Fractal Trigeometry

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Formula Mandelbulb/Juliusbulb/Juliabulb according to Jules Ruis

First created as BBM-15 d.d. 29 December 1997, see: www.fractal.org/BBM15.pdf

We want to calculate 3D fractals called the Mandelbulb, Juliusbulb and Juliabulb. Similar to the original 2D Mandelbrot the 3D formula is defined by z -> z^n + c but where 'z' and 'c' are hypercomplex ('triplex') numbers representing Cartesian x, y, and z coordinates.

The exponentiation term can be defined by:

{x,y,z} ^n = (r^n) { cos(n*ϕ) * cos(n*θ), sin(n*ϕ) * cos(n*θ), sin(n*θ)}

where r = sqrt (x^2 + y^2 + z^2) and r1 = sqrt (x^2 + y^2)

As we define θ as the angle in z-r1-space and ϕ as the angle in x-y-space

then θ = atan2 (z / r1) so θ = atan2 (z / sqrt (x^2 + y^2)) and ϕ = atan2 (y/x)

The addition term in z -> z^n + c is similar to standard complex addition, and is simply defined by:

(x,y,z} + {a,b,c) = {x+a, y+b, z+c}

The rest of the algorithm is similar to the 2D Mandelbrot!

Summary Formula 3D Mandelbulb, Juliusbulb and Juliabulb

r = sqrt (x^2 + y^2 + z^2)

θ = atan2 (z / sqrt(x^2 + y^2)

ϕ = atan2 (y/x)

newx = (r^n) * cos(n*ϕ) * cos(n*θ)

newy = (r^n) * sin(n*ϕ) * cos(n*θ)

newz = (r^n) * sin(n*θ)

where n is the order of the 3D Mandelbulb, Juliusbulb/Juliabulb.

Examples of 3D Mandelbulb/Juliusbulb/Juliabulb

3D Mandelbulb z^2	3D Juliusbulb z^2	3D Juliabulb z^2