Illustrating String Theory Using Fermat Surfaces

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We describe the path leading to the exploitation of Fermat Surfaces to represent the geometry and topology of the proposed hidden dimensions of String Theory. Several decades ago, the computer graphics community discovered some amusing techniques for deforming spheres to create flexible models of complicated solid objects, which happened to be closely related to the "Fermat Equations" familiar from Fermat's so-called Last Theorem. These models became known as "superquadrics," and were widely used for shape modeling in graphics as well as shape recognition in machine vision. Around 1988, I started studying how best to draw the complexifications of these shapes, known to geometers as "Fermat Surfaces." The outcome was a family of 4D graphics methods for interacting with the resulting complexified surfaces and an animated film entitled "Visualizing Fermat's Last Theorem," available on YouTube. A decade later, Bryan Greene noticed that my 5th degree Fermat Equation methods corresponded exactly to those needed to create plausible representations of a Calabi-Yau space that might embody the "hidden dimensions" of string theory. The resulting images were included in Brian Greene's 1999 best-seller "The Elegant Universe" and since then have appeared in many other scientific and artistic venues, including Bathsheba's laser-etched glass version, and my own 3D printed steel sculpture completed just this spring.