [48] (1, 72, 50), (1, 45, 77), (1, 69, 53), (1, 71, 51)
 [49] (1, 71, 51), (1, 80, 42), (1, 77, 45), (1, 53, 69)
 [50] (1, 71, 51), (1, 80, 42), (1, 53, 69), (1, 77, 45)
 [51] (1, 71, 51), (1, 77, 45), (1, 80, 42), (1, 53, 69)
 [52] (1, 71, 51), (1, 77, 45), (1, 53, 69), (1, 80, 42)
 [53] (1, 71, 51), (1, 72, 50), (1, 69, 53), (1, 45, 77)
 [54] (1, 71, 51), (1, 72, 50), (1, 45, 77), (1, 69, 53)
 [55] (1, 71, 51), (1, 69, 53), (1, 72, 50), (1, 45, 77)
 [56] (1, 71, 51), (1, 69, 53), (1, 45, 77), (1, 72, 50)
 [57] (1, 71, 51), (1, 53, 69), (1, 80, 42), (1, 77, 45)
 [58] (1, 71, 51), (1, 53, 69), (1, 77, 45), (1, 80, 42)
 [59] (1, 71, 51), (1, 45, 77), (1, 72, 50), (1, 69, 53)
 [60] (1, 71, 51), (1, 45, 77), (1, 69, 53), (1, 72, 50)
 [61] (1, 69, 53), (1, 78, 44), (1, 77, 45), (1, 51, 71)
 [62] (1, 69, 53), (1, 78, 44), (1, 51, 71), (1, 77, 45)
 [63] (1, 69, 53), (1, 77, 45), (1, 78, 44), (1, 51, 71)
 [64] (1, 69, 53), (1, 77, 45), (1, 51, 71), (1, 78, 44)
 [65] (1, 69, 53), (1, 72, 50), (1, 71, 51), (1, 45, 77)
 [66] (1, 69, 53), (1, 72, 50), (1, 45, 77), (1, 71, 51)
 [67] (1, 69, 53), (1, 71, 51), (1, 72, 50), (1, 45, 77)
 [68] (1, 69, 53), (1, 71, 51), (1, 45, 77), (1, 72, 50)
 [69] (1, 69, 53), (1, 51, 71), (1, 78, 44), (1, 77, 45)
 [70] (1, 69, 53), (1, 51, 71), (1, 77, 45), (1, 78, 44)
 [71] (1, 69, 53), (1, 45, 77), (1, 72, 50), (1, 71, 51)
 [72] (1, 69, 53), (1, 45, 77), (1, 71, 51), (1, 72, 50)
 [73] (1, 54, 68), (1, 80, 42), (1, 78, 44), (1, 72, 50)
 [74] (1, 54, 68), (1, 80, 42), (1, 72, 50), (1, 78, 44)
 [75] (1, 54, 68), (1, 78, 44), (1, 80, 42), (1, 72, 50)
 [76] (1, 54, 68), (1, 78, 44), (1, 72, 50), (1, 80, 42)
 [77] (1, 54, 68), (1, 72, 50), (1, 80, 42), (1, 78, 44)
 [78] (1, 54, 68), (1, 72, 50), (1, 78, 44), (1, 80, 42)

[79] (1, 54, 68), (1, 53, 69), (1, 51, 71), (1, 45, 77)
 [80] (1, 54, 68), (1, 53, 69), (1, 45, 77), (1, 51, 71)
 [81] (1, 54, 68), (1, 51, 71), (1, 53, 69), (1, 45, 77)
 [82] (1, 54, 68), (1, 51, 71), (1, 45, 77), (1, 53, 69)
 [83] (1, 54, 68), (1, 45, 77), (1, 53, 69), (1, 51, 71)
 [84] (1, 54, 68), (1, 45, 77), (1, 51, 71), (1, 53, 69)
 [85] (1, 53, 69), (1, 80, 42), (1, 77, 45), (1, 71, 51)
 [86] (1, 53, 69), (1, 80, 42), (1, 71, 51), (1, 77, 45)
 [87] (1, 53, 69), (1, 77, 45), (1, 80, 42), (1, 71, 51)
 [88] (1, 53, 69), (1, 77, 45), (1, 71, 51), (1, 80, 42)
 [89] (1, 53, 69), (1, 71, 51), (1, 80, 42), (1, 77, 45)
 [90] (1, 53, 69), (1, 71, 51), (1, 77, 45), (1, 80, 42)
 [91] (1, 53, 69), (1, 54, 68), (1, 51, 71), (1, 45, 77)
 [92] (1, 53, 69), (1, 54, 68), (1, 45, 77), (1, 51, 71)
 [93] (1, 53, 69), (1, 51, 71), (1, 54, 68), (1, 45, 77)
 [94] (1, 53, 69), (1, 51, 71), (1, 45, 77), (1, 54, 68)
 [95] (1, 53, 69), (1, 45, 77), (1, 54, 68), (1, 51, 71)
 [96] (1, 53, 69), (1, 45, 77), (1, 51, 71), (1, 54, 68)
 [97] (1, 51, 71), (1, 78, 44), (1, 77, 45), (1, 69, 53)
 [98] (1, 51, 71), (1, 78, 44), (1, 69, 53), (1, 77, 45)
 [99] (1, 51, 71), (1, 77, 45), (1, 78, 44), (1, 69, 53)
 [100] (1, 51, 71), (1, 77, 45), (1, 69, 53), (1, 78, 44)
 [101] (1, 51, 71), (1, 69, 53), (1, 78, 44), (1, 77, 45)
 [102] (1, 51, 71), (1, 69, 53), (1, 77, 45), (1, 78, 44)
 [103] (1, 51, 71), (1, 54, 68), (1, 53, 69), (1, 45, 77)
 [104] (1, 51, 71), (1, 54, 68), (1, 45, 77), (1, 53, 69)
 [105] (1, 51, 71), (1, 53, 69), (1, 54, 68), (1, 45, 77)
 [106] (1, 51, 71), (1, 53, 69), (1, 45, 77), (1, 54, 68)
 [107] (1, 51, 71), (1, 45, 77), (1, 54, 68), (1, 53, 69)
 [108] (1, 51, 71), (1, 45, 77), (1, 53, 69), (1, 54, 68)
 [109] (1, 45, 77), (1, 72, 50), (1, 71, 51), (1, 69, 53)
 [110] (1, 45, 77), (1, 72, 50), (1, 69, 53), (1, 71, 51)
 [111] (1, 45, 77), (1, 71, 51), (1, 72, 50), (1, 69, 53)
 [112] (1, 45, 77), (1, 71, 51), (1, 69, 53), (1, 72, 50)
 [113] (1, 45, 77), (1, 69, 53), (1, 72, 50), (1, 71, 51)
 [114] (1, 45, 77), (1, 69, 53), (1, 71, 51), (1, 72, 50)
 [115] (1, 45, 77), (1, 54, 68), (1, 53, 69), (1, 51, 71)
 [116] (1, 45, 77), (1, 54, 68), (1, 51, 71), (1, 53, 69)
 [117] (1, 45, 77), (1, 53, 69), (1, 54, 68), (1, 51, 71)
 [118] (1, 45, 77), (1, 53, 69), (1, 51, 71), (1, 54, 68)
 [119] (1, 45, 77), (1, 51, 71), (1, 54, 68), (1, 53, 69)
 [120] (1, 45, 77), (1, 51, 71), (1, 53, 69), (1, 54, 68)

[Count = 120]

{1, 42, 80} 12 + {1, 80, 42} 36 = 48
 {1, 44, 78} 12 + {1, 78, 44} 36 = 48
 {1, 45, 77} 48 + {1, 77, 45} 48 = 96
 {1, 50, 72} 12 + {1, 72, 50} 36 = 48
 {1, 51, 71} 48 + {1, 71, 51} 48 = 96
 {1, 53, 69} 48 + {1, 69, 53} 48 = 96
 {1, 54, 68} 36 + {1, 68, 54} 12 = 48

$$96 \times 5 = 480$$

In the 120 examples there are only 7 combinations of values on the axes. They appeared on the 4th axis as equally as on the other three axes.

This implies our success in making the 4-Dimensional Magic Object, doesn't it?

You could get the reasonable solution set by giving some Normalizing Inequality

Conditions such as: $n_1 < n_81$; $n_1 < n_9$; $n_1 < n_73$; and $n_2 > n_{10}$.

I found 60 standard solutions with $n_1=1$ and 2784 solutions in all. This count is an eighth(1/8) of 22272 primitive solutions.

#5. Another Way of Development: $3^4 = 3 \times 3 \times (3 \times 3) = 9 \times 9$

I noticed there is another way of development $3^4 = 3 \times 3 \times (3 \times 3) = 9 \times 9$ beside our $3 \times (3 \times 3 \times 3)$. Take a look at the Figure 6 below.

Each layer of the 3 cubes is placed flat in reasonable order on the two dimensional 9×9 sheet shown below. There are 3×3 blocks in it, each of which is already a semi-magic square of order 3, and on the whole you could suppose a single large 9×9 Self-Complementary magic square with 9 blocks of semi-squares 3×3 .

[Figure 6: Development
by $3 \times 3 \times (3 \times 3)$]

	1	2	3
1	1 2 3 28 29 30 55 56 57		
	4 5 6 31 32 33 58 59 60		
	7 8 9 34 35 36 61 62 63		
2	10 11 12 37 38 39 64 65 66		
	13 14 15 40 41 42 67 68 69		
	16 17 18 43 44 45 70 71 72		
3	19 20 21 46 47 48 73 74 75		
	22 23 24 49 50 51 76 77 78		
	25 26 27 52 53 54 79 80 81		

[No. 1]

1	2	11	20
4	3	13	12
5	14	23	
7	6	16	15
8	17	26	
9	18	27	
28	37	46	
29	38	47	
31	30	40	39
32	41	50	
34	33	43	42
35	44	53	
36	45	54	
55	64	73	
56	65	74	
58	57	67	66
59	68	77	
61	60	70	69
62	71	80	
63	72	81	

[No. 2]

[No. 3]

Could it be really a Self-complementary Magic Square of Order 9?

$$(n_1+n_2+n_3)+(n_{28}+n_{29}+n_{30})+(n_{55}+n_{56}+n_{57})=3K=369$$

$$(n_1+n_4+n_7)+(n_{10}+n_{13}+n_{16})+(n_{19}+n_{22}+n_{25})=3K=369$$

$$n_1+n_5+n_9+n_{37}+n_{41}+n_{45}+n_{73}+n_{77}+n_{81}$$

$$=(n_1+n_{81})+(n_5+n_{77})+(n_9+n_{73})+(n_{37}+n_{45})+n_{41}$$

$$=C+C+C+C+n_{41}=82+82+82+82+41=369$$

.....

All Complementary Pairs of C are located symmetrically.

Yes, it is a Self-complementary Magic Square 9×9 , and at the same time it is a special magic square that has 9 multiple-squares of Order 3 within.

In each block every 3 entries of each row or each column add up to the same constant 123, but the two primary diagonals do not always add up to 123.

In the central block the next two equations of diagonals always become true.

$$n_{37}+n_{41}+n_{45}=C+n_{41}=123; \quad n_{39}+n_{41}+n_{43}=C+n_{41}=123$$

Whenever you make a 4-Dimensional Magic Object of order 3, you could always get a Self-complementary Magic Square 9×9 automatically.

It is amazing, isn't it?

Does this imply the new hope for 'Dimension Converter'? I would say the double development could make it possible. Everything depends on:

$$3^4 = 3 \times (3 \times 3 \times 3) = 3 \times 3 \times (3 \times 3)$$

(Written in English on July 26, 2001; Retyped on May 9, 2005: by Kanji Setsuda)

#6. Decomposition by 9th and 3rd increment

Watch the next list below. The first Square of Order 9 is the one we got through down-conversion from the 4-D Extra-Cubic Object of Order 3. It has 3x3 little blocks of multiple squares 3x3 within.

Why don't you analyze it by the Euler's Method?

										1#	/N9i							
1	80	42	78	37	8	44	6	73		00	87	45	85	40	07	47	05	80
72	31	20	29	27	67	22	65	36		78	33	21	31	28	73	23	71	38
50	12	61	16	59	48	57	52	14		54	12	66	16	64	52	62	56	14
54	13	56	11	63	49	58	47	18		58	13	61	11	68	53	63	51	18
5	75	43	79	41	3	39	7	77		04	82	46	86	44	02	42	06	84
64	35	24	33	19	71	26	69	28		70	37	25	35	20	77	27	75	30
68	30	25	34	23	66	21	70	32		74	32	26	36	24	72	22	76	34
46	17	60	15	55	53	62	51	10		50	17	65	15	60	57	67	55	10
9	76	38	74	45	4	40	2	81		08	83	41	81	48	03	43	01	88

/D9i				H/				L/									
0	8	4	8	4	0	4	0	8	0	7	5	5	0	7	7	5	0
7	3	2	3	2	7	2	7	3	8	3	1	1	8	3	3	1	8
5	1	6	1	6	5	6	5	1	4	2	6	6	4	2	2	6	4
5	1	6	1	6	5	6	5	1	8	3	1	1	8	3	3	1	8
0	8	4	8	4	0	4	0	8	4	2	6	6	4	2	2	6	4
7	3	2	3	2	7	2	7	3	0	7	5	5	0	7	7	5	0
7	3	2	3	2	7	2	7	3	4	2	6	6	4	2	2	6	4
5	1	6	1	6	5	6	5	1	0	7	5	5	0	7	7	5	0
0	8	4	8	4	0	4	0	8	8	3	1	1	8	3	3	1	8

/D3i	27*	9*	3*	1*
021210102	021210102	021102210	012201120	
210102021	102021210	210021102	201120012	
102021210	210102021	102210021	120012201	
102021210	210102021	210021102	201120012	
021210102	021210102	102210021	120012201	
210102021	102021210	021102210	012201120	
210102021	102021210	102210021	120012201	
102021210	210102021	021102210	012201120	
021210102	021210102	210021102	201120012	

										3#	/N9i							
1	80	42	77	39	7	45	4	74		00	87	45	84	42	06	48	03	81
71	33	19	30	25	68	22	65	36		77	35	20	32	26	74	23	71	38
51	10	62	16	59	48	56	54	13		55	10	67	16	64	52	61	58	13
53	15	55	12	61	50	58	47	18		57	15	60	12	66	54	63	51	18
6	73	44	79	41	3	38	9	76		05	80	47	86	44	02	41	08	83
64	35	24	32	21	70	27	67	29		70	37	25	34	22	76	28	73	31
69	28	26	34	23	66	20	72	31		75	30	27	36	24	72	21	78	33
46	17	60	14	57	52	63	49	11		50	17	65	14	62	56	68	53	11
8	78	37	75	43	5	40	2	81		07	85	40	82	46	04	43	01	88

/D9i	H/	L/
0 8 4 8 4 0 4 0 8	0 7 5 4 2 6 8 3 1	
7 3 2 3 2 7 2 7 3	7 5 0 2 6 4 3 1 8	
5 1 6 1 6 5 6 5 1	5 0 7 6 4 2 1 8 3	
5 1 6 1 6 5 6 5 1	7 5 0 2 6 4 3 1 8	
0 8 4 8 4 0 4 0 8	5 0 7 6 4 2 1 8 3	
7 3 2 3 2 7 2 7 3	0 7 5 4 2 6 8 3 1	
7 3 2 3 2 7 2 7 3	5 0 7 6 4 2 1 8 3	
5 1 6 1 6 5 6 5 1	0 7 5 4 2 6 8 3 1	
0 8 4 8 4 0 4 0 8	7 5 0 2 6 4 3 1 8	

/D3i	27*	9*	3*	1*
021210102	021210102	021102210	012120201	
210102021	102021210	210021102	120201012	
102021210	210102021	102210021	201012120	
102021210	210102021	210021102	120201012	
021210102	021210102	102210021	201012120	
210102021	102021210	021102210	012120201	
210102021	102021210	102210021	201012120	
102021210	210102021	021102210	012120201	
021210102	021210102	210021102	120201012	

	5#	/N9i
1 80 42 72 31 20 50 12 61	00 87 45 78 33 21 54 12 66	
78 37 8 29 27 67 16 59 48	85 40 07 31 28 73 16 64 52	
44 6 73 22 65 36 57 52 14	47 05 80 23 71 38 62 56 14	
54 13 56 5 75 43 64 35 24	58 13 61 04 82 46 70 37 25	
11 63 49 79 41 3 33 19 71	11 68 53 86 44 02 35 20 77	
58 47 18 39 7 77 26 69 28	63 51 18 42 06 84 27 75 30	
68 30 25 46 17 60 9 76 38	74 32 26 50 17 65 08 83 41	
34 23 66 15 55 53 74 45 4	36 24 72 15 60 57 81 48 03	
21 70 32 62 51 10 40 2 81	22 76 34 67 55 10 43 01 88	

/D9i	H/	L/
0 8 4 7 3 2 5 1 6	0 7 5 8 3 1 4 2 6	
8 4 0 3 2 7 1 6 5	5 0 7 1 8 3 6 4 2	
4 0 8 2 7 3 6 5 1	7 5 0 3 1 8 2 6 4	
5 1 6 0 8 4 7 3 2	8 3 1 4 2 6 0 7 5	
1 6 5 8 4 0 3 2 7	1 8 3 6 4 2 5 0 7	
6 5 1 4 0 8 2 7 3	3 1 8 2 6 4 7 5 0	
7 3 2 5 1 6 0 8 4	4 2 6 0 7 5 8 3 1	
3 2 7 1 6 5 8 4 0	6 4 2 5 0 7 1 8 3	
2 7 3 6 5 1 4 0 8	2 6 4 7 5 0 3 1 8	

/D3i	27*	9*	3*	1*
021210102	021102210	021210102	012201120	
210102021	210021102	102021210	201120012	
102021210	102210021	210102021	120012201	
102021210	210021102	210102021	201120012	
021210102	102210021	021210102	120012201	
210102021	021102210	102021210	012201120	
210102021	102210021	102021210	120012201	
102021210	021102210	210102021	012201120	
021210102	210021102	021210102	201120012	

The figures after the solutions show the notation and decomposition by the 9th Increment Number System, and the decomposition by the 3rd Increment in the end.

Watch the 5# solution above at first, and examine the two layers of decomposition /D9i H/ and L/ in the middle block.

Each 9 entries on every row and column in each layer always consists of {0, 1, 2, 3, 4, 5, 6, 7, 8}, and uses each of them strictly once. It has no repetition and no drop-off of 9 members.

Therefore the sum of each row or each column is calculated in the same way as:

$$(0+1+2+3+4+5+6+7+8) \times 9^1 + (0+1+2+3+4+5+6+7+8) \times 9^0$$

$$36 \times 9 + 36 \times 1 = 360(\text{Decimal}) \quad (\text{It is always true that } n1 = 0)$$

360 here is logically equivalent to 369 in our classical notation.

Both high layer and low one consist of {0, 1, 2, 3, 4, 5, 6, 7, 8} by 9 times. These beautiful properties are the ones of so called 'Euler Square'.

But the two primary diagonals of that solution 5# are made of:

$$1+37+73+5+41+77+9+45+81$$

$$= (0+4+8+0+4+8+0+4+8) \times 9 + (0+0+0+4+4+4+8+8+8) \times 1 = 360$$

$$61+59+57+43+41+39+25+23+21$$

$$= (6+6+6+4+4+4+2+2+2) \times 9 + (6+4+2+6+4+2+6+4+2) \times 1 = 360$$

Although their sums are all right, their combinations of members are against the Euler's Request. It is not actually the 'Complete Euler Squares', strictly speaking.

Watch the 1# and 3# solutions next, and examine their /D9i H/ and L/, please.

They are no longer the 'Euler Squares' at all, even about their rows and columns.

It seems to be getting harder for us to compose the Euler Squares for the higher orders than 5.

But when you examine the list of /D3i(Decompositions by the 3rd Increment), you can surely know all of them are completely of Euler type about their rows and columns.

Each row and each column has the {0, 1, 2} three times in all, and even almost of all primary diagonals obey this Euler's request, with some exceptions having the pattern {1, 1, 1, 1, 1, 1, 1, 1, 1} only in their diagonals.

(1) All sums are calculated in the same way as:

$$\{(0+1+2) \times 3\} \times 3^3 + \{(0+1+2) \times 3\} \times 3^2 + \{(0+1+2) \times 3\} \times 3^1 + \{(0+1+2) \times 3\} \times 3^0$$

$$= 9 \times 27 + 9 \times 9 + 9 \times 3 + 9 \times 1 = 243 + 81 + 27 + 9 = 360(\text{Decimal})$$

(2) Each layer consists of {0, 1, 2} by 27 times.

What should we call these perfect properties of the Solutions 1# and 5#?

It is beautiful enough to be called 'Complete Euler Square', I think.

#7. List of our Compositions: Multiple type of Self-complementary MS99

The last long list below contains part of 2784 'standard' solutions of our special Magic Squares 9x9 with their decompositions by the 3rd increment.

** Super-Multiple 3x3 Type of Self-complementary Magic

Squares 9x9: Down-converted from 4-D ECO of Order 3 **

	1#	/D3i	27*	9*	3*	1*						
1	80	42	78	37	8	44	6	73	021210102	021210102	021102210	012201120
72	31	20	29	27	67	22	65	36	210102021	102021210	210021102	201120012
50	12	61	16	59	48	57	52	14	102021210	210102021	102210021	120012201
54	13	56	11	63	49	58	47	18	102021210	210102021	210021102	201120012
5	75	43	79	41	3	39	7	77	021210102	021210102	102210021	120012201
64	35	24	33	19	71	26	69	28	210102021	102021210	021102210	012201120
68	30	25	34	23	66	21	70	32	210102021	102021210	102210021	120012201
46	17	60	15	55	53	62	51	10	102021210	210102021	021102210	012201120
9	76	38	74	45	4	40	2	81	021210102	021210102	210021102	201120012

										3#	/D3i	27*	9*	3*	1*
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51	10	62	16	59	48	56	54	13	102021210	210102021	102210021	201012120			
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6	73	44	79	41	3	38	9	76	021210102	021210102	102210021	201012120			
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46	17	60	14	57	52	63	49	11	102021210	210102021	021102210	012120201			
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21	70	32	62	51	10	40	2	81	021210102	210021102	021210102	201120012			
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1	80	42	71	33	19	51	10	62	021210102	021102210	021210102	012120201			
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29	27	67	79	41	3	15	55	53	102210021	021210102	021210102	120012201			
22	65	36	39	7	77	62	51	10	021102210	210102021	102021210	012201120			
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77	39	7	12	61	50	34	23	66	210021102	210102021	102021210	120201012			
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22	65	36	38	9	76	63	49	11	021102210	210102021	102021210	012120201			
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72	29	22	31	27	65	20	67	36	210102021	102021210	201120012	210021102			
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64	33	26	35	19	69	24	71	28	210102021	102021210	012201120	021102210			
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9	74	40	76	45	2	38	4	81	021210102	021210102	201120012	210021102			

							23/	/D3i	27*	9*	3*	1*
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71	30	22	33	25	65	19	68	36	210102021	102021210	201120012	120201012
51	16	56	10	59	54	62	48	13	102021210	210102021	120012201	201012120
53	12	58	15	61	47	55	50	18	102021210	210102021	201120012	120201012
6	79	38	73	41	9	44	3	76	021210102	021210102	120012201	201012120
64	32	27	35	21	67	24	70	29	210102021	102021210	012201120	012120201
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46	14	63	17	57	49	60	52	11	102021210	210102021	012201120	012120201
8	75	40	78	43	2	37	5	81	021210102	021210102	201120012	120201012
							31/	/D3i	27*	9*	3*	1*
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54	5	64	13	75	35	56	43	24	102021210	201120012	210102021	210021102
68	46	9	30	17	76	25	60	38	210102021	120012201	102021210	102210021
78	29	16	37	27	59	8	67	48	210102021	201120012	102021210	210021102
11	79	33	63	41	19	49	3	71	021210102	120012201	021210102	102210021
34	15	74	23	55	45	66	53	4	102021210	012201120	210102021	021102210
44	22	57	6	65	52	73	36	14	102021210	120012201	210102021	102210021
58	39	26	47	7	69	18	77	28	210102021	012201120	102021210	021102210
21	62	40	70	51	2	32	10	81	021210102	201120012	021210102	210021102
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53	6	64	15	73	35	55	44	24	102021210	201120012	210102021	120201012
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45	22	56	4	65	54	74	36	13	102021210	120012201	210102021	201012120
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30	14	79	23	61	39	70	48	5	102021210	012201120	012120201	210102021
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22	39	62	38	61	24	63	23	37	012120201	210102021	102021210	021102210
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16	33	74	32	73	18	75	17	31	012120201	102021210	210102021	021102210
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59/ /D3i 27* 9* 3* 1*
1 51 71 54 65 4 68 7 48 012120201 021210102 012201120 021210102
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2 81 40 78 37 8 43 5 75 2 79 42 78 38 7 43 6 74 2 78 43 81 37 5 40 8 75
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2 76 45 81 38 4 40 9 74 2 72 49 81 31 11 40 20 63 2 70 51 81 32 10 40 21 62
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3 80 40 77 37 9 43 6 74 3 77 43 80 37 6 40 9 74 3 76 44 80 39 4 40 8 75
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19 72 32 36 23 64 68 28 27	20 72 31 36 22 65 67 29 27	21 71 31 35 22 66 67 30 26	62 49 12 13 57 53 48 17 58	61 50 12 14 57 52 48 16 59	62 49 12 13 57 53 48 17 58
42 2 79 74 43 6 7 78 38	42 1 80 73 44 6 8 78 37	40 3 80 75 44 4 8 76 39	60 47 16 11 61 51 52 15 56	58 47 18 11 63 49 54 13 56	59 46 18 10 63 50 54 14 55
37 9 77 81 41 1 5 73 45	39 7 77 79 41 3 5 75 43	37 9 77 81 41 1 5 73 45	26 67 30 31 21 71 66 35 22	26 69 28 33 19 71 64 35 24	27 68 28 32 19 72 64 36 23
44 4 75 76 39 8 3 80 40	45 4 74 76 38 9 2 81 40	43 6 74 78 38 7 2 79 42	24 65 34 29 25 69 70 33 20	23 66 34 30 25 68 70 32 21	24 65 34 29 25 69 70 33 20
55 54 14 18 59 46 50 10 63	55 53 15 17 60 46 51 10 62	56 52 15 16 60 47 51 11 61			
	1897/		1949/		2013/
22 72 29 36 20 67 65 31 27	23 72 28 34 20 69 66 31 26	24 70 29 34 20 69 65 33 25	57 50 16 14 61 48 52 12 59	57 49 17 14 63 46 52 11 60	56 51 16 15 61 47 52 11 60
44 1 78 73 42 8 6 80 37	43 2 78 75 40 8 5 81 37	43 2 78 74 42 7 6 79 38	56 49 18 13 63 47 54 11 58	55 50 18 15 61 47 53 12 58	55 50 18 14 63 46 54 10 59
43 3 77 75 41 7 5 79 39	44 3 76 73 41 9 6 79 38	45 1 77 73 41 9 5 81 37	24 71 28 35 19 69 64 33 26	24 70 29 35 21 67 64 32 27	23 72 28 36 19 68 64 32 27
45 2 76 74 40 9 4 81 38	45 1 77 74 42 7 4 80 39	44 3 76 75 40 8 4 80 39	23 70 30 34 21 68 66 32 25	22 71 30 36 19 68 65 33 25	22 71 30 35 21 67 66 31 26
55 51 17 15 62 46 53 10 60	56 51 16 13 62 48 54 10 59	57 49 17 13 62 48 53 12 58			
	2041/		2053/		2077/
25 39 59 33 80 10 65 4 54	26 39 58 31 80 12 66 4 53	27 37 59 31 80 12 65 6 52	30 77 16 71 1 51 22 45 56	30 76 17 71 3 49 22 44 57	29 78 16 72 1 50 22 44 57
68 7 48 19 42 62 36 74 13	67 8 48 21 40 62 35 75 13	67 8 48 20 42 61 36 73 14	29 76 18 70 3 50 24 44 55	28 77 18 72 1 50 23 45 55	28 77 18 71 3 49 24 43 56
67 9 47 21 41 61 35 73 15	68 9 46 19 41 63 36 73 14	69 7 47 19 41 63 35 73 13	27 38 58 32 79 12 64 6 53	27 37 59 32 81 10 64 5 54	26 39 58 33 79 11 64 5 54
69 8 46 20 40 63 34 75 14	69 7 47 20 42 61 34 74 15	68 9 46 21 40 62 34 74 15	26 37 60 31 81 11 66 5 52	25 38 60 33 79 11 65 6 52	25 38 60 32 81 10 66 4 53
28 78 17 72 2 49 23 43 57	29 78 16 70 2 51 24 43 56	30 76 17 70 2 51 23 45 55			
	2089/		2185/		2305/
28 81 14 26 40 57 69 2 52	29 81 13 24 37 62 70 5 48	30 80 13 23 37 63 70 6 47	78 11 34 37 63 23 8 49 66	79 14 30 38 63 22 6 46 71	71 4 48 28 81 14 24 38 61
17 31 75 60 20 43 46 72 5	15 28 80 61 23 39 47 72 4	22 39 62 72 5 46 29 79 15	18 32 73 58 21 44 47 70 6	16 32 75 56 27 40 51 64 8	26 40 57 64 9 50 33 74 16
29 79 15 27 41 55 67 3 53	33 73 17 25 41 57 65 9 49	31 75 17 27 41 55 65 7 51	76 12 35 38 61 24 9 50 64	74 18 31 42 55 26 7 50 66	66 8 49 32 73 18 25 42 56
77 10 36 39 62 22 7 51 65	78 10 35 43 59 21 2 54 67	67 3 53 36 77 10 20 43 60	16 33 74 59 19 45 48 71 4	11 36 76 60 19 44 52 68 3	21 44 58 68 1 54 34 78 11
30 80 13 25 42 56 68 1 54	34 77 12 20 45 58 69 1 53	35 76 12 19 45 59 69 2 52			
	2377/		2481/		2529/
31 81 11 20 40 63 72 2 49	32 81 10 16 29 78 75 13 35	33 80 10 17 28 78 73 15 35	75 14 34 43 57 23 5 52 66	73 14 36 33 79 11 17 30 76	74 13 36 31 81 11 18 29 76
17 28 78 60 26 37 46 69 8	18 28 77 74 15 34 31 80 12	16 30 77 75 14 34 32 79 12	18 29 76 58 27 38 47 67 9	21 40 62 59 27 37 43 56 24	20 40 63 58 27 38 45 56 22
32 79 12 21 41 61 70 3 50	44 57 22 19 41 63 60 25 38	43 57 23 21 41 61 59 25 39	73 15 35 44 55 24 6 53 64	58 26 39 45 55 23 20 42 61	60 26 37 44 55 24 19 42 62
74 13 36 45 56 22 4 54 65	70 2 51 48 67 8 5 54 64	70 3 50 48 68 7 5 52 66	16 30 77 59 25 39 48 68 7	6 52 65 71 3 49 46 68 9	6 53 64 71 1 51 46 69 8
33 80 10 19 42 62 71 1 51	47 69 7 4 53 66 72 1 50	47 67 9 4 54 65 72 2 49			

2585/									2625/									2665/								
34	78	11	12	35	76	77	10	36	35	78	10	12	34	77	76	11	36	36	67	20	11	54	58	76	2	45
75	17	31	32	73	18	16	33	74	73	17	33	32	75	16	18	31	74	64	26	33	51	55	17	8	42	73
14	28	81	79	15	29	30	80	13	15	28	80	79	14	30	29	81	13	23	30	70	61	14	48	39	79	5
20	43	60	58	21	44	45	59	19	19	44	60	59	21	43	45	58	20	10	53	60	78	1	44	35	69	19
40	57	26	27	41	55	56	25	42	42	55	26	25	41	57	56	27	40	50	57	16	7	41	75	66	25	32
63	23	37	38	61	24	22	39	62	62	24	37	39	61	23	22	38	63	63	13	47	38	81	4	22	29	72
69	2	52	53	67	3	1	54	68	69	1	53	52	68	3	2	54	67	77	3	43	34	68	21	12	52	59
8	49	66	64	9	50	51	65	7	8	51	64	66	7	50	49	65	9	9	40	74	65	27	31	49	56	18
46	72	5	6	47	70	71	4	48	46	71	6	5	48	70	72	4	47	37	80	6	24	28	71	62	15	46

2681/									2745/									2769/								
37	81	5	8	40	75	78	2	43	38	81	4	6	37	80	79	5	39	39	77	7	4	45	74	80	1	42
63	14	46	49	57	17	11	52	60	61	14	48	47	63	13	15	46	62	58	18	47	53	55	15	12	50	61
23	28	72	66	26	31	34	69	20	24	28	71	70	23	30	29	72	22	26	28	69	66	23	34	31	72	20
24	29	70	64	27	32	35	67	21	25	32	66	65	27	31	33	64	26	22	36	65	71	19	33	30	68	25
38	79	6	9	41	73	76	3	44	42	73	8	7	41	75	74	9	40	44	73	6	3	41	79	76	9	38
61	15	47	50	55	18	12	53	58	56	18	49	51	55	17	16	50	57	57	14	52	49	63	11	17	46	60
62	13	48	51	56	16	10	54	59	60	10	53	52	59	12	11	54	58	62	10	51	48	59	16	13	54	56
22	30	71	65	25	33	36	68	19	20	36	67	69	19	35	34	68	21	21	32	70	67	27	29	35	64	24
39	80	4	7	42	74	77	1	45	43	77	3	2	45	76	78	1	44	40	81	2	8	37	78	75	5	43

[Count(n1=1/A11)] = 60/2784] OK!

** Recompiled and Listed by Kanji Setsuda on
Mar.10, 2015 with MacOSX 10.10.2 & Xcode 6.2**

I have to report that we could have got only the 48 solutions of 'Complete Euler Squares' of Order 9 including multiple 3x3 little squares within.

The rest 2736 pieces in the list above do sometimes have the number pattern of {1,1,1,1,1,1,1,1,1} anywhere in some of the primary diagonals of any decomposed layer by the 3rd increment.

If you want to get only those precious 48 jewels, you have to design them explicitly for and make them as 'Complete Euler Squares' by the 'New Euler's Method'.

(First version was written in English on Jul.31, 2002 by Kanji Setsuda;
Revised on May 6, 2005 and on Mar.11, 2015 with MacOSX 10.10.2 & Xcode 6.2)

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<< Appendix: Program List >>

```

/** Super-Multiple 3x3 Type of Self-Complementary Magic **
/** Squares 9x9: Down-converted from 4-D ECO of Order 3 **
/** File: 'Multi3SC99.c' Dictated by Kanji Setsuda **
/** on Sep. 24, 2003; May 17, 2006; Recompiled on **
/** Mar.10, 2015 with MacOSX 10.10.2 & Xcode 6.2 **
//
#include <stdio.h>
//
/** Global Variables *
short int cnt, cnt1, cnt2, cnt3;
short LSM, SLSM, CC;
short nm[82], flg[82];
short dnm[5][82];
//
void stp00(void);
void stp01(void), stp02(void), stp03(void), stp04(void);
void stp05(void), stp06(void), stp07(void), stp08(void);

```

```

void stp09(void), stp10(void), stp11(void), stp12(void);
void stp13(void), stp14(void), stp15(void), stp16(void);
void stp17(void), stp18(void), stp19(void), stp20(void);
void stp21(void), stp22(void), stp23(void), stp24(void);
void stp25(void), stp26(void), stp27(void), stp28(void);
void stp29(void), stp30(void), stp31(void), stp32(void);
void stp33(void), stp34(void), stp35(void), stp36(void);
void stp37(void), stp38(void), stp39(void), stp40(void);
void ansprint(void), nprint(void);
void decomp(void);
//
/** Main Program *
int main(){
short n;
printf("\n");
printf("*** Super-Multiple 3x3 Type of Self-complementary Magic\n");
printf("    Squares 9x9: Down-converted from 4-D ECO of Order 3 **\n");
for(n=0;n<82;n++){nm[n]=0; flg[n]=0;}
LSM=369; SLSM=123; CC=82;
cnt=0; cnt1=0; cnt3=0;
nm[41]=41; flg[41]=1;
stp00();    /** Begin the Calculations *
flg[41]=0;
printf("\n");
printf(" [Count(n1=1/All) = %d/%d] OK!\n",cnt1,cnt);
printf("\n");
printf("*** Recompiled and Listed by Kanji Setsuda on\n");
printf("    Mar.10, 2015 with MacOSX 10.10.2 & Xcode 6.2 **\n");
printf("\n");
return 0;
}
//
/** Begin the Calculations *
/** Set n1 & n81 & n1<n81 *
void stp00(){
short a,b;
for(a=1;a<40;a++){b=CC-a;
if((flg[a]==0)&&(flg[b]==0)){cnt2=0;
nm[1]=a; nm[81]=b;
flg[a]=1; flg[b]=1;
stp01();
flg[b]=0; flg[a]=0;}}
}
}
/** Set n2 & n80 *
void stp01(){
short a,b;
for(a=81;a>0;a--){b=CC-a;
if((flg[a]==0)&&(flg[b]==0)){if(nm[1]==1){cnt2=0;}}
nm[2]=a; nm[80]=b;
flg[a]=1; flg[b]=1;
stp02();
flg[b]=0; flg[a]=0;}}
}
}
/** Set n3=123-n1-n2 & n79 *
void stp02(){
short a,b;
a=SLSM-nm[1]-nm[2];
if((0<a)&&(a<82)){b=CC-a;
if((flg[a]==0)&&(flg[b]==0)){
nm[3]=a; nm[79]=b;
flg[a]=1; flg[b]=1;
stp03();
flg[b]=0; flg[a]=0;}}
}
}

```

```

}
/** Set n4 & n78 *
void stp03(){
  short a,b;
  for(a=81;a>0;a--){b=CC-a;
    if((flg[a]==0)&&(flg[b]==0)){//if(nm[1]==1){cnt2=0;}
      nm[4]=a; nm[78]=b;
      flg[a]=1; flg[b]=1;
      stp04();
      flg[b]=0; flg[a]=0;}
  }
}
/** Set n7=123-n1-n4 & n75 *
void stp04(){
  short a,b;
  a=SLSM-nm[1]-nm[4];
  if((0<a)&&(a<82)){b=CC-a;
    if((flg[a]==0)&&(flg[b]==0)){
      nm[7]=a; nm[75]=b;
      flg[a]=1; flg[b]=1;
      stp05();
      flg[b]=0; flg[a]=0;}}
}
/** Set n5 & n77 *
void stp05(){
  short a,b;
  for(a=1;a<82;a++){b=CC-a;
    if((flg[a]==0)&&(flg[b]==0)){
      nm[5]=a; nm[77]=b;
      flg[a]=1; flg[b]=1;
      stp06();
      flg[b]=0; flg[a]=0;}
  }
}
/** Set n6=123-n4-n5 & n76 *
void stp06(){
  short a,b;
  a=SLSM-nm[4]-nm[5];
  if((0<a)&&(a<82)){b=CC-a;
    if((flg[a]==0)&&(flg[b]==0)){
      nm[6]=a; nm[76]=b;
      flg[a]=1; flg[b]=1;
      stp07();
      flg[b]=0; flg[a]=0;}}
}
/** Set n8=123-n2-n5 & n74 *
void stp07(){
  short a,b;
  a=SLSM-nm[2]-nm[5];
  if((0<a)&&(a<82)){b=CC-a;
    if((flg[a]==0)&&(flg[b]==0)){
      nm[8]=a; nm[74]=b;
      flg[a]=1; flg[b]=1;
      stp08();
      flg[b]=0; flg[a]=0;}}
}
/** Set n9=123-n7-n8 & n73 & n1<n9 & n1<n73 *
void stp08(){
  short a,b;
  a=SLSM-nm[7]-nm[8];
  b=SLSM-nm[3]-nm[6];
  if((nm[1]<a)&&(a<82)&&(a==b)){b=CC-a;
    if((nm[1]<b)&&(flg[a]==0)&&(flg[b]==0)){
      nm[9]=a; nm[73]=b;
      flg[a]=1; flg[b]=1;

```

```

        stp09();
        flg[b]=0; flg[a]=0;}}
}
/** Level #2: *
/** Set 10(<n2) & n72 *
void stp09(){
    short a,b;
    for(a=nm[2]-1;a>0;a--){b=CC-a;
        if((flg[a]==0)&&(flg[b]==0)){
            nm[10]=a; nm[72]=b;
            flg[a]=1; flg[b]=1;
            stp10();
            flg[b]=0; flg[a]=0;}
        }
}
/** Set n19=123-n1-n10 & n63 *
void stp10(){
    short a,b;
    a=SLSM-nm[1]-nm[10];
    if((0<a)&&(a<82)){b=CC-a;
        if((flg[a]==0)&&(flg[b]==0)){
            nm[19]=a; nm[63]=b;
            flg[a]=1; flg[b]=1;
            stp11();
            flg[b]=0; flg[a]=0;}}
}
/** Set n46=123-n19-n73 & n36 *
void stp11(){
    short a,b;
    a=SLSM-nm[19]-nm[73];
    if((0<a)&&(a<82)){b=CC-a;
        if((flg[a]==0)&&(flg[b]==0)){
            nm[46]=a; nm[36]=b;
            flg[a]=1; flg[b]=1;
            stp12();
            flg[b]=0; flg[a]=0;}}
}
/** Set n28 & n54 *
void stp12(){
    short a,b;
    for(a=81;a>0;a--){b=CC-a;
        if((flg[a]==0)&&(flg[b]==0)){
            nm[28]=a; nm[54]=b;
            flg[a]=1; flg[b]=1;
            stp13();
            flg[b]=0; flg[a]=0;}
        }
}
/** Set n55=123-n1-n28 & n27 *
void stp13(){
    short a,b;
    a=SLSM-nm[1]-nm[28];
    if((0<a)&&(a<82)){b=CC-a;
        if((flg[a]==0)&&(flg[b]==0)){
            nm[55]=a; nm[27]=b;
            flg[a]=1; flg[b]=1;
            stp14();
            flg[b]=0; flg[a]=0;}}
}
/** Set n18=123-n9-n27 & n64 *
void stp14(){
    short a,b;
    a=SLSM-nm[9]-nm[27];
    if((0<a)&&(a<82)){b=CC-a;
        if((flg[a]==0)&&(flg[b]==0)){

```

```

        nm[18]=a; nm[64]=b;
        flg[a]=1; flg[b]=1;
        stp15();
        flg[b]=0; flg[a]=0;}}
}
/** Set n37=123-n10-n64 & n45 *
void stp15(){
short a,b;
a=SLSM-nm[10]-nm[64];
b=SLSM-nm[28]-nm[46];
if((0<a)&&(a<82)&&(a==b)){b=CC-a;
    if((flg[a]==0)&&(flg[b]==0)){
        nm[37]=a; nm[45]=b;
        flg[a]=1; flg[b]=1;
        stp16();
        flg[b]=0; flg[a]=0;}}
}
/** Level #3: *
/** Set n11 & n71 *
void stp16(){
short a,b;
for(a=1;a<82;a++){b=CC-a;
    if((flg[a]==0)&&(flg[b]==0)){
        nm[11]=a; nm[71]=b;
        flg[a]=1; flg[b]=1;
        stp17();
        flg[b]=0; flg[a]=0;}}
}
}
/** Set n12=123-n10-n11 & n70 *
void stp17(){
short a,b;
a=SLSM-nm[10]-nm[11];
if((0<a)&&(a<82)){b=CC-a;
    if((flg[a]==0)&&(flg[b]==0)){
        nm[12]=a; nm[70]=b;
        flg[a]=1; flg[b]=1;
        stp18();
        flg[b]=0; flg[a]=0;}}
}
}
/** Set n20=123-n2-n11 & n62 *
void stp18(){
short a,b;
a=SLSM-nm[2]-nm[11];
if((0<a)&&(a<82)){b=CC-a;
    if((flg[a]==0)&&(flg[b]==0)){
        nm[20]=a; nm[62]=b;
        flg[a]=1; flg[b]=1;
        stp19();
        flg[b]=0; flg[a]=0;}}
}
}
/** Set n21=123-n3-n12 & n61 *
void stp19(){
short a,b;
a=SLSM-nm[3]-nm[12];
b=SLSM-nm[19]-nm[20];
if((0<a)&&(a<82)&&(a==b)){b=CC-a;
    if((flg[a]==0)&&(flg[b]==0)){
        nm[21]=a; nm[61]=b;
        flg[a]=1; flg[b]=1;
        stp20();
        flg[b]=0; flg[a]=0;}}
}
}
/** Set n15=123-n12-n18 & n67 *
void stp20(){

```

```

short a,b;
a=SLSM-nm[12]-nm[18];
if((0<a)&&(a<82)){b=CC-a;
  if((flg[a]==0)&&(flg[b]==0)){
    nm[15]=a; nm[67]=b;
    flg[a]=1; flg[b]=1;
    stp21();
    flg[b]=0; flg[a]=0;}}
}
/* Set n24=123-n21-n27 & n58 *
void stp21(){
  short a,b;
  a=SLSM-nm[21]-nm[27];
  b=SLSM-nm[6]-nm[15];
  if((0<a)&&(a<82)&&(a==b)){b=CC-a;
    if((flg[a]==0)&&(flg[b]==0)){
      nm[24]=a; nm[58]=b;
      flg[a]=1; flg[b]=1;
      stp22();
      flg[b]=0; flg[a]=0;}}
}
/* Set n47=123-n34-n36 & n35 *
void stp22(){
  short a,b;
  a=SLSM-nm[20]-nm[74];
  if((0<a)&&(a<82)){b=CC-a;
    if((flg[a]==0)&&(flg[b]==0)){
      nm[47]=a; nm[35]=b;
      flg[a]=1; flg[b]=1;
      stp23();
      flg[b]=0; flg[a]=0;}}
}
/* Set n34=123-n7-n61 & n48 *
void stp23(){
  short a,b;
  a=SLSM-nm[7]-nm[61];
  b=SLSM-nm[35]-nm[36];
  if((0<a)&&(a<82)&&(a==b)){b=CC-a;
    if((flg[a]==0)&&(flg[b]==0)){
      nm[34]=a; nm[48]=b;
      flg[a]=1; flg[b]=1;
      stp24();
      flg[b]=0; flg[a]=0;}}
}
/* Set n31=123-n28-n34 & n51 *
void stp24(){
  short a,b;
  a=SLSM-nm[28]-nm[34];
  b=SLSM-nm[4]-nm[58];
  if((0<a)&&(a<82)&&(a==b)){b=CC-a;
    if((flg[a]==0)&&(flg[b]==0)){
      nm[31]=a; nm[51]=b;
      flg[a]=1; flg[b]=1;
      stp25();
      flg[b]=0; flg[a]=0;}}
}
/* Level #3: *
/* Set n13 & n69 *
void stp25(){
  short a,b;
  for(a=1;a<82;a++){b=CC-a;
    if((flg[a]==0)&&(flg[b]==0)){
      nm[13]=a; nm[69]=b;
      flg[a]=1; flg[b]=1;
      stp26();

```

```

        flg[b]=0; flg[a]=0;}
    }
}
/** Set n14=123-n13-n15 & n68 *
void stp26(){
    short a,b;
    a=SLSM-nm[13]-nm[15];
    if((0<a)&&(a<82)){b=CC-a;
        if((flg[a]==0)&&(flg[b]==0)){
            nm[14]=a; nm[68]=b;
            flg[a]=1; flg[b]=1;
            stp27();
            flg[b]=0; flg[a]=0;}}
}
/** Set n16=123-n10-n13 & n66 *
void stp27(){
    short a,b;
    a=SLSM-nm[10]-nm[13];
    if((0<a)&&(a<82)){b=CC-a;
        if((flg[a]==0)&&(flg[b]==0)){
            nm[16]=a; nm[66]=b;
            flg[a]=1; flg[b]=1;
            stp28();
            flg[b]=0; flg[a]=0;}}
}
/** Set n17=123-n16-n18 & n65 *
void stp28(){
    short a,b;
    a=SLSM-nm[16]-nm[18];
    b=SLSM-nm[11]-nm[14];
    if((0<a)&&(a<82)&&(a==b)){b=CC-a;
        if((flg[a]==0)&&(flg[b]==0)){
            nm[17]=a; nm[65]=b;
            flg[a]=1; flg[b]=1;
            stp29();
            flg[b]=0; flg[a]=0;}}
}
/** Set n38=123-n11-n65 & n44 *
void stp29(){
    short a,b;
    a=SLSM-nm[11]-nm[65];
    if((0<a)&&(a<82)){b=CC-a;
        if((flg[a]==0)&&(flg[b]==0)){
            nm[38]=a; nm[44]=b;
            flg[a]=1; flg[b]=1;
            stp30();
            flg[b]=0; flg[a]=0;}}
}
/** Set n39=123-n37-n38 & n43 *
void stp30(){
    short a,b;
    a=SLSM-nm[37]-nm[38];
    b=SLSM-nm[12]-nm[66];
    if((0<a)&&(a<82)&&(a==b)){b=CC-a;
        if((flg[a]==0)&&(flg[b]==0)){
            nm[39]=a; nm[43]=b;
            flg[a]=1; flg[b]=1;
            stp31();
            flg[b]=0; flg[a]=0;}}
}
/** Set n40=123-n37-n43 & n42 *
void stp31(){
    short a,b;
    a=SLSM-nm[37]-nm[43];
    b=SLSM-nm[13]-nm[67];

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    if((0<a)&&(a<82)&&(a==b)){b=CC-a;
        if((flg[a]==0)&&(flg[b]==0)){
            nm[40]=a; nm[42]=b;
            flg[a]=1; flg[b]=1;
            stp32();
            flg[b]=0; flg[a]=0;}}
}
/** Level #4: *
/** Set n29=123-n38-n47 & n53 *
void stp32(){
    short a,b;
    a=SLSM-nm[38]-nm[47];
    if((0<a)&&(a<82)){b=CC-a;
        if((flg[a]==0)&&(flg[b]==0)){
            nm[29]=a; nm[53]=b;
            flg[a]=1; flg[b]=1;
            stp33();
            flg[b]=0; flg[a]=0;}}
}
/** Set n30=123-n28-n29 & n52 *
void stp33(){
    short a,b;
    a=SLSM-nm[28]-nm[29];
    b=SLSM-nm[39]-nm[48];
    if((0<a)&&(a<82)&&(a==b)){b=CC-a;
        if((flg[a]==0)&&(flg[b]==0)){
            nm[30]=a; nm[52]=b;
            flg[a]=1; flg[b]=1;
            stp34();
            flg[b]=0; flg[a]=0;}}
}
/** Set n32=123-n29-n35 & n50 *
void stp34(){
    short a,b;
    a=SLSM-nm[29]-nm[35];
    if((0<a)&&(a<82)){b=CC-a;
        if((flg[a]==0)&&(flg[b]==0)){
            nm[32]=a; nm[50]=b;
            flg[a]=1; flg[b]=1;
            stp35();
            flg[b]=0; flg[a]=0;}}
}
/** Set n33=123-n31-n32 & n49 *
void stp35(){
    short a,b,c;
    a=SLSM-nm[31]-nm[32];
    b=SLSM-nm[30]-nm[36];
    c=SLSM-nm[42]-nm[51];
    if((0<a)&&(a<82)){
        if((a==b)&&(a==c)){b=CC-a;
            if((flg[a]==0)&&(flg[b]==0)){
                nm[33]=a; nm[49]=b;
                flg[a]=1; flg[b]=1;
                stp36();
                flg[b]=0; flg[a]=0;}}}
}
/** Set n22=123-n4-n13 & n60 *
void stp36(){
    short a,b;
    a=SLSM-nm[4]-nm[13];
    b=SLSM-nm[49]-nm[76];
    if((0<a)&&(a<82)&&(a==b)){b=CC-a;
        if((flg[a]==0)&&(flg[b]==0)){
            nm[22]=a; nm[60]=b;
            flg[a]=1; flg[b]=1;

```

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        stp37();
        flg[b]=0; flg[a]=0;}}
}
/** Set n23=123-n22-n24 & n59 *
void stp37(){
short a,b,c;
a=SLSM-nm[22]-nm[24];
b=SLSM-nm[5]-nm[14];
c=SLSM-nm[50]-nm[77];
if((0<a)&&(a<82)){
    if((a==b)&&(a==c)){b=CC-a;
        if((flg[a]==0)&&(flg[b]==0)){
            nm[23]=a; nm[59]=b;
            flg[a]=1; flg[b]=1;
            stp38();
            flg[b]=0; flg[a]=0;}}}
}
/** Set n25=123-n19-n22 & n57 *
void stp38(){
short a,b,c;
a=SLSM-nm[19]-nm[22];
b=SLSM-nm[52]-nm[79];
c=SLSM-nm[7]-nm[16];
if((0<a)&&(a<82)){
    if((a==b)&&(a==c)){b=CC-a;
        if((flg[a]==0)&&(flg[b]==0)){
            nm[25]=a; nm[57]=b;
            flg[a]=1; flg[b]=1;
            stp39();
            flg[b]=0; flg[a]=0;}}}
}
/** Set n26=123-n25-n27 & n42 *
void stp39(){
short a,b,c,d;
a=SLSM-nm[25]-nm[27];
b=SLSM-nm[20]-nm[23];
c=SLSM-nm[8]-nm[17];
d=SLSM-nm[53]-nm[80];
if((0<a)&&(a<82)){
    if((a==b)&&(a==c)&&(a==d)){b=CC-a;
        if((flg[a]==0)&&(flg[b]==0)){
            nm[26]=a; nm[56]=b;
            flg[a]=1; flg[b]=1;
            ansprint();
            flg[b]=0; flg[a]=0;}}}
}
//
/** Print the Answers with /D3i *
void ansprint(void){
    cnt++; if(nm[1]==1){cnt1++;}
    cnt2++;
    if(cnt2==1){decomp(); nprint();}
}
//
/** Print the Answer *
void nprint(){
short l,l9,m,n;
printf("%27d# /D3i%4d*%9d*%9d*%9d*\n",cnt,27,9,3,1);
for(l=0;l<9;l++){l9=l*9;
    printf(" ");
    for(n=1;n<10;n++){printf("%3d",nm[l9+n]);}
    printf(" ");
    for(m=3;m>=0;m--){
        printf(" ");
        for(n=1;n<10;n++){

```

```

        printf("%d", dnm[m][l9+n]);
    }
}
printf("\n");
}
}
//
/* Decompose it by 3rd Incliments *
void decomp(){
    short l,m,n;
    for(n=1;n<82;n++){
        for(m=0;m<4;m++){dnm[m][n]=0;}
        m=0; l=nm[n]-1;
        while(l>0){dnm[m][n]=l%3; l=l/3; m++;}
        dnm[m][n]=0;
    }
}
//

```