19b) Short manual to the module Cubic Parameterspace3

This, and the previous article is a short manual for the new module *Cubic Parameterspace3* written by *Stig Pettersson.* This sub-module has the same purpose as the erlier excellent *Cubic Parameterspace* and *Cubic Parametrspace2* the first mentioned released in spring 1999, that is to make it possible to draw all six perpendiculars systems of slices of cubic parameter space with respect to one or both critical points. In summer 2001, *Quartic Parameterspace* was released. In this the code and user-interface was refined. Grounded on this refined sub-module, the new *Cubic Parameterspace2* was written. Due to the new features of Ultra Fractal 4, *Cubic Parametrspace3* realeased 2006 at the same time as *Quartic Parameterspace3* and *Pentic Parameterspace3*. NOTE: the number "3" after the newest quartic (the second version) and pentics (the very first version) modules is for denoting they have the same features as cubic parameterspace3. The rotation routines are not described.

   1) Select "new" and then "sp3" and thereunder "Cubic Parameterspace3". Change the "Color Density" to 2 and increase the max iteration to 1000 (or at least 500). You will now come up with figure 1 "Default" (Note: I've used the default gradient of UF2. With the default gradient of UF4 you will come up with darker colors, but that doesn't matter).

   2) Change "PlottedPlane" to "6) b-real, b-imag" (meaning b_{real}, b_{imag}), and you will come up with figure 2 "CubicMandel".

   3) Type 0.57735 in the box a-real and you will come up with figure 3 "M+". In Cubic Parameterspace3, like in the erlier versions of the cubic modules, you can type values in the boxes a-real, a-imag, b-real, and b-imag. Since two of these axis' are plotted (selected under "Plotted Planes"), typing
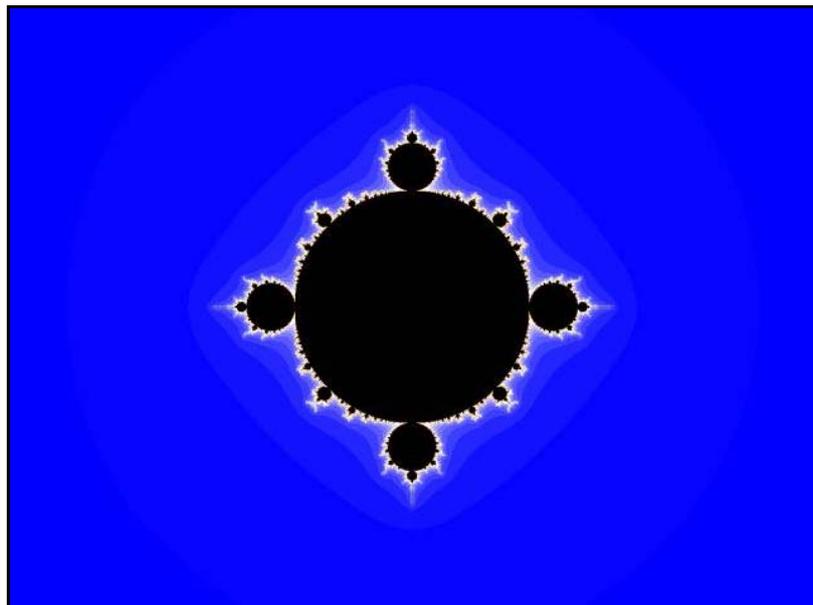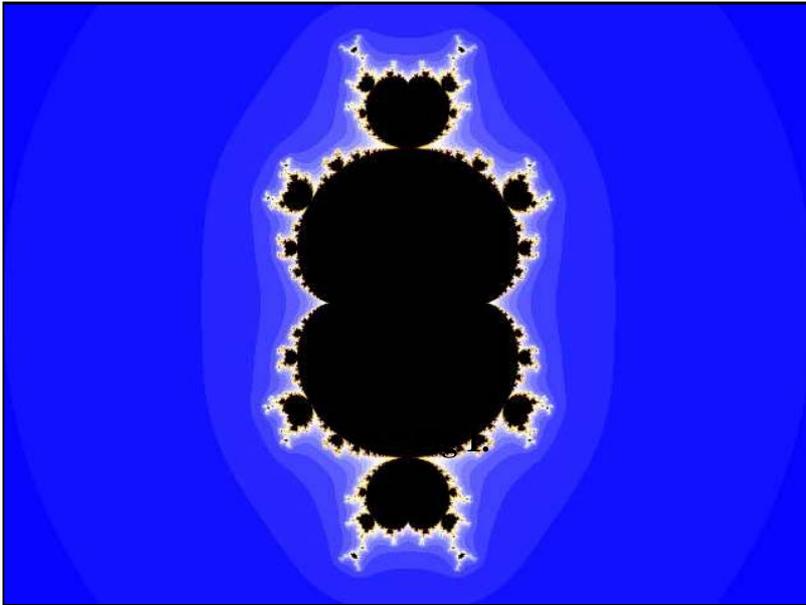

Fig 1.

Fig 2.

numbers in these axis' that are plotted would make no sense, and here comes a new feature in Cubic Parameterspace3, using a new feature in UF4, *so the two axis' that are plotted are dimmed.* Typing values in the other two boxes, in this case a-real and a-imag means you are moving along these axis', both of them perpendiculars to the plotted axes!!! Let's say that the first one is coming out of the screen and giving you a punch on the nose and the other is pointing into the fourth spatial dimension.

4) Under "M", select M-, and UF will draw figure 4 M-, that's the set for which the variable "z" is initialized the other critical point, -a.

5) Under "M", select "CCL" (cubic connectedness locus). UF will now draw the set that is common to M+ and M-, figure 5. In order to do that, UF calculates both critical orbits. If both these orbits are bounded the tested pixel represents a coordinate which belongs to CCL. If not, the pixel is colored according to the critical orbit that requires the lowest iteration-number to escape. CCL is the set that corresponds to the Mandelbrot set for quadratic polynomials.

6) Under "M", select "M+ and/or M-" and UF will draw the union set of M+ and M- as shown in figure 6 "Both". If the tested pixel represents a coordinate that belongs to at least one of the two subsets, the pixel is colored black. Otherwise the pixel is colored according to the critical orbit that requires the highest number of iterations to escape.

7) Now under "M", select M+, and thereafter click the little box "SetBorders" This exactly corresponds to mode "High" in the previous Cubic Parameterspace2. UF will now draw M+, but the contour of the part of M- outside M+ is now visible (figure 7). If the tested pixel represents a coordinate that belongs to solely M-, UF will color the pixel according to the iteration-number of the escaping critical point (+a). If both critical orbit escape, that is the tested point belongs to neither M+ nor M- (i e E-locus), the pixel is colored after the number of iteration of the critical point that escapes last (has the highest iteration-number).

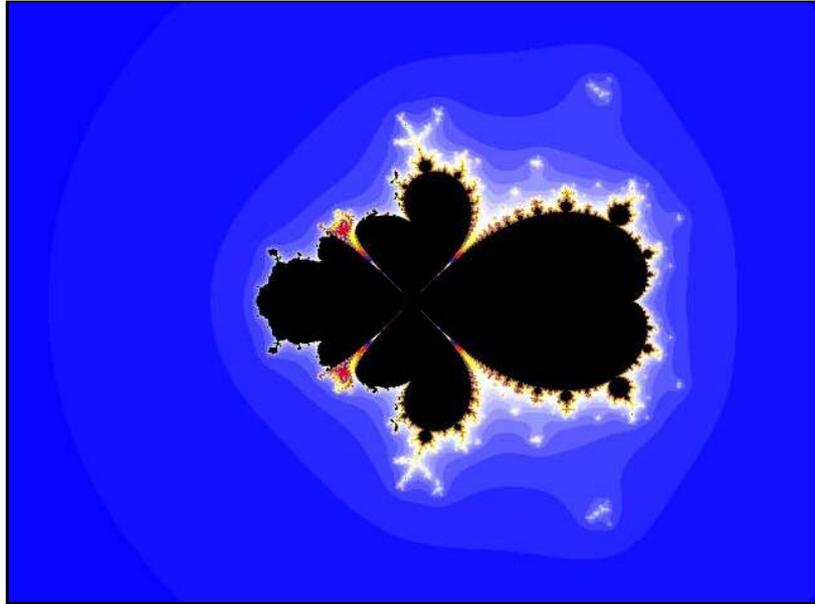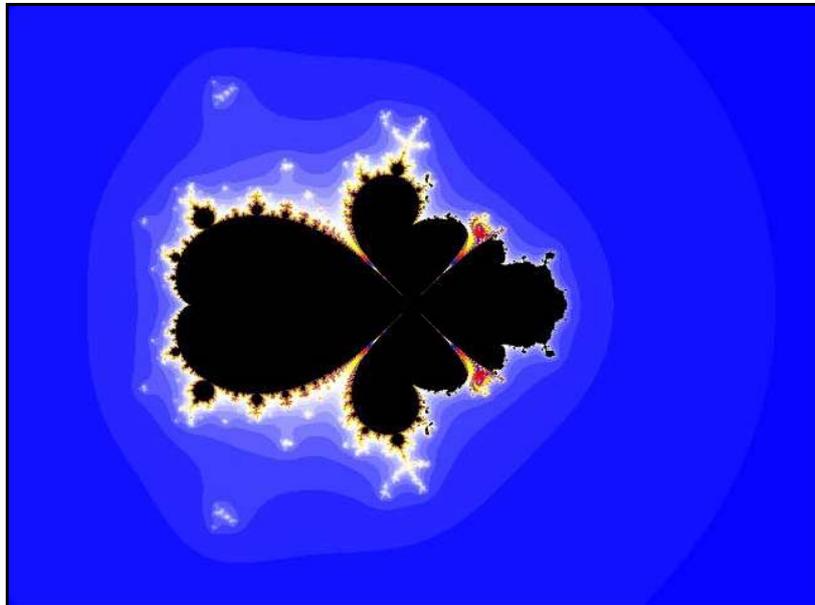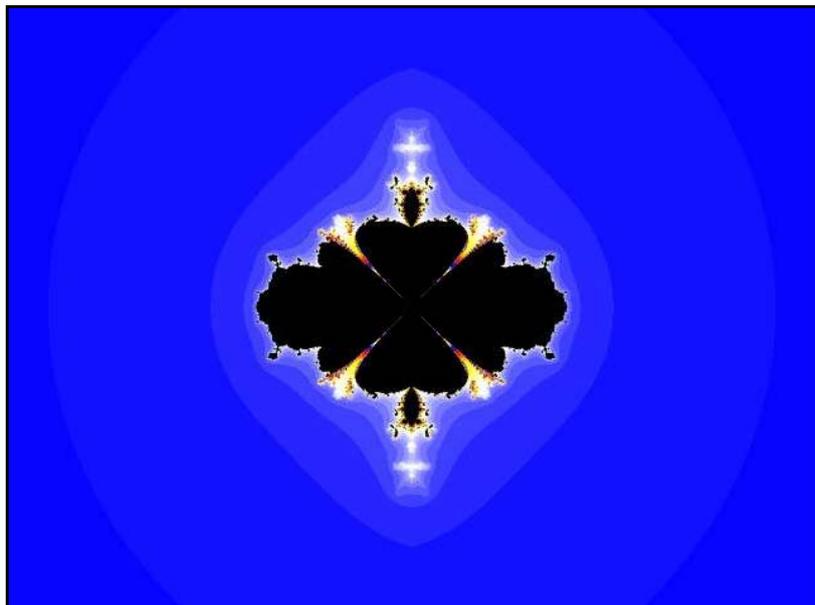8) Now under "M", select M- and behold "SetBorders" selected. UF will

Fig 3.

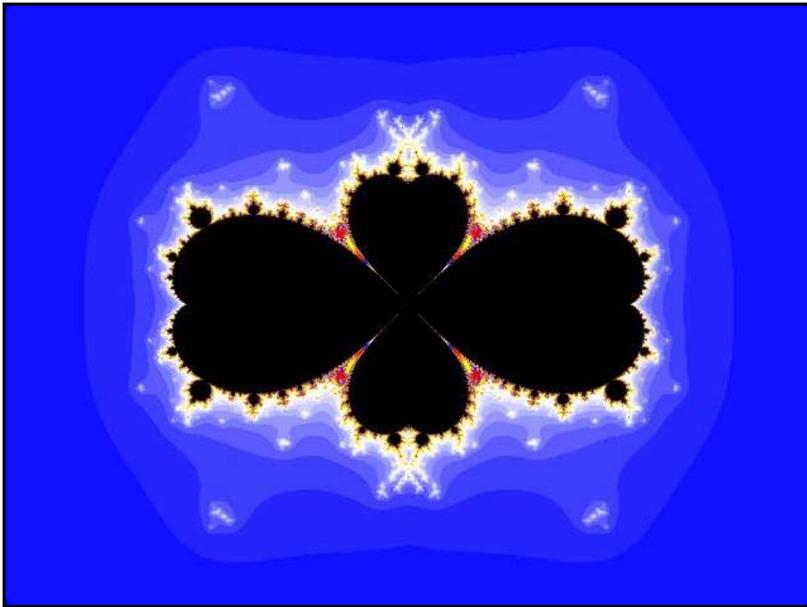**Fig 4.**

Fig 5.

Fig 6.

now draw M-, but the contour of the part of M+ outside M- is now visible (figure 8). If the tested pixelrepresents a coordinate that belongs to solely M+,UF will color the pixel according to the iteration number of the escaping critical point (-a). If both critical orbit escape, that is the tested point belongs to neither M+ nor M- (i e E-locus), the pixel is colored after the number of iteration of the critical point that escapes last (has the highest iteration-number).

9) Under "M", select CCL and behold "SetBorders" (figure 9). If only one of the two critical points has a bounded orbit, UF will color the pixel corresponding to that coordinate after the number of iterations requiring for the other critical point to escape. If, on the other hand, both critical points escape, the pixel representing that coordinate is colored after the number of iteration of the critical point that escapes last (has the highest teration-number).

Regarding the use of "SetBorders", point 9 in my opinion is the most interesting because you will see both the border of C-locus and the border of B-locus towards E-locus. This can also be done in the old way by drawing M+ and M- (not using SetBorders) in separate layers as described in the previous article (figure 10). But then every change in the Formula and Location tab, after M+ and M-have been established, must be done equally. However by using different gradients, you can see what parts of B-locus belongs to M+ or M-. The last image "DualCritical" is an example of that.

Regarding mode "High" in the previous Cubic parameterspace2: This mode does not mean "high quality", but made it possible to see the borders of the different sets which are within the range of your computer-window without using one layer for each set. For this reason we now use the term "SetBorders" instead. If there is only the border of one set, or the borders of many sets coalesce, it's makes no difference to have SetBorders activated, despite from that the calculation time will be much longer. The time of calculation is also longer for figure 9 than figure 10 using my traditional method (one layer for each set).

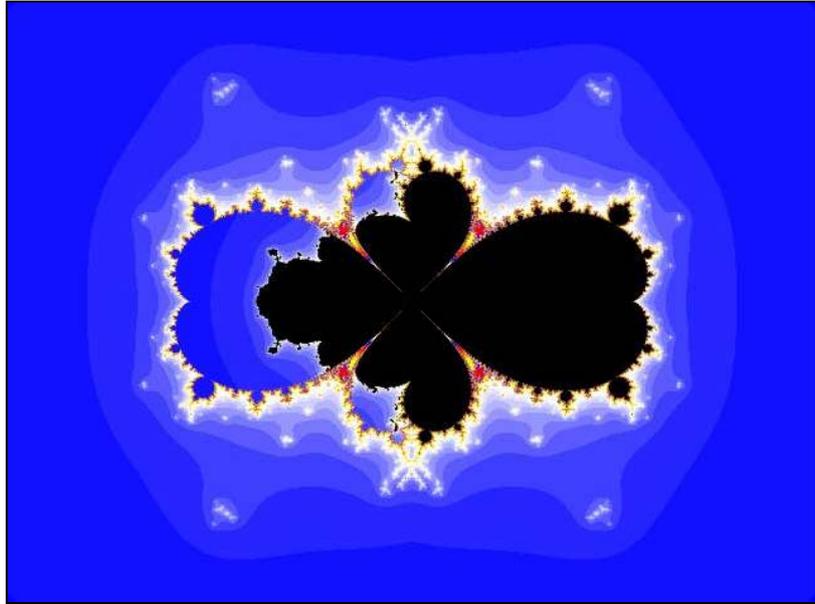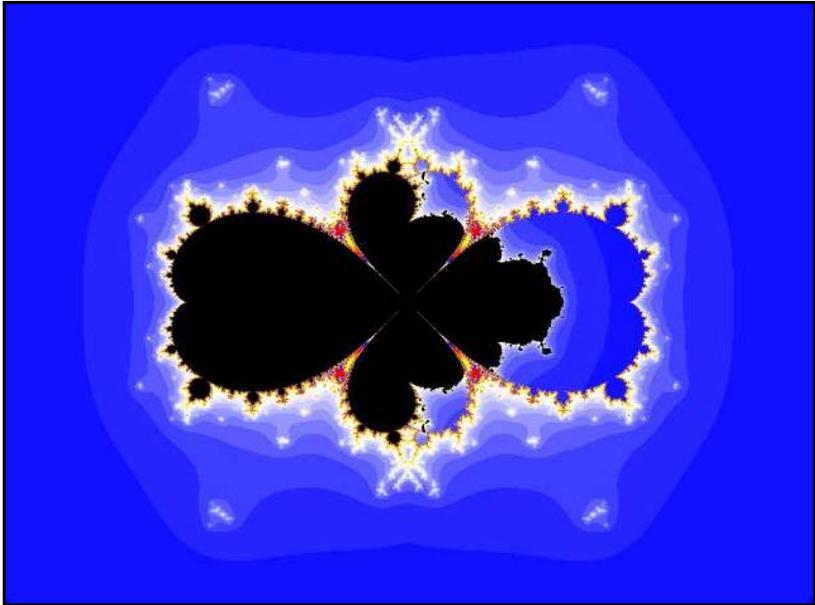**Switch Mode:** The bug in the first Cubic Parameterspace is fixed. This
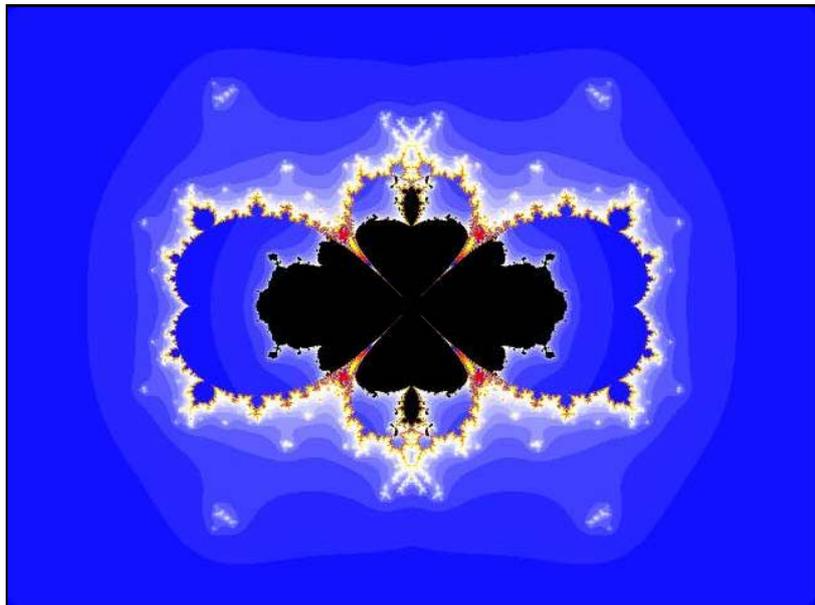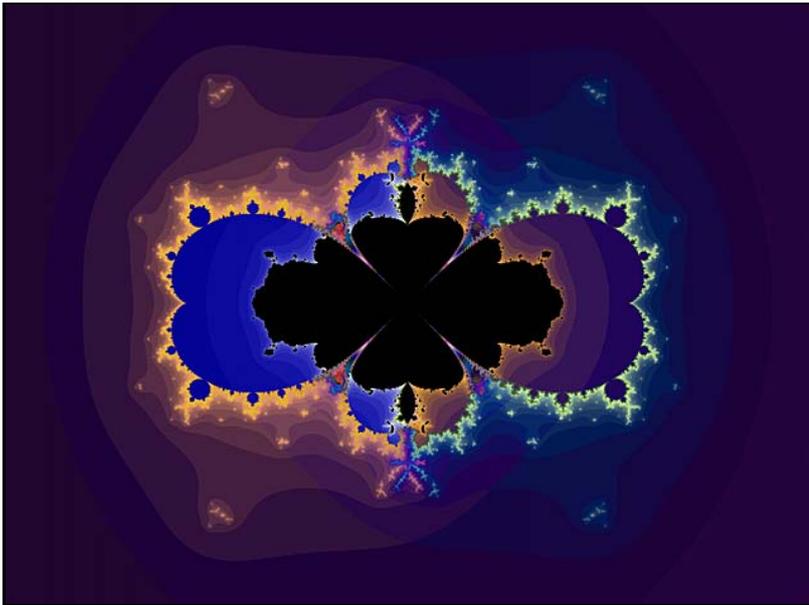
Fig 7.

Fig 8.

Fig 9.

Fig 10.

means you will come up with correct Julia sets from Switch Mode even if you have rotated between the perpendicular planes.

This article, as well as the previous one, have been devoted how to handle Cubics with Ultra Fractal. The following articles will not be so UF-specific.

To see more images from Cubic Parameterspace click "Pictures from Cubic Parameterspace" and don't forget my Cubic Tutorial where all obscure terms in this article are explained, click: "Cubic Tutorial" from my index-page.

Regards
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