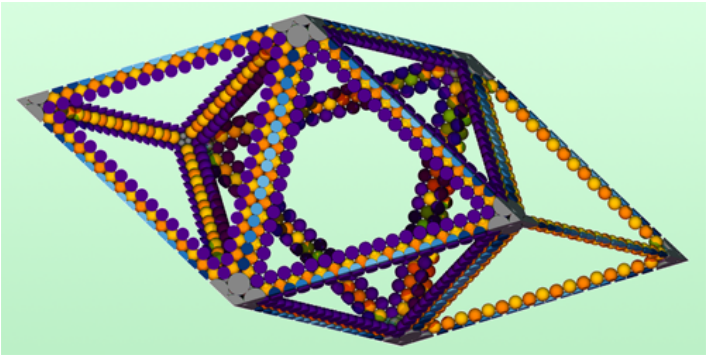
# Stable Hard-Sphere Packings with Arbitrarily Low Density

**A new strategy for packing hard spheres of different sizes could lead to novel ways of creating strong, lightweight materials.**

By **Martin Rodriguez-Vega**

To create structures that are light and strong, researchers leverage the interplay between internal compression and tension, removing unnecessary material that does not contribute to this balance of forces. Because packed assemblages of hard spheres lack internal tension, the conventional wisdom is that reducing the density of such structures eventually leads to instabilities, establishing limits on how strong and lightweight they can be. Now, Robert Dennis and Eric Corwin at the University of Oregon have found a way to pack hard spheres at vanishingly small densities such that their structures are as light as desired while remaining mechanically stable [**1**].

The duo started by considering a "Böröczky packing," a way of arranging identical disks in 2D that allows the construction of long bridges spanning arbitrarily large voids. A Böröczky packing is not resistant to deformations, but Dennis and Corwin showed that more robust structures can be achieved by taking advantage of the extra degrees of freedom afforded by using disks of different radii. Moreover, they demonstrated that the 3D generalization—in which the disks are replaced by hard spheres—is also stable, producing packed-sphere structures that resist pressure and shear stress.



Credit: R. C. Dennis and E. I. Corwin [**1**]

Reflecting the opposition between Dionysus and Apollo in Greek mythology, the researchers call their strategy "Dionysian packing." ("Apollonian packing," its opposite, is a fractal arrangement in which the entire volume is filled with ever-smaller spheres.) By demonstrating the theoretical existence of structures that are light and strong even in the absence of stretching forces, the duo's construction could lead to stiff structures employing small quantities of material. However, they say that practical applications of Dionysian packing require further studies that consider effects such as friction between the spheres.

Martin Rodriguez-Vega is an Associate Editor for *Physical Review Letters.*

## REFERENCES

1. R. C. Dennis and E. I. Corwin, "Dionysian hard sphere packings are mechanically stable at vanishingly low densities," **Phys. Rev. Lett. 128, 018002 (2022).**