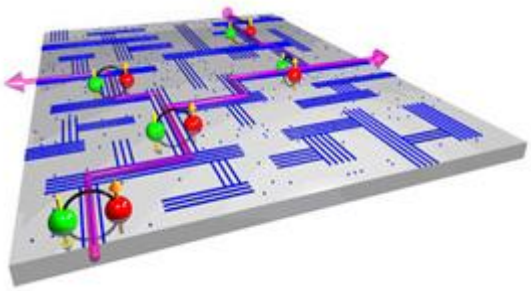
Monday, August 16, 2010

Will Fractals Revolutionize Physics, Biology and Other Sciences?

A new discovery, reported in the latest *Nature*, hints at higher universal laws of the physical world, as well as new ways to approach and understand life in general. Even though the European discovery actually dealt with superconductors, it has an interesting twist with implications for the life sciences.



A group of physicists from London Centre for Nanotechnology at UCL and their collaborators at Sapienza University of Rome and European Synchrotron Radiation Facility in Grenoble, France were studying properties of so-called high-transition-temperature (high-T_c) copper oxide superconductors. They were looking at the microstructures that these superconductors form as they are cooled down. To the surprise of investigators, they discovered that microstructures, exhibited by oxygen atoms, seemed to organize into self-repeating fractals. Moreover, these fractal shapes, some extending almost to the millimeter scale, were correlating to superconductivity. In fact, larger fractals correlated with higher superconductivity temps.

What does it have to do with life? We think, plenty. Fractals, known for their geometric morphologies that are made up of patterns that repeat themselves at smaller scales infinitely, were first discovered by mathematician Benoit Mandelbrot in 1960s. Since then, they took the world of natural sciences by storm. As mathematicians and physicists discovered more and more interesting properties of these unique constructs, people started to notice fractals' ubiquitous presence in nature. Whether in the living world or in inorganic one, they seem to pop up in unexpected places. Somehow, there are laws of physics that favor these structures for whatever reason.

To us, the discovery of fractal function is eerily reminiscent of polarization in pre-quantum mechanical physics. Not until Niels Bohr, Albert Einstein and others laid the foundations of quantum mechanics, polarization of light has remained a mystery. Now we have a new puzzle to answer. Fractals are ubiquitous in the physical and living world for some unknown reason, and there is a function to them.

Paper in *Nature*: Scale-free structural organization of oxygen interstitials in La_2CuO_{4+y}
UCL press release: Fractals make better superconductors ...
More from *Wired*: Inexplicable Superconductor Fractals Hint at Higher Universal Laws...

Side image: *Heat treatment improves the superconductivity of a ceramic copper oxide by creating a fractal network of connected channels of ordered oxygen defects. The green and red spheres represent the paired electrons responsible for superconductivity. Artwork by Manuel Vogtli (LCN).*