20b) The reason why the Trolls burst

Before reading this article I strongly recommend the dear reader to repeat Article 18.

To see why the trolls burst, let's add an extra layer to each of the figures 1 - 3, "Crack1 - 3", in order to draw the set obtained were "z" is initialized to the other critical point. As (by default) the set drawn in the images in the previous article is M+, we in the other layer let UF display M-. For the yesterday's images Crack1-3, we obtain today's Crack1-3Both. What extra information does that give us? We see that M- fills almost the whole screen except for a small valley looking like the valley near the root-point between a bud and a bigger hyperbolic component of the ordinary M set (you can see it more clearly if you for a moment disable the layer M+). In fact the actual valleys in our cases all are Seahorse Valleys with the body-component to the left and head-component to the right. If you take one of my images and do successive out-zooms you will see more clearly what I'm talking about.

Question: Must there really be a crack in M+ because a Mandelbrot valley (in this case the Seahorse Valley) of M- crosses it?

Answer: The Seahorse Valley belonging to M- have the same shape as the Seahorse Valley belonging to the prototype Mandelbrot set, despite from that islands (built up according to the principle of "Julia-like barriers") are present. These islands are uttermost built up of copies of the ordinary M set. According to Article18 the border of M+ or M- only has the structure of the M set towards E-Locus (the part of the cubic parameter space were both critical orbits escape). Consequently the Seahorse Valley belonging to M- can not be situated inside M+, but must be situated a little bit outside M+ in order to preserve this statement. This is the "half-mathematical" explanation giving by me, based on my own computer-experiments.

If we have a look at the knobs at both side of the crack, they first look similar. However a closer look will reveal some difference. If we look at the knobs to the right we see they are joined to the "continent" by 2-armed spirals. And this is what we might expect as we are now in the "head" of M-. The head of the M set represents period 2. To the left, on the other hand, the knobs are not joined to the continent by extreme-points but of small passages where two 1-armed spirals meet, one at each side. To see this, you have to do a little zoom (if doing so, first delete M- as you will be entirely inside this set and drawing it will only slow down the speed of calculation). In the crack the border - region of M+ also have disconnected Julia shaped pieces. See especially "Crack2both".

Perturbed M sets: Not only in slices of cubic and even higher parameter spaces, but also in perturbed M sets crack may occur. The figure 3, "Perturbed", is a 2-layers image produced by the standard Mandelbrot module in UF. In one layer the ordinary M set is displayed. That is the c-plane is drawn for the dynamical process $z \rightarrow z^2 + c$ with the critical initiation $z = 0 + 0i$ ($z_{real} = 0$ and $z_{imag} = 0$). In the other layer z is initiated to the non-critical $0 + 0.85i$. ($z_{real} = 0$ and $z_{imag} = 0.85$). Note that all perturbed M sets are situated inside the ordinary M set (if we for a moment forget that the M set and

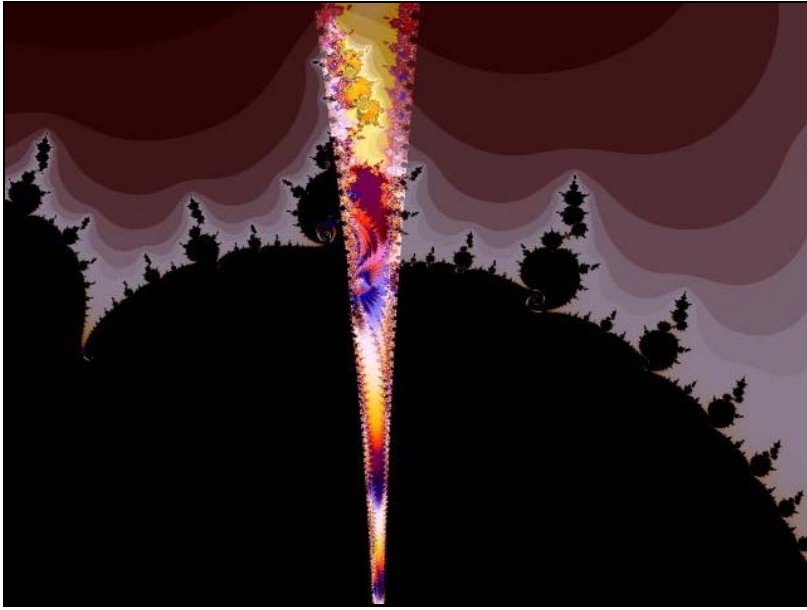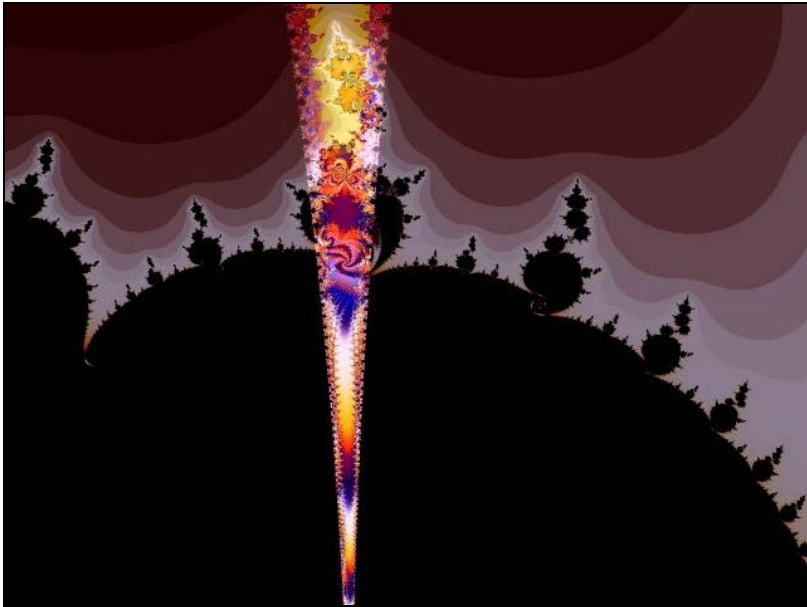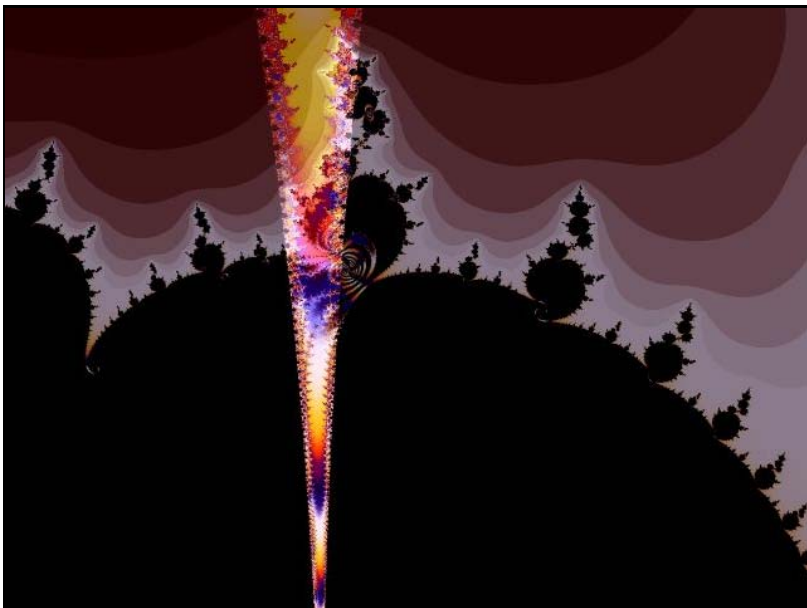**Fig 1. Crack 1 Both.**

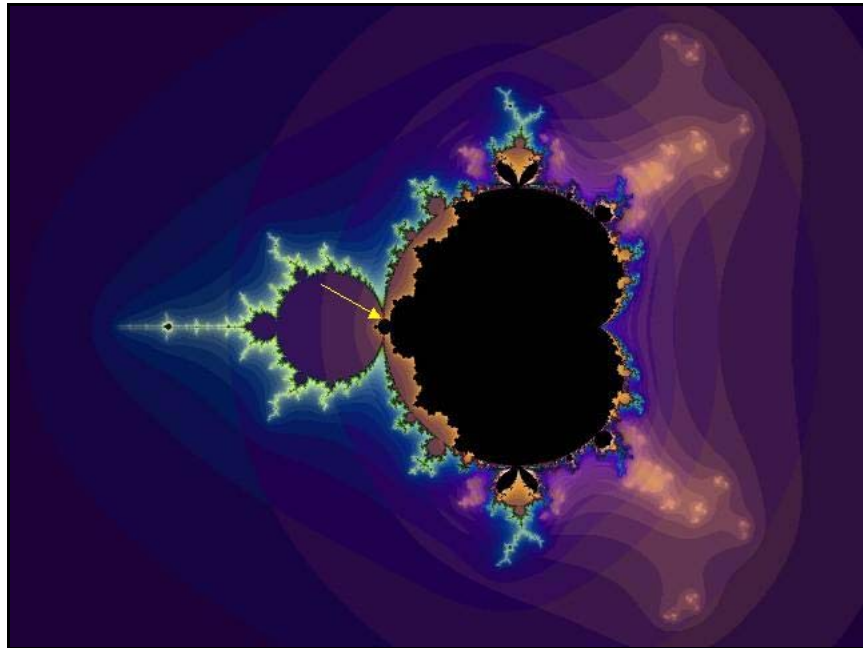**Fig 2. Crack 2 Both.**

Fig 3. Crack 3 Both.
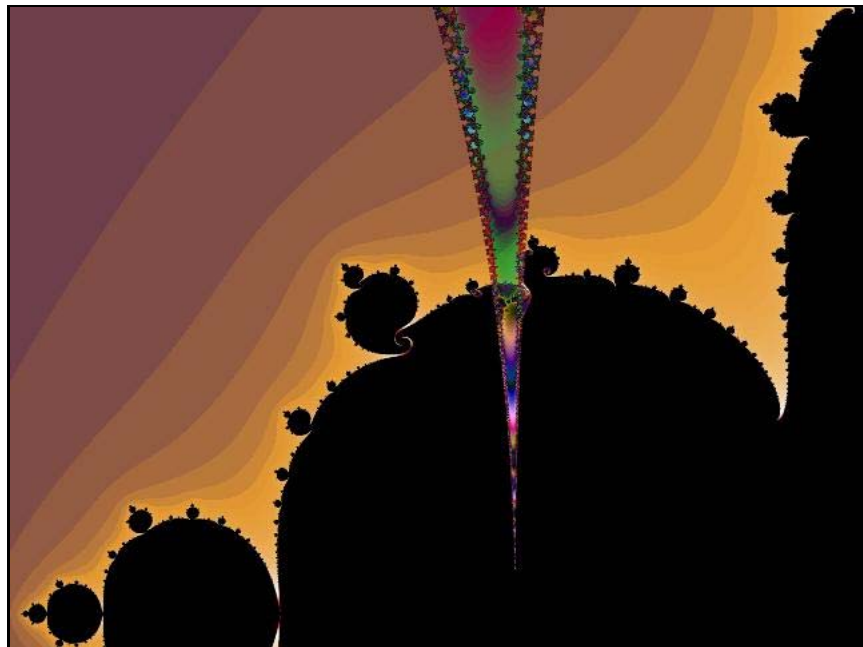
Fig 4. Perturbed.

Fig 5. Perturbed-zoom.

the perturbed one are two different parallel slices of the four dimensional Juliabrot, see Article15).

For that reason the Seahorse Valley of the ordinary M set splits a small knob of the perturbed set. The yellow arrow points out were the figure 4, "Perturbed-zoom", is zoomed in. The border of perturbed M sets has much of properties of cubic connectedness locus. An important difference: There are no bridges on the knobs to yet more Julia-like structures with copies of the M set in the middle (see Article 18).

Back to Cubics: Two other crack-images from cubic parameter space are showed along with this article: 1) Figure 5, "Heavenly Laser Cuts the Fruits of Eden". This image was one of my contributions to the FAME contest the year 2002. 2) Figure 6, "Light-ribbon". The bud to the right is a
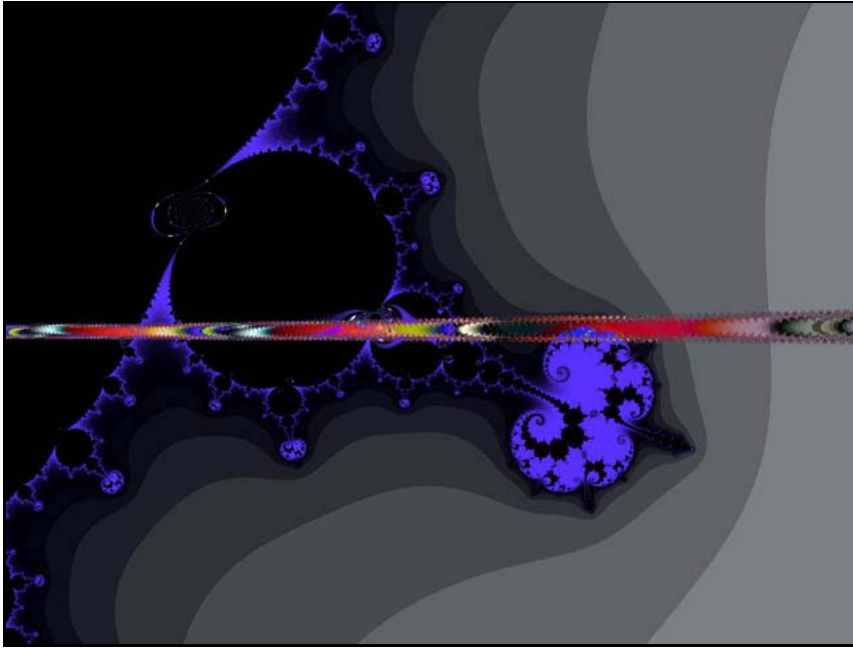
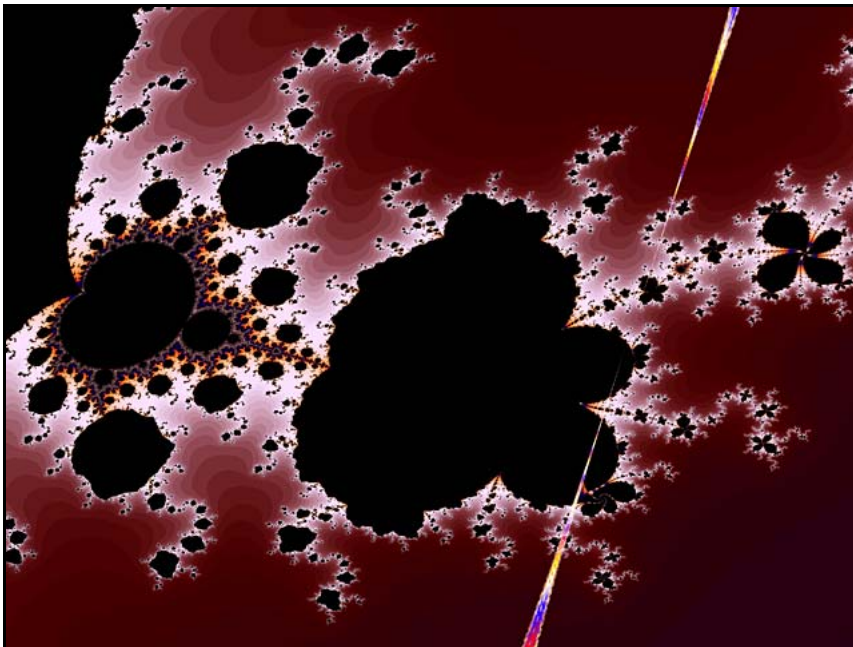**Fig 6. Heavenly Laser Cuts the Fruits of Eden.**

Fig 7. Light-ribbbon.

very deformed one that seems to have two bifurcation-points to the body. The second one is situated outside the image in upper direction (the dear readers are encouraged to see this by running the parameter file zoom out a little bit and scroll down the image). This type of deformed structures are common in the systems of slices others than (a_{real}, a_{imag}) and (b_{real}, b_{imag}), and also when you've rotated between the perpendiculars planes.

A quite different type of ravine: There is another type of ravines that should not be associated with the above described phenomena. In this type of crack only one of the subsets burst. Moreover there seems to be a Mandelbrot–border against the other set (between C-locus and B-locus). The attached example "QuasiCrack" illustrate this.

A closer look however will show that there are connected Julia-shaped components attached to these Mandelbrot-patterns. Moreover the iteration-
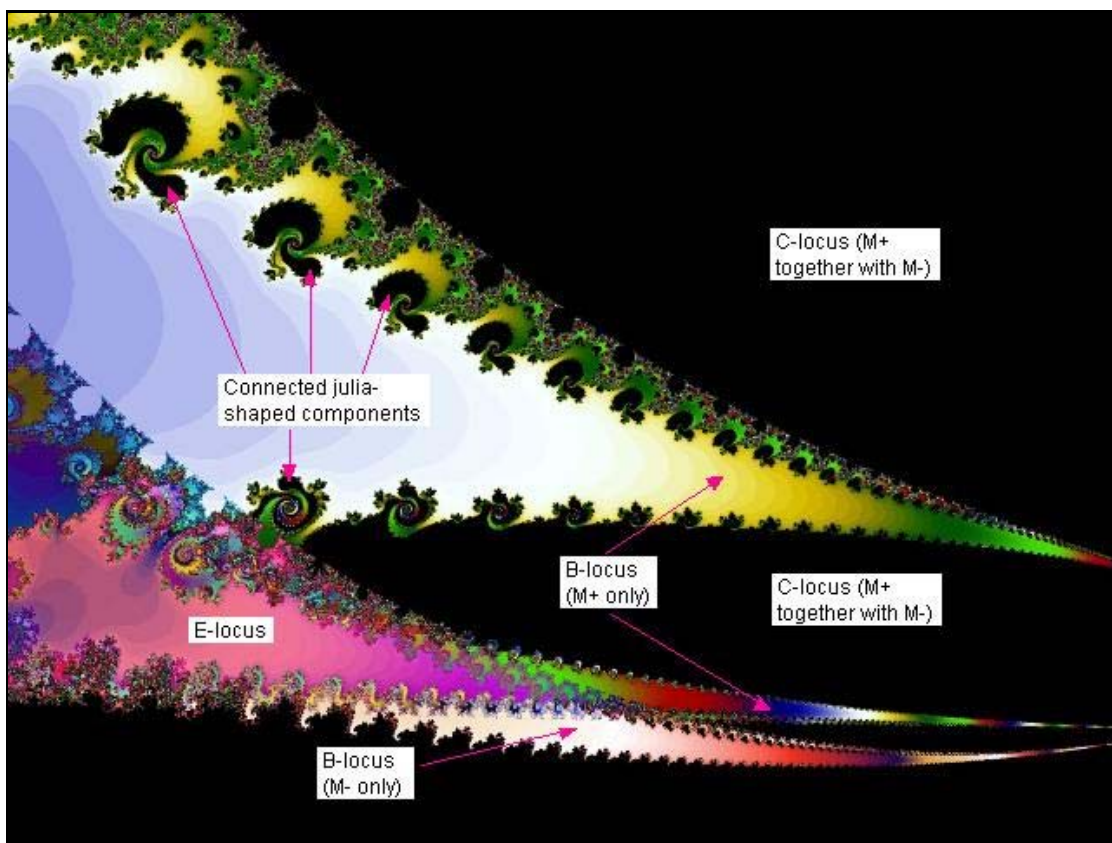
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Fig 8. Quasi Cracks.

number at their ends does not increase so drastically as in the case of the "real cracks". In other words, the thesis in Article18 will still fit.

Don't forget my "Cubic Tutorial" and "Pictures from Cubic Parameterspace" reachable from my index page.

Regards
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