

# Why does the Mandelbrot set work?

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*Source:* <http://sci.tech-archive.net/Archive/sci.math/2007-04/msg02915.html>

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This question has puzzled me forever.

The Mandelbrot set has always fascinated me for one thing:

An incredibly simple iterative formula like " $z = z^2 + c$ " produces an astonishingly wide variety of organic shapes.

I have collected some of my findings in this page:

<http://warp.povusers.org/snaps/fract/>

It's just incredible that all those images have been created by simply iterating that simple formula and then coloring the pixels according to how many iterations it takes to bailout. Using a clever color palette produces these stunning images.

If someone (who is not a math guru and has never heard of the Mandelbrot set) was given the problem of iterating a formula like " $z = z + c$ ", where  $c$  is a complex number in the complex plane and then coloring the equivalent pixel according to the number of iterations it takes for  $z$  to go outside a circle of a given radius, and then this person is asked what would the result be like, he would probably think a moment and guess, correctly, that the result would be a series of colored concentric circles. As the formula is iterated  $z$  simply grows in the direction of  $c$  until it goes outside the circle and that's it.

Now, tell this person "how about  $z = z^2 + c$  instead?". His first guess will still most probably be "concentric circles, the radii probably not being arranged linearly but in a quadratic way" or something similar.

Even if you point out that " $z^2$ " doesn't actually just go in the same direction as the previous iteration due to how complex number multiplication works, he would still most probably just think that the result is some simple pattern. If he thinks about that for a bit he might perhaps guess that it maybe forms a spiral or something like that.

When this person is then shown what it actually produces, the result is most astonishing and unexpected. For a complete layman like me, who doesn't understand anything about complex number dynamics, the result is most astonishing and unexpected.

## Why does the Mandelbrot set work?

I just can't understand \*why\* that formula produces those results.  
I just can't even begin to comprehend how it is even possible.

If I had no experience whatsoever about the Mandelbrot set and I was given any of the images on that webpage of mine I mentioned above and was asked to guess the mathematical formula it was produced with, and after having no idea the correct answer of "iterating  $z = z^2 + c$  and coloring the result according to the number of iterations until bailout" (more detailedly explained,