"Why is geometry often described as 'cold' and 'dry'? One reason lies in its inability to describe the shape of a cloud, a mountain, a coastline, or a tree. Clouds are not spheres, mountains are not cones, coastlines are not circles, and bark is not smooth, nor does lightning travel in a straight line... Nature exhibits not simply a higher degree but an altogether different level of complexity."

— **Benoit Mandelbrot**

The Fractal Geometry of Nature (1977), Introduction, xiii.

“Fractal is a word invented by Mandelbrot to bring together under one heading a large class of objects that have [played] ... an historical role ... in the development of pure mathematics. A great revolution of ideas separates the classical mathematics of the 19th century from the modern mathematics of the 20th. Classical mathematics had its roots in the regular geometric structures of Euclid and the continuously evolving dynamics of Newton. Modern mathematics began with Cantor's set theory and Peano's space-filling curve. Historically, the revolution was forced by the discovery of mathematical structures that did not fit the patterns of Euclid and Newton. These new structures were regarded ... as ‘pathological’, ... as a ‘gallery of monsters’, akin to the cubist paintings and atonal music that were upsetting established standards of taste in the arts at about the same time. The mathematicians who created the monsters regarded them as important in showing that the world of pure mathematics contains a richness of possibilities going far beyond the simple structures that they saw in Nature. Twentieth-century mathematics flowered in the belief that it had transcended completely the limitations imposed by its natural origins. ◆ Now, as Mandelbrot points out, ... Nature has played a joke on the mathematicians. The 19th-century mathematicians may not have been lacking in imagination, but Nature was not. The same pathological structures that the mathematicians invented to break loose from 19th-century naturalism turn out to be inherent in familiar objects all around us.”

— Freeman Dyson

‘Characterizing Irregularity’, *Science* (12 May 1978), **200**, No. 4342, 677-678.
Quoted in Benoit Mandelbrot, *The Fractal Geometry of Nature* (1977), 3-4.

“We’re all deeply conscious today that the enthusiasm of our forebears for the marvelous achievement of Newtonian mechanics led them to make generalizations in this area of predictability which, indeed, we may have generally tended to believe before 1960, but which we now recognize were false.

We collectively wish to apologize for having misled the general educated public by spreading ideas about the determinism of systems satisfying Newton’s laws of motion that, after 1960, were proved to be incorrect.”

—**Sir James Lighthill**

“The Recently Recognized Failure of Predictability in Newtonian Dynamics” (1986)

“The solvable systems are the ones shown in textbooks. They behave. Confronted with a nonlinear system, scientists would have to substitute linear approximations or find some other uncertain backdoor approach. Textbooks showed students only the rare nonlinear systems that would give way to such techniques. They did not display sensitive dependence on initial conditions. Nonlinear systems with real chaos were rarely taught and rarely learned. When people stumbled across such things— and people did —all their training argued for dismissing them as aberrations. Only a few were able to remember that the solvable, orderly, linear systems were the aberrations. Only a few, that is, understood how nonlinear nature is in its soul. … The mathematician Stanislaw Ulam remarked that to call the study of chaos ‘nonlinear science’ was like calling zoology ‘the study of nonelephant animals’.”

—James Gleick

Chaos: Making a New Science