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The Design of Cyclidic Volumes

Abstract
The Conformal Geometric Algebra framework provides a rich tool set for generating and navigating cyclidic surfaces and volumes, which are piecewise-smooth manifolds whose curvature lines lie on circles and whose constant coordinate surfaces are spheres. These manifolds are conformal immersions with triply orthogonal coordinate systems, and their discrete rationalization can provide designers a reliable mechanism for producing well-behaved meshes, without torsion and shearing. For animators, texture details are preserved during conformal mesh deformation. For architects, the same nodal joint can be reused across a conformal structure, and offsets preserve those same nice qualities. We will detail a variety of methods for constructing cyclidic volumes and a number of forms designed with these methods. Whereas typical approaches to construction usually depend upon a prerequisite parameterization of a surface using circular support nets, we instead leverage readily available elements unique to CGA, such as spheres and tangents, for a more direct and geometrically intuitive formulation of practical use in computer-assisted design. We demonstrate how tangent generators can be used to create constant coordinate spheres and how we can naturally preserve orthogonality as we interpolate constant coordinate surface spheres using simple rotors. Throughout, we rely heavily on CGA's built-in ability to help us choose our coordinate surfaces wisely.