

Numbers and Complex Symmetric Multiple Arguments in the Ring System

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Abstract:- In this article illustrate the use of complex numbers grouped in sets and multiple arguments grouped in sets of trigonometric functions, assembled into systems that acquire a cyclic behavior.

I. SUMMARY

Earlier this article is an example of the 3D extension of a cycle curve generated by parametric equations.

The following example uses two arguments 4 systems forming constructive set, whose interaction by segmenting their determinants and plotting parametric behavior shows obvious symmetry and interconnected dynamic system such as a multi-way reversible.

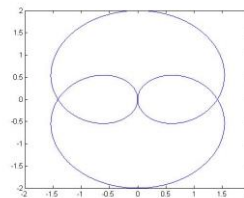
The third example defines a set of complex numbers spread in the real part and the system imaginary part, which are exactly the same determinant on the segment it into products plotted parametric obtain a system with elements of intersection triple (= common solutions), and Tangential elements (= common solutions).

The fourth example uses one argument and 8 complex numbers (all possible combinations + - sin / cos). Plot elements not only include imaginary factor obtain a body of intersection of disc surfaces of polyhedra family rules.

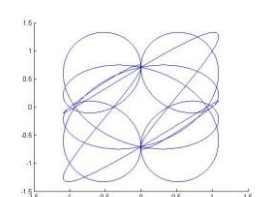
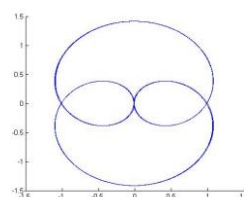
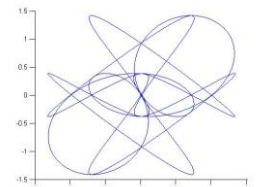
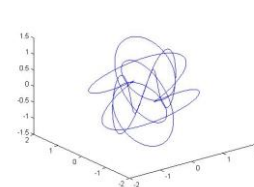
Example "Render" is a set of systems that have identical forefront of parametric whose plot we can develop ideas on knot theory. Example "Twenty Five" presents a diagram of a coherent system in size in size 5. All 5 following example uses all positive and negative combinations of three arguments of the two trigonometric functions, constitute a "headboard" 5 * 5. Continue using the same "edge", complete with a "core" ... (one of the images is "Folium of Descartes").

Here's how we can expand using complex numbers in 3D, a cyclic curve has two parametric equations (one of the 3D projections is really epicyclic the plan)

```
t=[0:0.001:2*pi]; x=cos(t)-cos(3*t); y=sin(t)-sin(3*t);
plot(x,y);
```



```
t=[0:0.001:2*pi];x1=cos(t)+i*cos(2*t);x2=cos(2*t)+i*sin(t);y1=sin(t)+i*sin(2*t);y2=sin(2*t)+i*cos(t);plot3(x1.*x2,
x2.*y1,y1.*y2);hold on;x1=cos(t)-i*cos(2*t);x2=cos(2*t)+i*sin(t);y1=sin(t)-i*sin(2*t);y2=sin(2*t)+i*cos(t);plot3(x1.*x2,x2.*y1,y1.*y2);hold on;
x1=cos(t)+i*cos(2*t);x2=cos(2*t)-i*sin(t);y1=sin(t)+i*sin(2*t);y2=sin(2*t)-i*cos(t);plot3(x1.*x2,x2.*y1,y1.*y2);hold on;
x1=cos(t)-i*cos(2*t);x2=cos(2*t)+i*sin(t);y1=sin(t)+i*sin(2*t);y2=sin(2*t)-i*cos(t);plot3(x1.*x2,x2.*y1,y1.*y2);hold on;
```



It's like a feedback system that evolves placeCAM ...

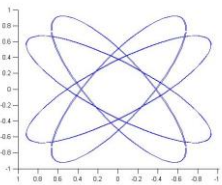
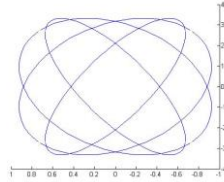
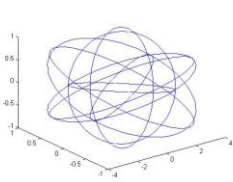
Moving into another level, use 4 * 4 systems:

P=[1 cos(p) sin(p) 1; sin(s) 0 0 cos(q); cos(s) 0 0 sin(r); 1 sin(r) cos(r) 1];	Q=[1 cos(p) sin(q) 1; sin(p) 0 0 cos(q); cos(s) 0 0 sin(r); 1 sin(s) cos(r) 1];	R=[1 cos(p) sin(r) 1; sin(q) 0 0 cos(q); cos(s) 0 0 sin(s); 1 sin(p) cos(r) 1];	S=[1 cos(p) sin(s) 1; sin(r) 0 0 cos(q); cos(s) 0 0 sin(p); 1 sin(q) cos(r) 1];
--	--	--	--

simplify(det(P-Q+R-S)) ans =-(sin(p) - sin(q) + sin(r) - sin(s))^4;
simplify(det(P-Q-R+S)) ans =-(sin(p) + sin(q) - sin(r) - sin(s))^2*(sin(p) - sin(q) - sin(r) + sin(s))^2;

We have three distinct elements to the power 2, 2, 4!
A=sin(p) - sin(q) + sin(r) - sin(s); B=sin(p) + sin(q) - sin(r) - sin(s); C=sin(p) - sin(q) - sin(r) + sin(s);
p=[0:0.001:2*pi]; q=2*pi-p; r=2*pi-q; s=2*pi-r;

$A=\sin(p) - \sin(q) + \sin(r) - \sin(s)$; $B=\sin(p) + \sin(q) - \sin(r) - \sin(s)$; $C=\sin(p) - \sin(q) - \sin(r) + \sin(s)$;
`plot3(A,B,C);hold on;plot3(-A,B,C);hold on;plot3(A,-B,C);hold on;plot3(A,B,-C);hold on;plot3(-A,-B,C);hold on;plot3(-A,-B,-C);hold on;`



HEXAEDRAL

$Z1=\cos(u)*\cos(v)+i*\sin(u)*\sin(v)$;
 $Z2=\cos(u)*\sin(u)+i*\cos(v)*\sin(v)$;
 $Z3=\cos(u)*\sin(v)+i*\cos(v)*\sin(u)$;
 $Z4=\cos(v)*\sin(u)+i*\cos(u)*\sin(v)$;
 $Z5=\cos(v)*\sin(v)+i*\cos(u)*\sin(u)$;
 $Z6=\sin(u)*\sin(v)+i*\cos(u)*\cos(v)$;
`matrix([[cos(u)*cos(v),cos(u)*sin(u),cos(u)*sin(v)],[1,1,1],`
`[cos(v)*sin(u),cos(v)*sin(v),sin(u)*sin(v)])]`

$$\begin{pmatrix} \cos(u) \cos(v) & \cos(u) \sin(u) & \cos(u) \sin(v) \\ 1 & 1 & 1 \\ \cos(v) \sin(u) & \cos(v) \sin(v) & \sin(u) \sin(v) \end{pmatrix}$$

`linalg::det(matrix([[cos(u)*cos(v), cos(u)*sin(u),`
`cos(u)*sin(v)], [1, 1, 1], [cos(v)*sin(u), cos(v)*sin(v),`
`sin(u)*sin(v)]))`

$$-\cos(u) \cos(v)^2 \sin(v) + \cos(u) \cos(v) \sin(u)^2 + \cos(u)$$

`Simplify(-cos(u)*cos(v)^2*sin(v) + cos(u)*cos(v)*sin(u)^2 -`
`cos(u)*sin(u)^2*sin(v))`

$$-\cos(u) (\cos(v) - \sin(v)) (\cos(u)^2 + \cos(v) \sin(v) - 1)$$

`matrix([[sin(u)*sin(v),sin(v)*cos(v),sin(u)*cos(v)],[1,1,1],`
`sin(v)*cos(u),sin(u)*cos(u),cos(u)*cos(v)])]`

$$\begin{pmatrix} \sin(u) \sin(v) & \cos(v) \sin(v) & \cos(v) \sin(u) \\ 1 & 1 & 1 \\ \cos(u) \sin(v) & \cos(u) \sin(u) & \cos(u) \cos(v) \end{pmatrix}$$

`linalg::det(matrix([[sin(u)*sin(v), cos(v)*sin(v),`
`cos(v)*sin(u)], [1, 1, 1], [cos(u)*sin(v), cos(u)*sin(u),`
`cos(u)*cos(v)]))`

$$-\cos(u) \cos(v)^2 \sin(v) + \cos(u) \cos(v) \sin(u)^2 + \cos(u)$$

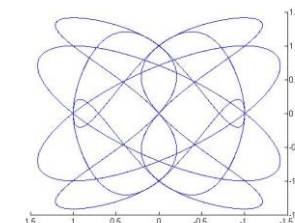
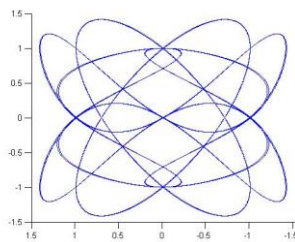
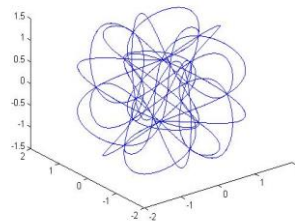
`Simplify(-cos(u)*cos(v)^2*sin(v) + cos(u)*cos(v)*sin(u)^2 -`
`cos(u)*sin(u)^2*sin(v))`

$$-\cos(u) (\cos(v) - \sin(v)) (\cos(u)^2 + \cos(v) \sin(v) - 1)$$

It's a triple product! Plot it completely (convolution)

`u=[0:0.001:2*pi]; =2*pi-u;`

$X=-\cos(u)$; $Y=\cos(v)-\sin(v)$; $Z=\cos(u)^2+\cos(v)*\sin(v)-1$;
`plot3(X,Y,Z);hold on;plot3(-X,Y,Z);hold on;plot3(X,-Y,Z);hold on;plot3(X,Y,-Z);hold on;plot3(-X,-Y,Z);hold on;plot3(X,-Y,-Z);hold on;plot3(-X,-Y,-Z);hold on;plot3(Y,Z,X);hold on;plot3(-Y,Z,X);hold on;plot3(Y,-Z,X);hold on;plot3(-Y,-Z,X);hold on;plot3(Y,Z,-X);hold on;plot3(-Y,Z,-X);hold on;plot3(Y,-Z,-X);hold on;plot3(-Y,-Z,-X);hold on;plot3(Z,X,Y);hold on;plot3(-Z,X,Y);hold on;plot3(Z,-X,Y);hold on;plot3(-Z,-X,Y);hold on;plot3(Z,X,-Y);hold on;plot3(-Z,X,-Y);hold on;plot3(Z,-X,-Y);hold on;plot3(-Z,-X,-Y);hold on;`



I work in a single complex argument with all options:

$Z(1)=\cos(t)+i*\sin(t)$; $Z(2)=\cos(t)+i*\cos(t)$;

$Z(3)=\sin(t)+i*\sin(t)$; $Z(4)=\cos(t)-i*\sin(t)$;

$Z(5)=\sin(t)+i*\cos(t)$; $Z(6)=\cos(t)-i*\cos(t)$; $Z(7)=\sin(t)-i*\sin(t)$; $Z(8)=\sin(t)-i*\cos(t)$;

for k=1:4

for j=1:4k=j+1;

simplify(Z(k)*Z(j))

k=j+2;

simplify(Z(k)*Z(j))

k=j+3;

simplify(Z(k)*Z(j))

k=j+4;

simplify(Z(k)*Z(j))

end

end;

... only factor without imaginary elements are:

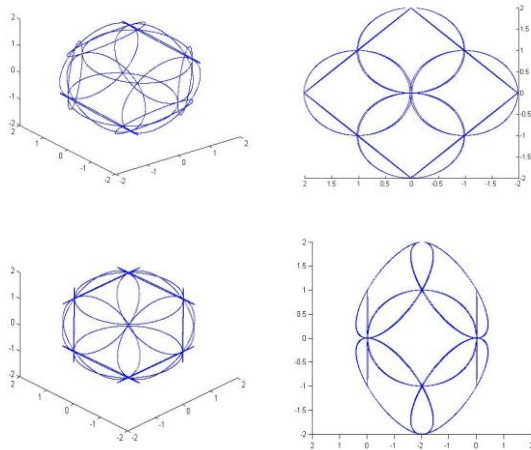
`t=[0:0.001:2*pi]; X=2*cos(t).^2; Y=2*sin(t).^2;`

`Z=sin(2*t);`

```

plot3(X,Y,Z);hold on;plot3(-X,Y,Z);hold on;plot3(X,-Y,Z);hold on;plot3(X,Y,-Z);hold on;plot3(-X,-Y,Z);hold on;plot3(-X,Y,-Z);hold on;plot3(X,-Y,-Z);hold on;plot3(-X,-Y,-Z);hold on;plot3(Y,Z,X);hold on;plot3(-Y,Z,X);hold on;plot3(Y,-Z,X);hold on;plot3(-Y,-Z,X);hold on;plot3(Z,X,Y);hold on;plot3(-Z,X,Y);hold on;plot3(Z,-X,Y);hold on;plot3(-Z,-X,Y);hold on;plot3(X,Y,Z);hold on;plot3(-X,Y,Z);hold on;plot3(X,-Y,Z);hold on;plot3(X,Y,-Z);hold on;plot3(-X,-Y,Z);hold on;plot3(-X,Y,-Z);hold on;plot3(X,-Y,-Z);hold on;plot3(-X,-Y,-Z);hold on;plot3(Y,Z,X);hold on;plot3(-Y,Z,X);hold on;plot3(Y,-Z,X);hold on;plot3(-Y,-Z,X);hold on;plot3(Z,X,Y);hold on;plot3(-Z,X,Y);hold on;plot3(Z,-X,Y);hold on;plot3(-Z,-X,Y);hold on;

```



“RENDER”

First line the same

$$\begin{pmatrix} \sin(t) & \cos(t) \\ \sin(t+u) & -\cos(t+u) \end{pmatrix}$$

Simplify(linalg::det(matrix([[sin(t), cos(t)], [sin(t + u), -cos(t + u)]])))

$$-\sin(2t+u)$$

$$\begin{pmatrix} \sin(t) & \cos(t) \\ \sin(t+v) & -\cos(t+v) \end{pmatrix}$$

Simplify(linalg::det(matrix([[sin(t), cos(t)], [sin(t + v), -cos(t + v)]])))

$$-\sin(2t+v)$$

$$\begin{pmatrix} \sin(t) & \cos(t) \\ \cos(t+v) & \sin(t+v) \end{pmatrix}$$

Simplify(linalg::det(matrix([[sin(t), cos(t)], [cos(t + v), sin(t + v)]])))

$$-\cos(2t+v)$$

$$\begin{pmatrix} \sin(t) & \cos(t) \\ \cos(t+u) & \sin(t+u) \end{pmatrix}$$

Simplify(linalg::det(matrix([[sin(t), cos(t)], [cos(t + u), sin(t + u)]])))

$$-\cos(2t+u)$$

t=[0:0.001:2*pi]; u=[pi:0.001:3*pi]; v=[2*pi:0.001:4*pi];

X1=sin(2*t+u)-2.2*sin(v); Y1=cos(2*t+u)-2.2*cos(v);

X2=sin(2*t+v)-3*sin(u); Y2=cos(2*t+v)-3*cos(u);

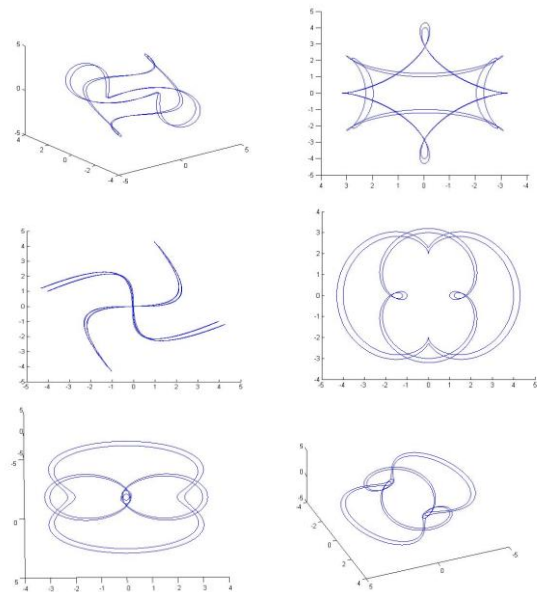
X3=sin(2*t+v)-2*sin(u); Y3=cos(2*t+v)-2*cos(u);

X4=sin(2*t+u)-3.3*sin(u); Y4=cos(2*t+u)-3.3*cos(u);

```

plot3(X1,Y1,X2);hold on; plot3(X2,Y2,X3);hold on;
plot3(X3,Y3,X4);hold on; plot3(X4,Y4,X1);hold on;

```



Knot theory ...?

Login DIMENSION 5:
TWENTY-FIVE

$$\begin{pmatrix} -\cos(u) & \sin(u) & \sin(v) & \sin(u) & \cos(u) \\ -\sin(u) & \cos(u) & \cos(v) & \cos(u) & \sin(u) \\ \sin(v) & \cos(v) & -1 & \cos(u) & \sin(u) \\ \sin(v) & \cos(v) & \cos(u) & \cos(v) & \sin(v) \\ \cos(v) & \sin(v) & \sin(u) & \sin(v) & \cos(v) \end{pmatrix}$$

Simplify(linalg::det(matrix([[-cos(u), sin(u), sin(v), sin(u), cos(u)], [-sin(u), cos(u), cos(v), cos(u), sin(u)], [sin(v), cos(v), -1, cos(u), sin(u)], [sin(v), cos(v), cos(u), cos(v), sin(v)], [cos(v), sin(v), sin(u), sin(v), cos(v)]))))

$$4 \cos(u+v) (\cos(u) + \cos(v)) (\cos(u) - \cos(v))^2$$

LINE 1,2,3,4,5 :

$$\begin{pmatrix} -\sin(u) & \cos(u) \\ \cos(u) & \sin(u) \\ \sin(v) & \cos(v) \\ \cos(v) & \sin(v) \end{pmatrix}$$

$$\begin{pmatrix} -\cos(u) & \sin(u) & \sin(v) & \sin(u) & \cos(u) \\ -\sin(u) & \cos(u) & \cos(v) & \cos(u) & \sin(u) \\ \sin(v) & \cos(v) & -1 & \cos(u) & \sin(u) \\ \sin(v) & \cos(v) & \cos(u) & \cos(v) & \sin(v) \\ \cos(v) & \sin(v) & \sin(u) & \sin(v) & \cos(v) \end{pmatrix}$$

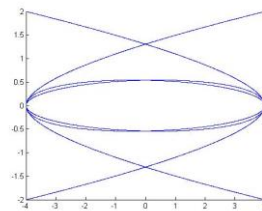
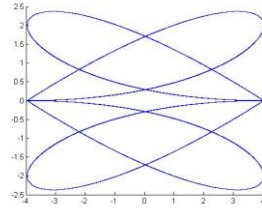
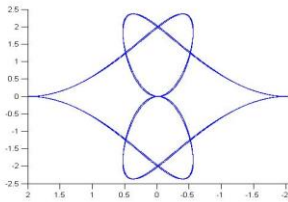
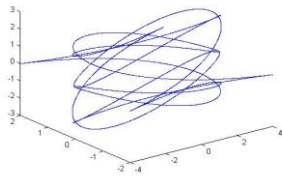
u=[0:0.001:2*pi]; v=2*u;

X=4*cos(u+v); Y=cos(u)+cos(v); Z=(cos(u)-cos(v)).^2;

```

plot3(X,Y,Z);hold on; plot3(-X,Y,Z);hold on;plot3(X,-Y,Z);hold on;plot3(X,Y,-Z);hold on;plot3(-X,-Y,Z);hold on;plot3(-X,Y,-Z);hold on;plot3(X,-Y,-Z);hold on;plot3(-X,-Y,-Z);hold on;

```



BORDER FULL (all possible combinations!):
A2=

$\text{Sin}(t+u+v)$	$\text{Sin}(-t-u+v)$	$\text{Sin}(-t+u-v)$	$\text{Sin}(t-u-v)$	$\text{Sin}(-t+u+v)$
$\text{Cos}(-t-u-v)$	-1	-1	-1	$\text{Sin}(t-u+v)$
$\text{Cos}(t+u-v)$	-1	-1	-1	$\text{Sin}(t+u-v)$
$\text{Cos}(t-u+v)$	-1	-1	-1	$\text{Sin}(-t-u-v)$
$\text{Cos}(-t+u+v)$	$\text{Cos}(t-u-v)$	$\text{Cos}(-t+u-v)$	$\text{Cos}(-t-u+v)$	$\text{Cos}(t+u+v)$

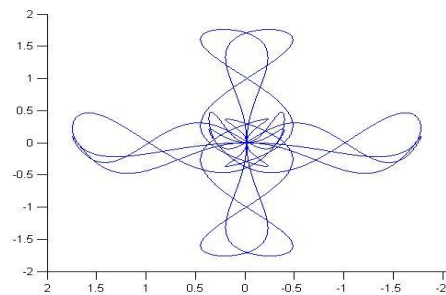
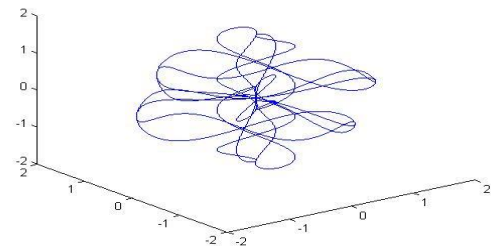
```
A2=[sin(t+u+v) sin(-t+u+v) sin(-t+u-v) sin(t-
u-v) sin(-t+u+v);
cos(-t-u-v) -1 -1 -1 sin(t+u+v);
cos(t+u-v) -1 -1 -1 sin(t+u-v);
cos(t-u+v) -1 -1 -1 sin(-t-u-v);
cos(-t+u+v) cos(t-u-v) cos(-t+u-v) cos(-t-
u+v) cos(t+u+v)];
```

```
>> simplify(det(A2))ans =
-16*
```

```
(sin(t)^2 - sin(v)^2)*
(cos(t)^2*cos(v)^2*sin(u)^4 - cos(u)^4*sin(t)^2*sin(v)^2);
```

4 PRODUCT, PLOT:

```
t=[0:0.001:2*pi]; u=2*t; v=-2*t;
X=(sin(t) - sin(v));
Y=(sin(t) + sin(v));
Z=(cos(t).*cos(v).*sin(u).^2 - cos(u).^2.*sin(t).*sin(v));
V=(cos(t).*cos(v).*sin(u).^2 + cos(u).^2.*sin(t).*sin(v));
plot3(X,Y,Z);hold on;plot3(X,Y,V);hold on;
plot3(Z,V,X);hold on;plot3(Z,V,Y);hold on;
```



Borders and core (CASE)

$\text{cos}(t+u+v)$	0	$\text{cos}(t+u+v)$	$\text{cos}(t+u+v)$	0
0	$\text{cos}(t+u+v)$	0	0	$\text{Sin}(-t+u+v)$
$\text{cos}(t+u+v)$	0	$\text{cos}(t+u+v)$	$\text{cos}(t+u+v)$	$\text{Sin}(t-u+v)$
$\text{Sin}(t+u+v)$	$\text{Sin}(-t-u+v)$	$\text{Sin}(-t+u-v)$	$\text{Sin}(t-u-v)$	$\text{Sin}(-t+u+v)$
$\text{Cos}(-t-u-v)$	$\text{cos}(t+u+v)$	0	$\text{cos}(t+u+v)$	$\text{Sin}(t-u+v)$
$\text{Cos}(t+u-v)$	0	0	0	$\text{Sin}(t+u-v)$
$\text{Cos}(t-u+v)$	$\text{cos}(t+u+v)$	0	$\text{cos}(t+u+v)$	$\text{Sin}(-t-u-v)$
$\text{Cos}(-t+u+v)$	$\text{Cos}(t-u-v)$	$\text{Cos}(-t+u-v)$	$\text{Cos}(-t-u+v)$	$\text{Cos}(t+u+v)$

$$\text{NAC} = \begin{bmatrix} \sin(t+u+v) & \sin(-t-u+v) & \sin(-t+u-v) \\ \sin(t-u-v) & \sin(-t+u+v) & 0 \\ \cos(-t-u-v) & \cos(t+u+v) & 0 \\ \sin(t-u+v); & & \\ \cos(t+u-v) & 0 & 0 \\ \cos(t-u+v) & \cos(t+u+v) & 0 \\ \sin(-t-u-v); & & \end{bmatrix}$$

$$\begin{bmatrix} \cos(-t+u+v) & \cos(t-u-v) & \cos(-t+u-v) & \cos(-t-u+v) \\ \cos(t+u+v) \end{bmatrix};$$

simplify(det(NAC)) ans =
 $\cos(t+u-3*v)/4 - \cos(3*t-u-v)/4 +$
 $\cos(t+u+5*v)/4 - \cos(5*t+u+v)/4;$

$$\begin{bmatrix} \sin(t+u+v) \\ 0 \\ \sin(t+u+v) \end{bmatrix}$$

$$\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} \sin(t+u+v) \\ 0 \\ \sin(t+u+v) \end{bmatrix}$$

$$\begin{bmatrix} \sin(t+u+v) \\ \cos(-t-u-v) \\ \cos(t-u-v) \\ \cos(t+u+v) \\ \cos(-t+u+v) \end{bmatrix}$$

$$\begin{bmatrix} \sin(-t-u+v) \\ \sin(t+u+v) \\ 0 \\ \sin(t+u+v) \\ \cos(t-u-v) \end{bmatrix}$$

$$\begin{bmatrix} \sin(-t+u-v) \\ 0 \\ 0 \\ 0 \\ \cos(-t+u-v) \end{bmatrix}$$

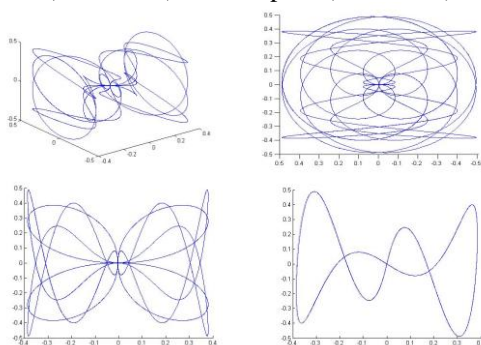
$$\begin{bmatrix} \sin(t-u-v) \\ \sin(t+u+v) \\ 0 \\ \sin(t+u+v) \\ \cos(-t-u-v) \end{bmatrix}$$

$$\begin{bmatrix} \sin(-t+u+v) \\ \sin(t+u+v) \\ \sin(t+u+v) \\ \sin(-t-u-v) \\ \cos(t+u+v) \end{bmatrix}$$

$$\text{NAS} = \begin{bmatrix} \sin(t+u+v) & \sin(-t-u+v) & \sin(-t+u-v) \\ \sin(t-u-v) & \sin(-t+u+v) & 0 \\ \cos(-t-u-v) & \sin(t+u+v) & 0 \\ \sin(t-u+v); & & \\ \cos(t+u-v) & 0 & 0 \\ \cos(t-u+v) & \sin(t+u+v) & 0 \\ \sin(-t-u-v); & & \\ \cos(-t+u+v) & \cos(t-u-v) & \cos(-t+u-v) & \cos(-t-u+v) \end{bmatrix};$$

simplify(det(NAS))ans =
 $\sin(3*t-u-v)/4 + \sin(t+u-3*v)/4 +$
 $\sin(t+u+5*v)/4 - \sin(5*t+u+v)/4;$

Generate four equations: IS THE symmetry Plot:
 $t=[0:0.001:\pi]; u=2*t; v=3*t;$
 $X1=\cos(t+u-3*v)/4 - \cos(3*t-u-v)/4 ;$
 $X2=\cos(t+u+5*v)/4 - \cos(5*t+u+v)/4;$
 $Y1=\sin(3*t-u-v)/4 + \sin(t+u-3*v)/4 ;$
 $Y2=\sin(t+u+5*v)/4 - \sin(5*t+u+v)/4;$
 $\text{plot3}(X1,X2,Y1);\text{hold on};\text{plot3}(X1,X2,Y2);\text{hold on};$
 $\text{plot3}(Y1,Y2,X1);\text{hold on};\text{plot3}(Y1,Y2,X2);\text{hold on};$



II. CONCLUSION

These examples using the pool in restricted constructive and complete sets, we can induce the idea of an evolutionary behavior of dynamic systems whose degrees of freedom are non fractal dimension whole. The different types of symmetries they manifest their behavior and critical points of intersection or tangential prove the existence of a single systemic and predictable behavior.

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