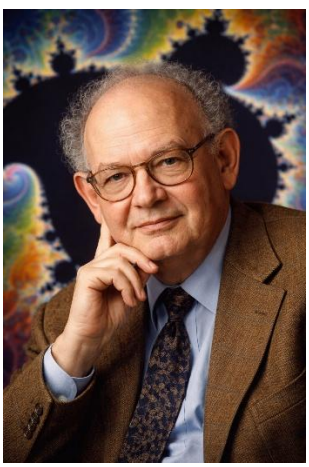
Fractals; Order or Chaos? – June 2020

Fractals - patterns or geometric shapes recurring in nature, at progressively smaller,

or larger scales. A network of veins in leaves, the symmetry of a snowflake

a river system seen from the air;

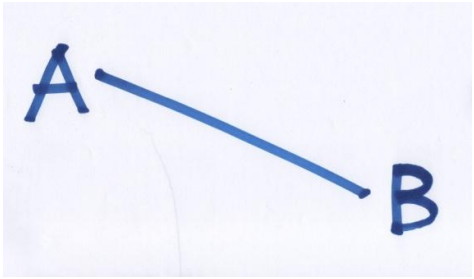
Fractals really are everywhere.



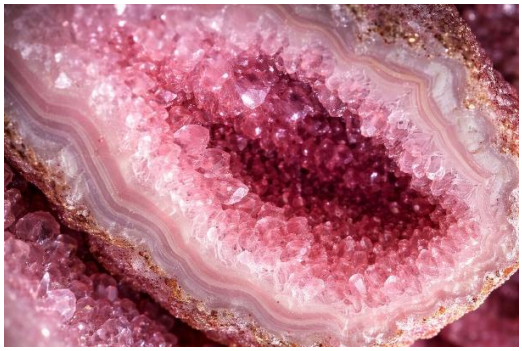
Benoit Mandelbrot first described them in 1975, noticing that mathematical rules apply to natural systems

like clouds, coastlines, even galaxies.

Initially, these systems seem 'chaotic', but on closer inspection their order becomes evident. Fascinating. But there's more.



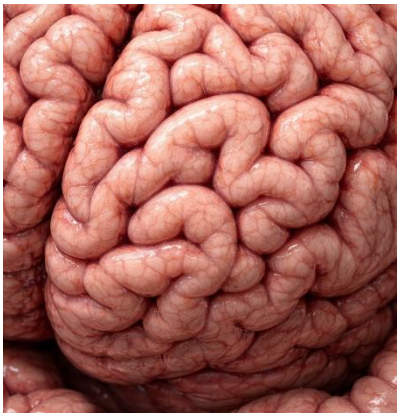
If I ask you to draw a straight line, you will likely start at A, and end at B, like this. But a line is an *infinite* set of dots laid next to each other, so your segment will be just a piece, a geometrical *expression* of the line. The same in 3D.



A crystal's structure expands infinitely outwards, but crystals have finite size, and many defects. Perfection is imaginary, not real.

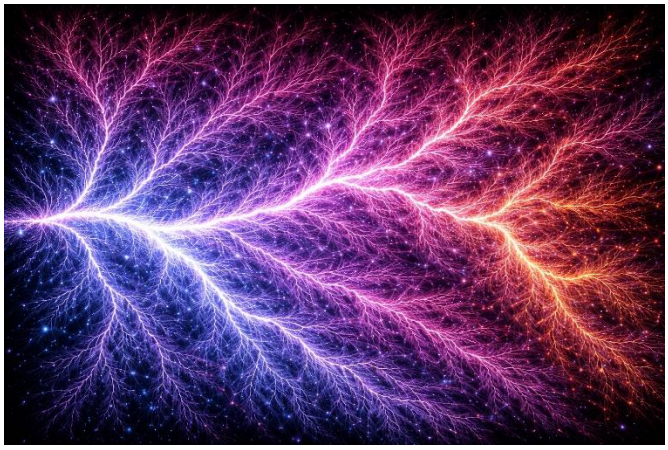
We describe slices of the universe to understand it, isolating this,

from this.



Which begs a philosophical question. Are physical systems really fractal, or are these patterns a *function* of our perception?

Meet Richard Taylor, a physicist obsessed

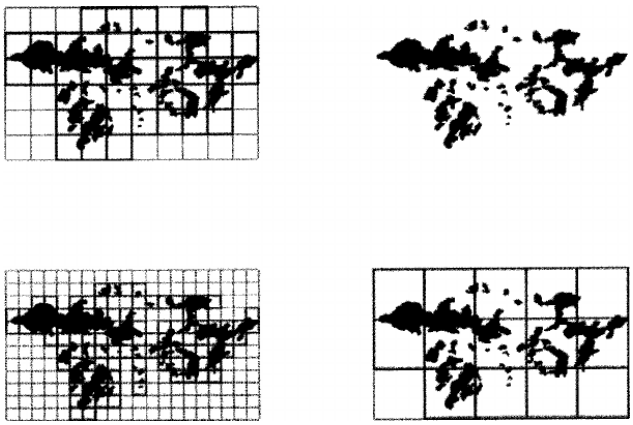


with the fractal nature of electricity

and the paintings of Jackson Pollock.

In 1950, Pollock dripped paint on canvas laid over his studio floor.

Taylor built a pendulum that splattered paint when the wind blew, to see whether 'when nature painted', it looked like a Pollock. It did.

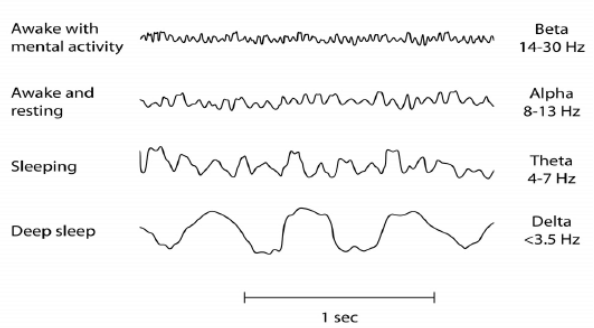


Using a box-counting method, he analysed Pollock's paintings, and found that Pollock had indeed painted fractals, 25 years before they were discovered!

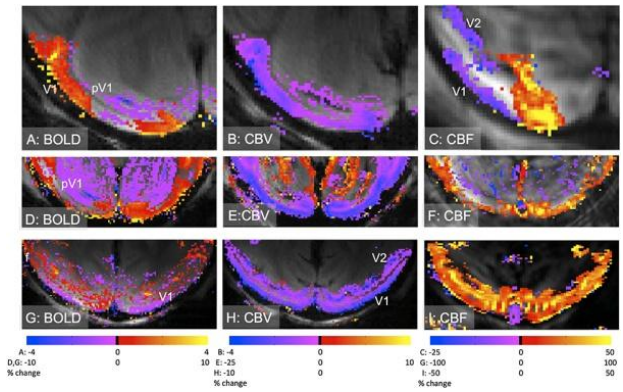
Fractal dimension is measured as a number between 1 and 2; the more complex the image, the higher it's 'D'. This has a D near 1,

this of almost 2. Taylor measured people’s nervous system activity in response to images with different Ds, and found people preferred Ds between 1.3 and 1.5,

like this, and this, and this.



He measured people's brain waves with an electroencephalogram, and found that mid-range Ds produced states of wakeful relaxedness



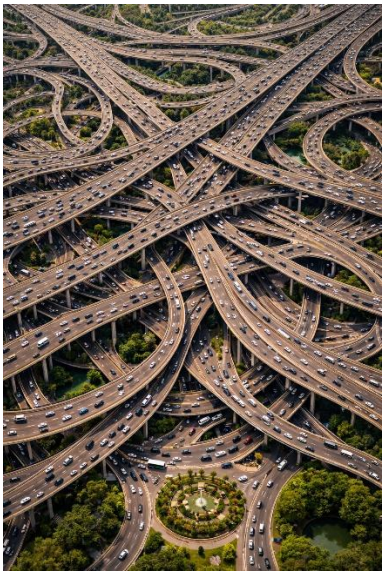
Using magnetic resonance imaging he showed that the parts of the brain most stimulated by the images, were those involved in visual and spatial processing, but also the parahippocampus, which regulates emotion, and is lit up by music.

Looking at an ocean it seems, may affect us emotionally as listening to Brahms does.

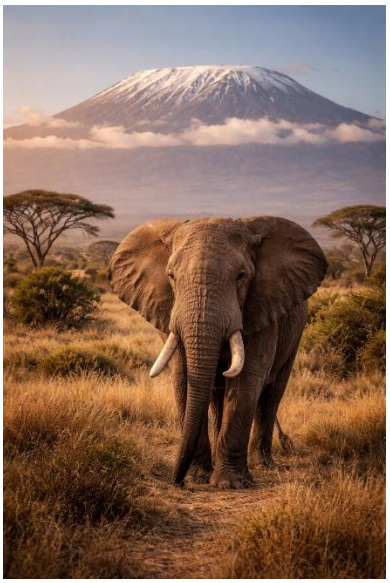
Taylor showed we have intrinsic kinship with nature, that our brains are most relaxed there. Comparing the MRIs of people viewing Pollock's paintings and images of forests, he found them identical. Both activities make people *measurably* happier. But why?

Finally, Taylor used a machine to track how people looked, at both the paintings and the images of nature. He found that the search pattern of the eye *is itself fractal*. We scan the larger elements of the field, then make increasingly smaller passes.

This is how an eagle scans the ground, looking for patterns, a strategy honed over millions of years.



If a scene is over-complicated, we are subconsciously uncomfortable.



We're most at home where we evolved; in nature. And reality really is about how we perceive our world, not how it actually is.

Taylor thinks we don't see enough fractals nowadays. We live in straight-lined urban environments, and are risking our visual fluency with nature.

Yet another reason to bring greenery into cities, and to get into Nature way way more.