Generating Highly Symmetric and Congruently Tiled Cages

Chandrajit Bajaj
University of Texas at Austin
http://www.cs.utexas.edu/~bajaj

I shall describe the generation of all possible shell and dome cages that can be uniquely tiled using a single type of face tile, and following a single tiling rule. The rule governs the tile arrangement with maximal vertex, edge and face symmetries. Such tiling arrangements or congruently tiled cages, are frequently found in chemical forms (e.g fullerenes or Bucky balls, crystals, quasi-crystals, virus nano shells or capsids), and synthesized cages (e.g. sports domes, modern architectural facades). Congruently tiled cages are both aesthetic and complete, as they support maximal mesh symmetries with minimal complexity and possess simple generation rules. I shall describe TilerGen which generates congruent tilings and layouts that satisfy these optimality conditions. Further, the congruent tilings are uniquely mappable to an almost regular 3D polyhedron (or its dual polyhedron) and which exhibits face-transitive (and edge-transitive) congruency with at most two types of vertices (each type transitive to the other). The family of all such congruently tiled cages create a new generative class of polyhedra, beyond the well-studied regular, semi-regular and quasi-regular classes, and their duals (platonic, Catalan and Johnson). While our new polyhedra class is infinite, we prove that there exists a unique parametrization, where each member of the class can be represented by two integer lattice variables, and moreover efficiently constructable. This construction further enables the prediction of generative tiled caged models of shells and domes of a given shape and form.

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