# Julia set maps and certain trigonometric functions in modeling stretch & fold, load paths and density in a capacitor foil with air and structured surface

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# Julia set maps and certain trigonometric functions in modeling stretch & fold, load paths and density in a capacitor foil with air and structured surface.

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*Abstract.* Functional expressions modeling electric load paths in foil memristor- capacitors are assumed. Devices with batteries, LED and capacitors were evaluated in previous papers [1-4]. Experimental results indicate that loads occupy surfaces of the foil at occasions during the (process of) lighting a LED with a battery, [1-4]. Based on this and the possibilities for stretch and fold when following the surface, fractal expressions are analysed. Calculated load paths are visualised with polar plots. Electric loads and densities are assumed in a Maxwell model for EM.

*Keywords:* Load density, Voltage, current, Capacitor, non-linear, iteration map, Julia set fractal, stretch and fold, Maxwell's equation

## 1. Introduction with Purpose of Study, Background

With nanotechnologies and metamaterials, to some extent, high power may be obtained at small scale. However, knowledge of the 'mechanisms' is of interest to control, and manage safety. Especially upscaling, to obtain high power and possibilities for a variety of materials and methods are of great value.

In pure theoretical physics, also shape and appearance of loads are subjects in development, historically, as well as today.

Experimental results and modeling [1-4], were performed in order to enhance electricity from generators and PV-systems. One reliable result is that for battery usage, where the power got limited to instead last longer. Another is to magnify, which unloads a limited battery more fast.

Tests with sources other than batteries are not done. Since the current and voltage from a PV-panel is controlled by design into an upper limit, it is possible that the outcome will not be exponential magnification.

When the capacitor unloads, it might provide high power locally, and often (if fast with a high frequency), which would be a beneficial result, if the adjacent circuit e.g. battery, that should be loaded or a network, can use the higher values by time integration. A serial coupling of several devices may become stable. If not securing the panels so much, it may interact with the capacitor but then the material might be damaged, however often nature develops a regulator to maintain a process, as is seen for the PPB with LED and Li-ion-battery. If the main generating circuit mimics the behaviour stemming from that with amplification by a PPB-capacitor, it would result in higher power. Putting several in series might level out a non-uniform current-voltage- delivery.

In the present paper, certain types of capacitor conductors [1-4], will be described. A modeling with load paths, is proposed in terms of iteration maps and fractals. This is followed by a discussion on relations to EM-modeling and scaling.

## 2. PPB-Capacitors. Functions and modeling

Since electricity is found to develop and multiply on surfaces of capacitor, a fractal model will be exploited. Other fractals in dynamics and structures are found in [5,6]. In a capacitor, Figure 1, to some extent, loads are gathered. The encapsulated, at right, deliver more power, but then the entire circuit also requires more from the battery. This is not the case for the free sheet (aka foil capacitor), Figure 1, left, where instead it contributes into a significant increase of the life-time for the lightning from the Li-battery.

Figure 1. Two types of capacitors with different behaviour.

For the load at a location z, a power dependency in terms of a Julia Set fractal, Figure 2, is assumed such that

$z_{n+1} = az^p_n + c$ .........(1)

where $z=x+iy$, x and y being the Cartesian coordinate axis, i is the imaginary number $i^2=-1$, n is an integer for fix point iterations, and a, p and c are parameters.

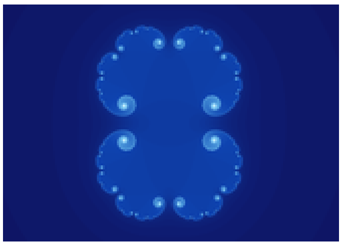


Figure 2. Julia set $z_{n+1} = az^p_n + c$, $p=2$, $c=0.285$. $z=r*\exp(iv)$, where $r=x^2+y^2$ and v is the angle in polar coordinates (r,v) and $z=x+iy$ in Cartesian coordinates (x,y).

Since a complex representation, the dependency to the power of p, does not necessarily give an exponentially increasing load. Instead, the format allows for a homology with fractals developing on the xy-plane.

The complex representation has the ability to distribute on a surface. The format provides control and limitations when adding an upper bound for the radial coordinate. Including a radius not equal to 1, it multiplies exponentially to the power of p, and in modeling this can be adjusted to fit with the amount of available energy. For example, in some capacitors, a larger temperature increases the current. The angle v, is modulo 2pi, when dependency through trigonometric functions sin(v) and cos(v). Adopting a memory format, also larger angles may contribute. Here, a Taylor expansion of the trigonometric function will be assumed, and the angle is kept within a smaller range $[0, 3^{1/2}/2]$, c.f. Figure 3.

With $p=3$, $\mathrm{Im}(c)=0$ and $x^2+y^2=1$, the imaginary part of (1) reads $\sin(v_{n+1})=a\sin(3v_n)$. With a trigonometric identity for the angle and a Taylor series expansion

$v_{n+1}=3av_n(1-(4/3)v_n^2)$ ........... (2)

For a=1 and 0.5, the functions in this logistic map are given in Figure 3. At bifurcations, the distribution z becomes two dimensional, i.e. occupies several angular positions. For increasing number of bifurcations and towards chaos, a correspondence to densification is tacitly assumed. From (the surface of) a foil capacitor, it is found that the loads leave such that the state when a steady light of the LED-diode is achieved.

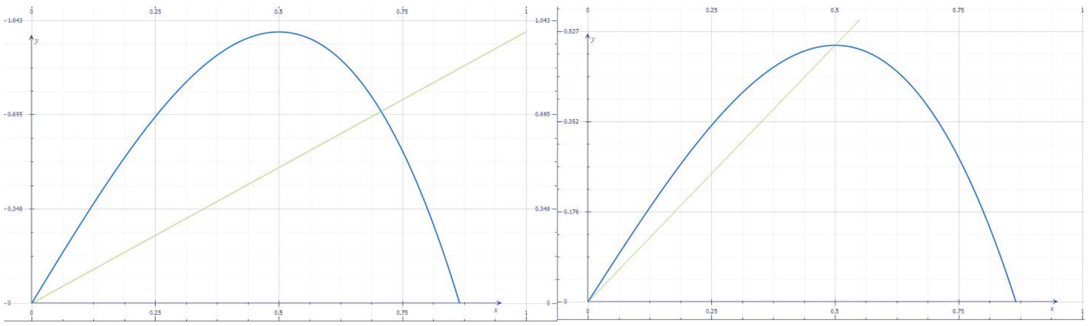


Figure 3. Left. $3x(1-4x^2/3)$ Right. $1.5x(1-4x^2/3)$ . Range of angle for the model is $3^{1/2}/2$ rad

## 2.1. Encapsulated foil

In the encapsulated foil, an increasing effective radius is assumed, such that bifurcations and chaos are achieved. This leads to a high concentration of electric loads, which rearranges into current and voltage that rules the circuit .

Diagrams for fix points and bifurcations genarally, schematic, are given in Figure 4.

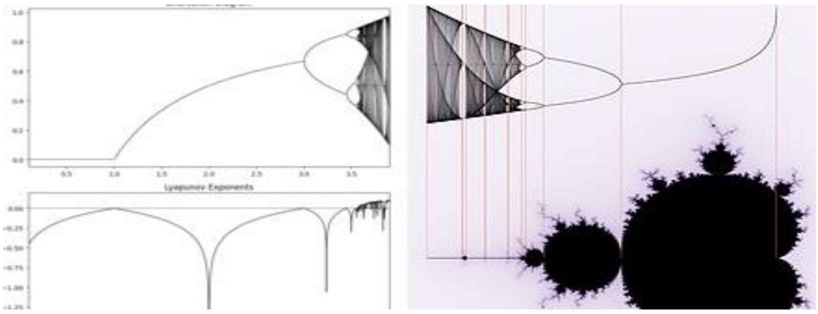


Figure 4. The logistic map with illustrations from from Wikipedia; Logistic map and Mandelbrot set

While the free foil works without input, the encapsulated (if not arranged as audio feed-back on Al [3,4], 'howling') needs a certain mechanical touch [7], to unload. Apparently, there is a threshold below which EM-energy do not leave the capacitor.

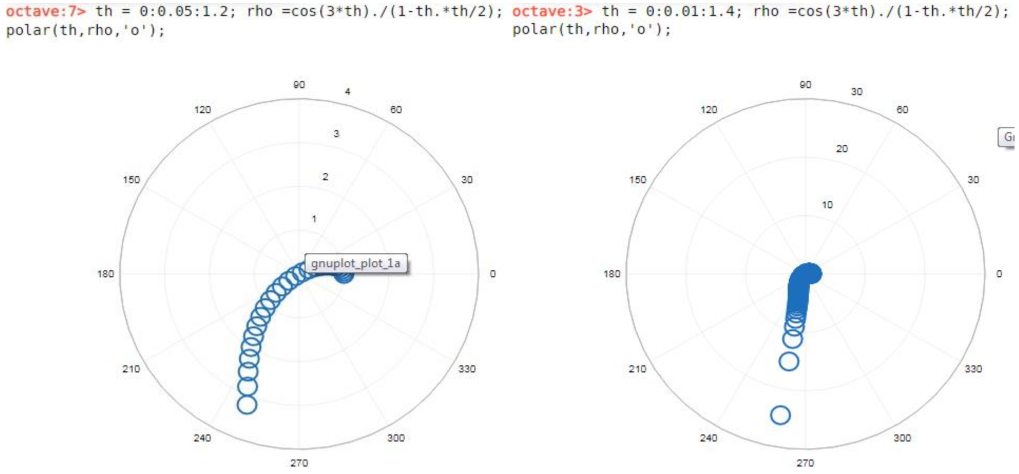
The more dense capacitor, the more power is needed in the mechanical push. Hence, this function is a matter for testing when upscaling.

## 2.2. Free foil

On the free foil, we assume that loads not distribute on a long stretched radius, since the energy ranges less. Instead several angles may be occupied giving r=r(v), and since the loadings are close in the folded matter, a density is achieved. This fulfil Maxwell's equation div D= r, from which a potential is created. That adds to the battery, and supplies the lamp. With a radius given by the first iteration in the Julia set $z_{n+1} = z^3_n$ , a small angle approximation , and the first radius =1

$r(v)=\cos(3v)/(1-v^2/2)$ ........(3)

This is given as a polar plot, Figure 5.



```
octave:7> th = 0:0.05:1.2; rho =cos(3*th)./(1-th.*th/2);
polar(th,rho,'o');
```

```
octave:3> th = 0:0.01:1.4; rho =cos(3*th)./(1-th.*th/2);
polar(th,rho,'o');
```

Figure 5. Polar plot of $r(v)=\cos(3v)/(1-v^2/2)$, when the angle ranges from 0 to 1.2 at left and 0 to 1.4 at right.

## 3. Fractal levels

Large whirls have smaller whirls that feed on their velocity. Also the opposite might be the case as is seen for e.g. a nco with f=1. The sidereal rotation phenomena may give an (initia)l velocity (outwards), and the part may contribute to the main upper level motion by stretching on one side and relaxing at the other (located at the angle pi from the other).

### *3.1. Fractal expressions for pi*

The real story about pi, is found in [8]. However, assuming a finite width of the circle line, and/or a deviation into an ellipsoid, would give real bounds of the value, as well as adding spatial physics in terms of size dependency.

One expression with the nomenclature of a noncircular orbit, is given by 3+sin(3) and more fractal, but less accurate 3+sin(3*3)/3

Another, more spectacular, and notified as the 'coolest', reads ln(6)^(ln(5)^(ln(4)^(ln(3)^ln(2))))

### *3.2. Finite fractal levels*

Fractals have limited amount of levels. This, since space is limited, and when many levels, the densification provides energy into other processes e.g. dynamics with diffusion [9] or fast escape from that place. Spatially, a rotation for an elongated body gives a curl energy as in a torsional spring.

Also in acoustics and other oscillations, the fractals are limited since, in general, the initial energy cannot excite so many higher levels. Exceptions are resonance, as in e.g. audio feed-back, howling [3,4].

### *3.3 Fractal fractal expressions*

$z_{n+1} = \exp(z_n) + bz^4_n$ ..........(4)

In Figure 6, a polar plot for the function $\mathrm{Re}(z_{n+1})$ is shown for the parameters b=1, -1, i

*Remark.* From the rotating frame of the radius vector of $z_{n+1}$ , the $\mathrm{Re}(z_{n+1})$ is a radius vector with this behaviour, relatively.

In agreement with the example of polarplots in Wolfram [10], also a low frequency term with high power was added. The reason for considering such a term may be to include a lower time scale, but the power of 7 increases the frequency, as well as keeps the negative sign in the dependencies.

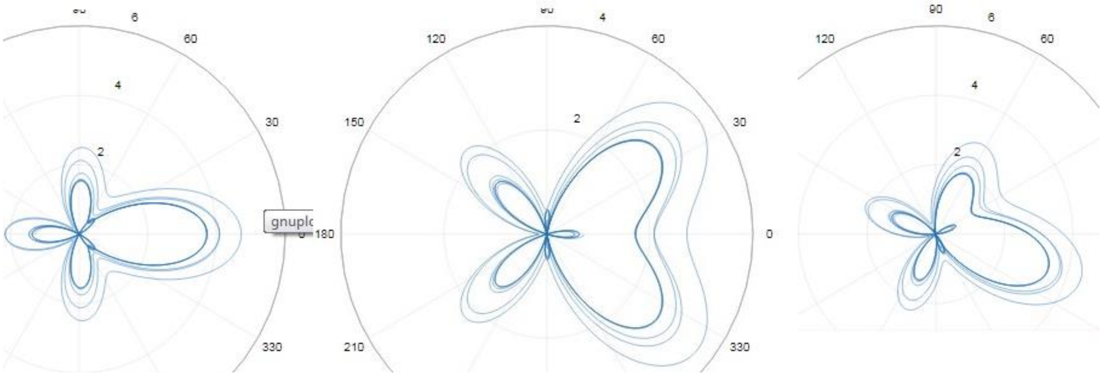
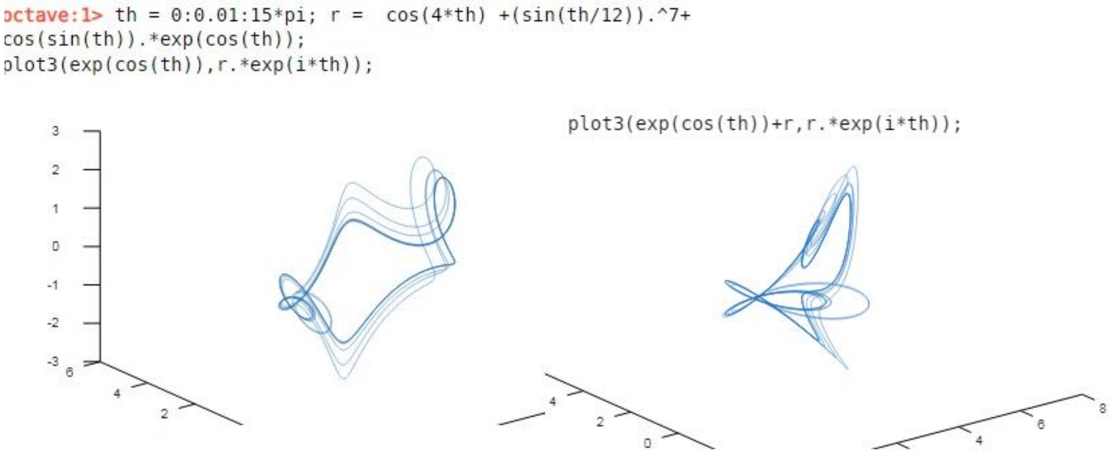


Figure 6. A visualistation of the Real part in (4) in a polarplot.
v = 0:0.01:15*pi;re =(b*cos(4*v) +exp(cos(v)).*cos(sin(v))+(sin(v/12)).^7);polar(v,re);
with b= 1 and -1, from left, and for the rightmost, the first term is -sin(4*v)and b=0.

In a 3-dimensional fractal electric surrounding, we assume that the real part of (4) becomes an in-plane radius. The z-coordinate out-of-plane is constituted as exp(cos(v)). This is a sub-part of the angular velocity in a noncircular orbit, nco, in the format of Strömberg (2015). The path is seen in Figure 7, left. As a comparison, a visualisation when the real part of (4) is added to the z-coordinate is given at right.



```
octave:1> th = 0:0.01:15*pi; r =  cos(4*th) +(sin(th/12)).^7+
cos(sin(th)).*exp(cos(th));
plot3(exp(cos(th)),r.*exp(i*th));
```

```
plot3(exp(cos(th))+r,r.*exp(i*th));
```

Figure 7. Assumed paths in a structured surface consisting of air, Al and electricity.

## 4. Conclusion and discussion

- The Julia Set map, with no cumulative sum, modeling load paths on and at capacitors in a pot plant battery (PPB) were considered.
- The goal is to amplify and manage electric power and hitherto tests and results with Li-batteries as the source, are available.

*Potentials in electricity generation*. In principle, the behaviour is in accordance with Maxwell's equation div D=r, where D is the electric field and r is the load density. A spatial integration of div D gives the electric field field at two points. Comparing with the foil capacitor, the loads probably arranges to give an additional voltage, enough to light the LED, e.g. the magnitude of that in the pot, i.e. galvanic stress around 0.6V. For the encapsulated capacitor, apparently a potential develops, which requires a current from the entire circuit including the battery. If this behaviour could be used adjacent to Solar Power generators or in Wind Power, it would magnify a lot. It requires some *interaction* or to be included in the design of Solar Panels. Could be that the panel construction were fast enough to interact with the demand of more power supply, or co-working with additional features e.g. loading several batteries. In wind power, inertia may be sufficient, such that it maintains the rotation, or accelerate somewhat. If parts of the current in the capacitor goes the other way at first, it may not be beneficial.

*Future work*.

For the modeling approach, the issue is to relate the presumed paths to load density which, in turn, generates current, voltage and output. Optional EM-modeling are that within fields of EM-conductivity [11], Quantum qubits [12], Josephson Junctions [13], and generalised piezoelectricity [7], etc [14], however only parts are in accordance with the present devices. A dependency on size and lengths between the electrodes in the PPB would be beneficial, and may be obtained by integrating Maxwell's equation div D =r, since this is spatial.

To obtain power and upscaling, the issue is to
*make larger and more solid units, and in serial coupling , (for stability )
*decide where to have output , preferably at the secondary circuit not close to the battery, which needs to be replaced with renewable PV, or other source.

A third issue is to compare this hypothetical electrolyte-approach to obtain more power with components and space, with ground potential [15], and attachment to a single point in a (shell-shaped) well.

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