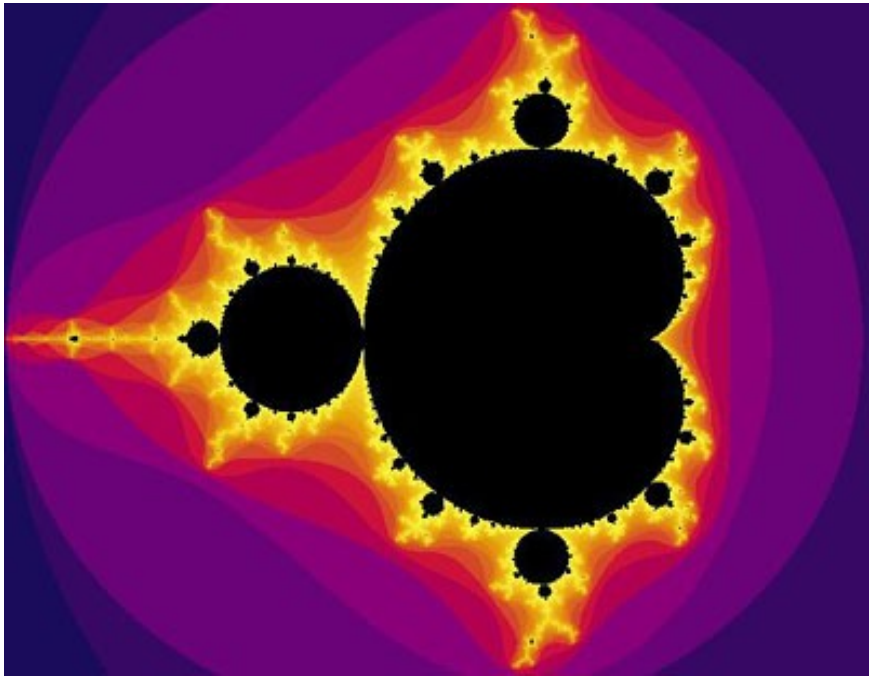
Ray Tracing: Mandelbulb

CSCI 4239/5239
Advanced Computer Graphics
Spring 2013

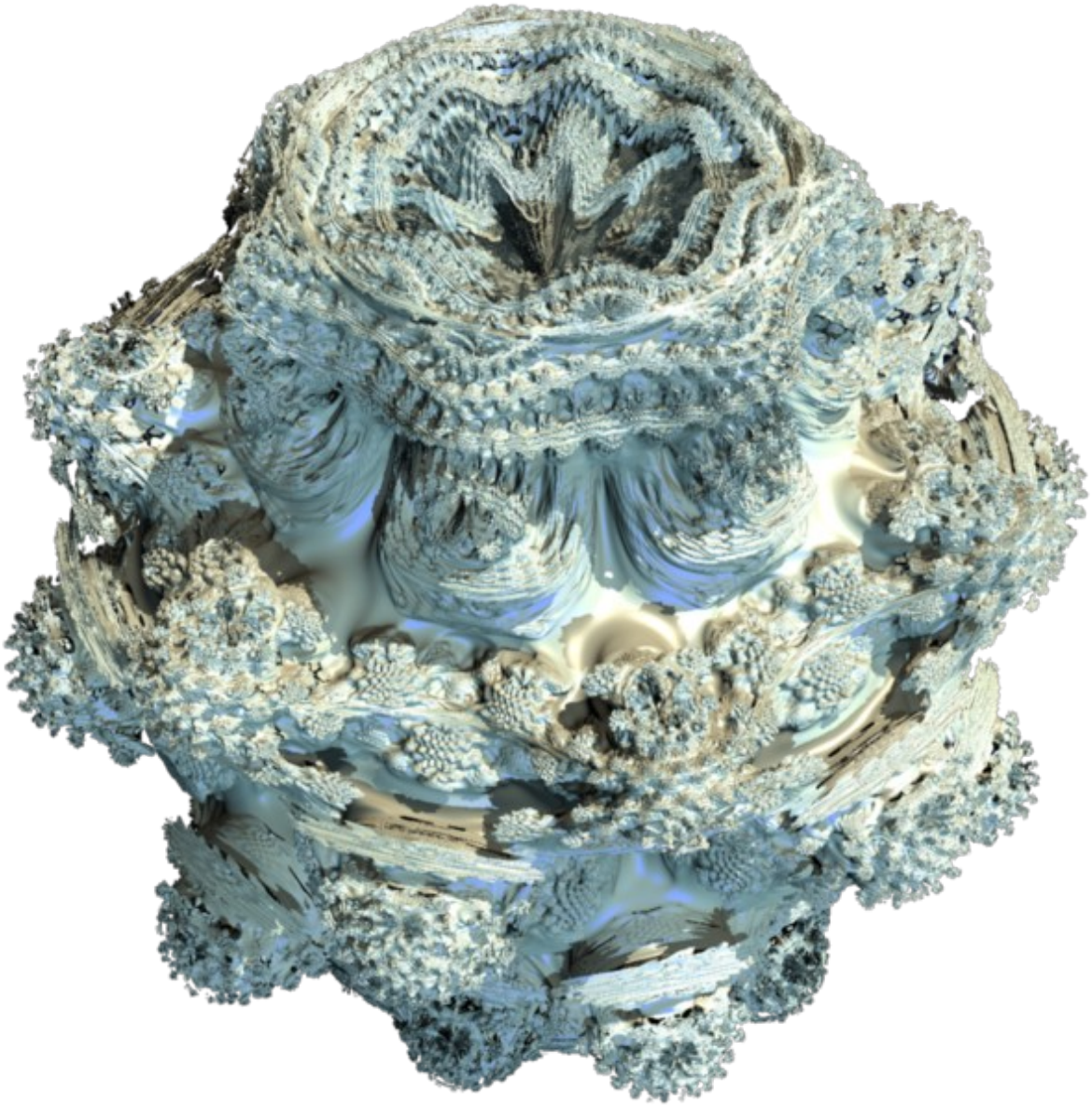
Mandelbrot Set

- Complex Quadratic Polynomial Sequence
  - $z_{n+1} = z_n^2 + c$
- For which values of *c* is the sequence bounded?
- This is a fractal set
  - Finite area
  - Boundary is infinite
  - Self-similar
  - 2D



Mandlebulb 3D Domain

- Defined mathematically
- Has appearance of Gothic architecure
- Shading needed to see details



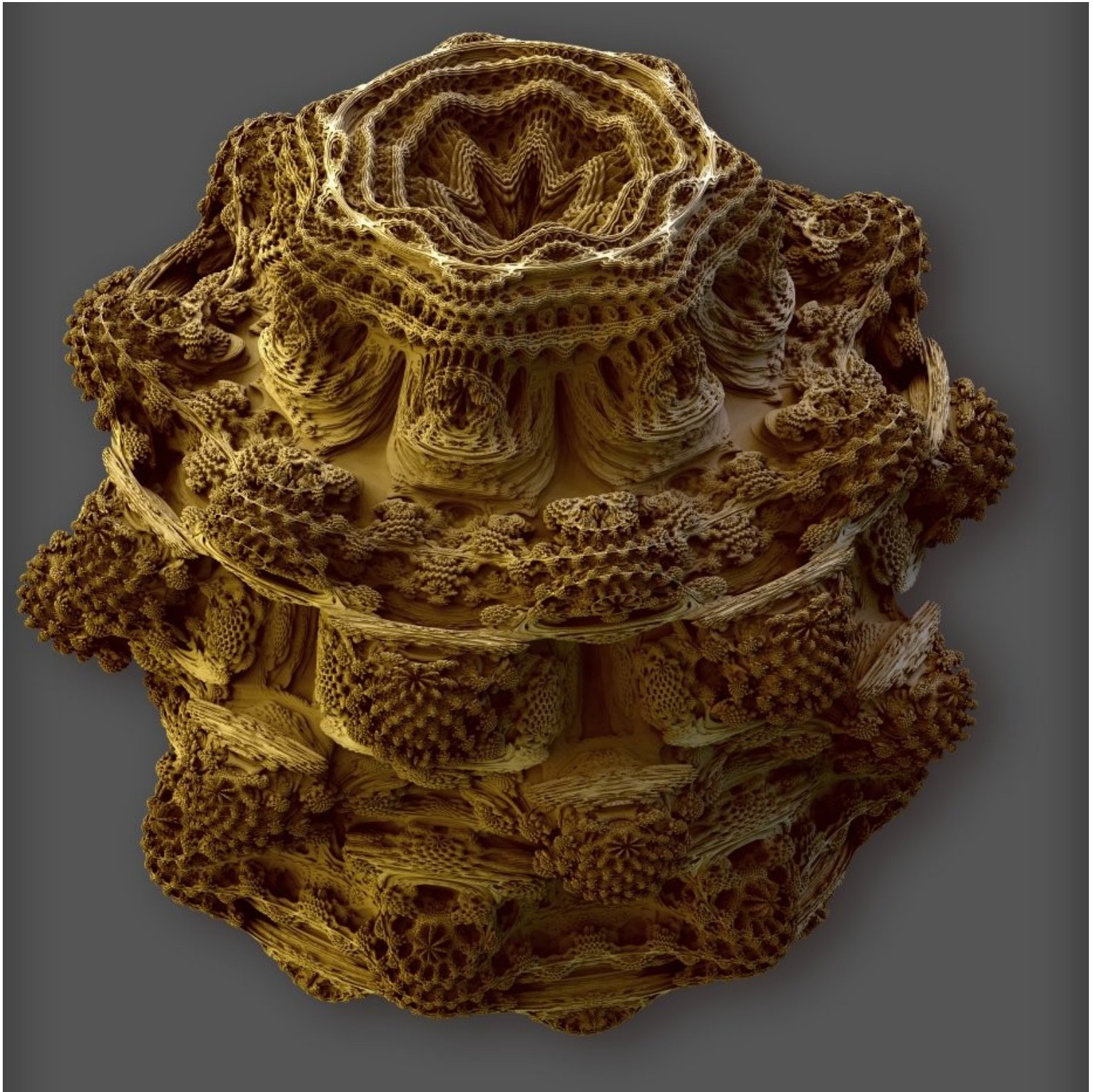
Mandelbulb Equation

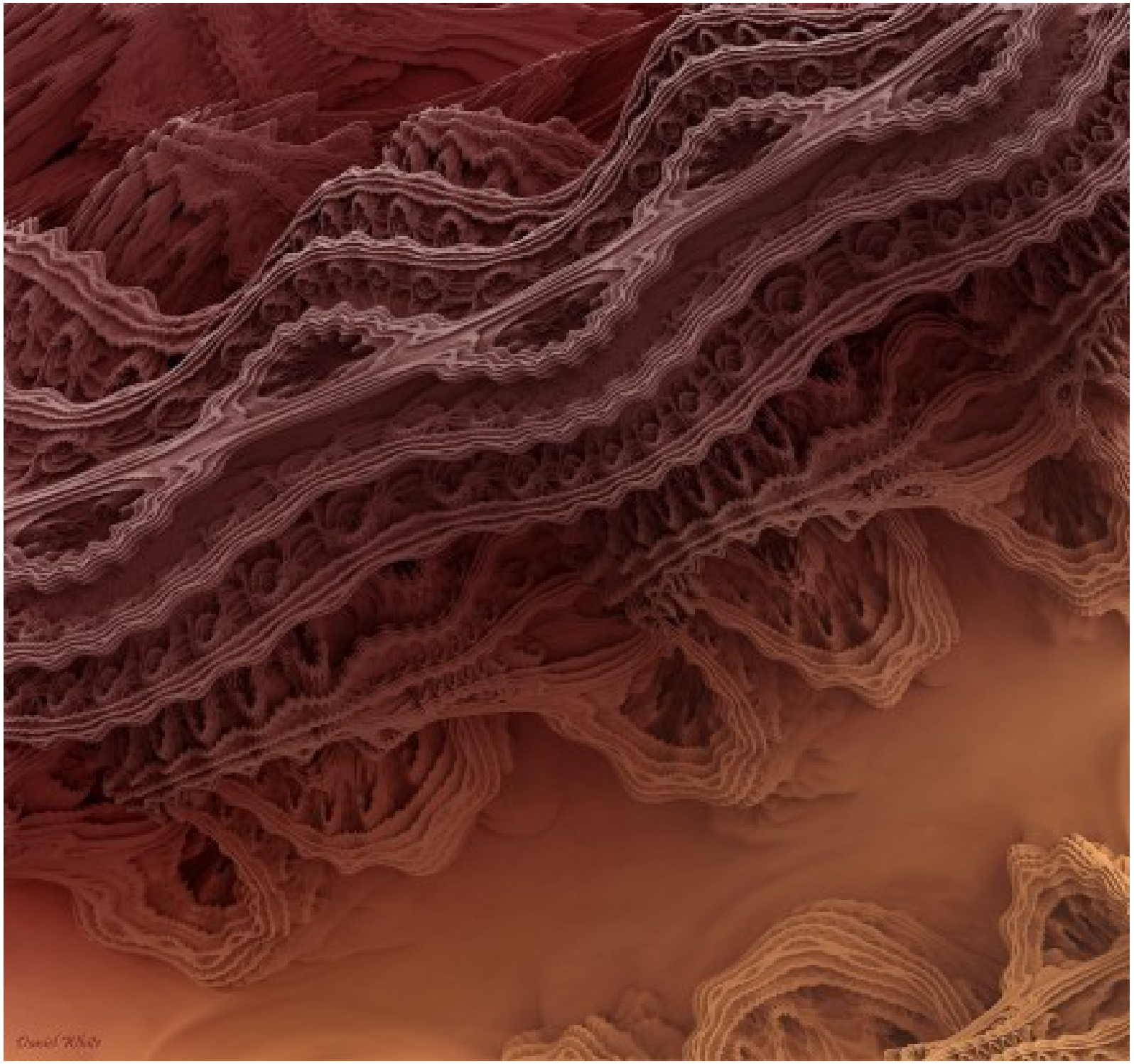
- $z_{n+1} = z_n^2 + c$
- Domain for this equation converges
- No direct equivalent to complex for 2D
- White and Nylander spherical coordinates
- How do you render this set?
  - POVray used for many images
  - ex26 and ex27 are primitive but real time
- *See handout for details*

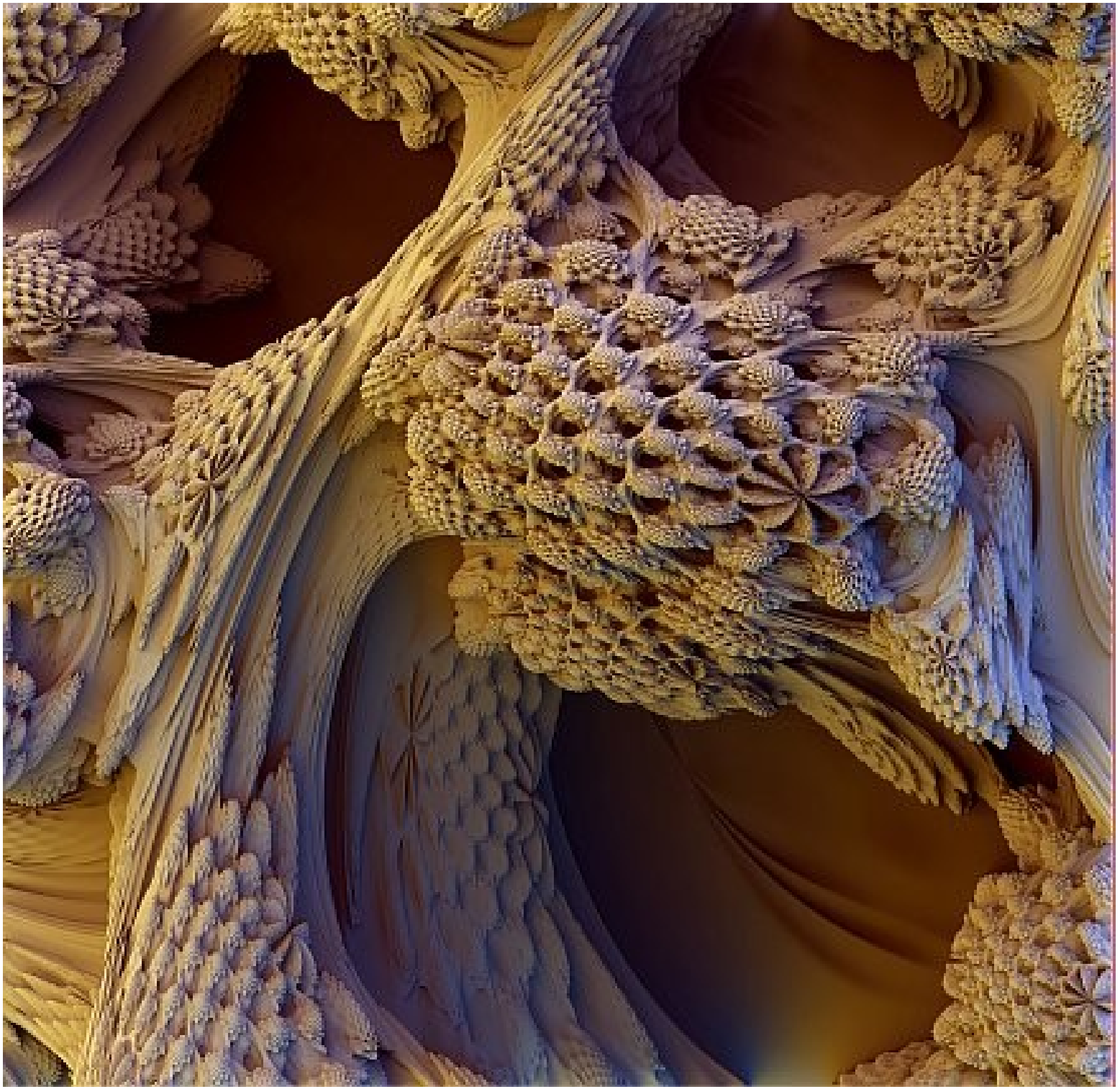
Gallery of Daniel White

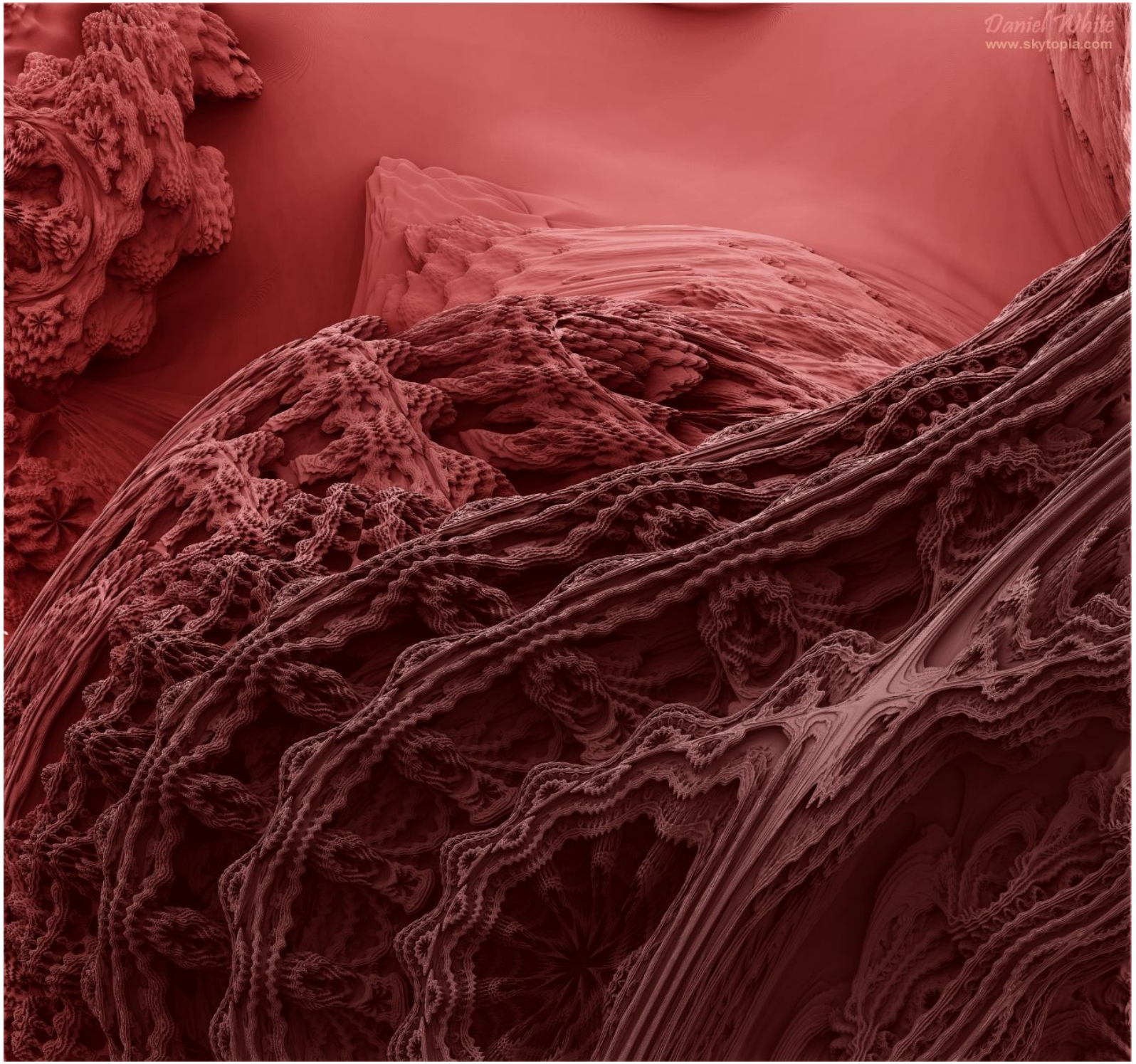
- The Unravelling the Real 3D Mandelbulb

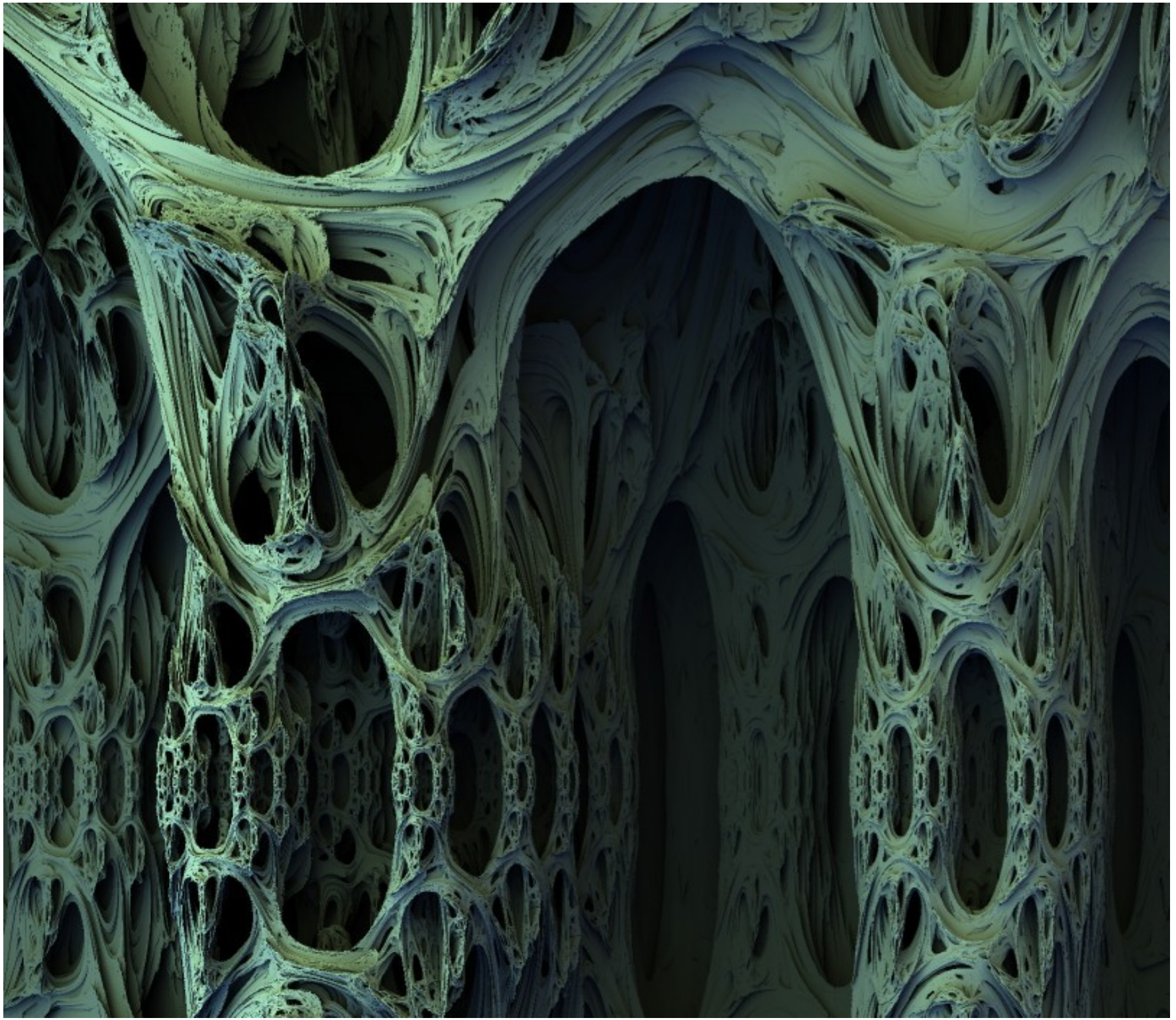
  http://www.skytopia.com/project/fractal/mandelbulb.html
- Explores and zooms into the mandelbulb
- Ray traced using colored lights
- Most are the n=8 mandelbulb

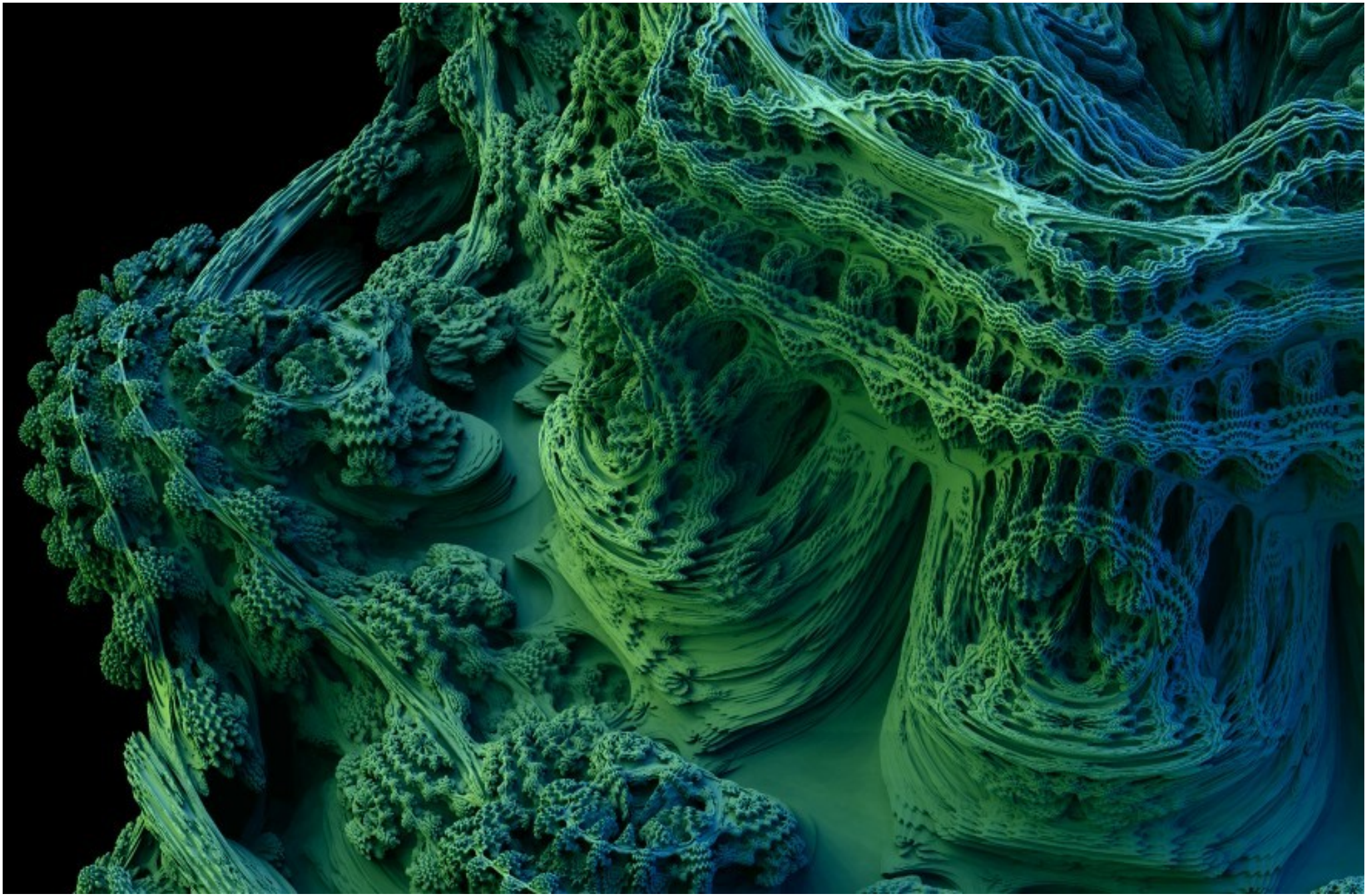






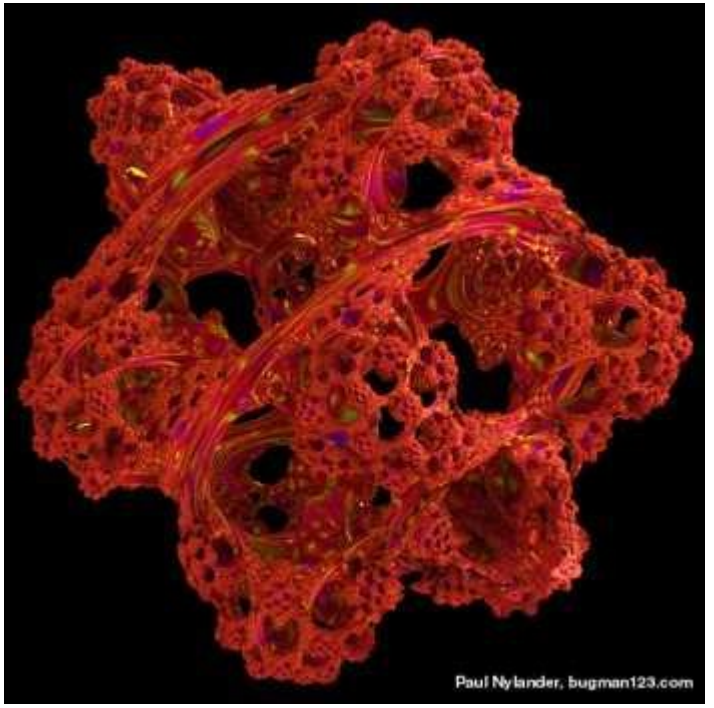

Daniel White
www.skytopia.com





Other Fractal Sets

- Mandelbrot set is just one of many 2D fractal sets
  - Julia
  - Lyapunov
  - Sierpinski triangle
- Many extensions to 3D



Real Time Ray Tracer

- ex26
  - Iterative solver for ray marching
  - OpenMP for parallel rays
- ex27
  - Adapts ex26 to CUDA
- Why not use GLSL?