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Density of disc and sphere packings

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How to stack an infinite number of oranges to maximize the proportion of the covered space? Kepler conjectured that the "cannonball" packing is an optimal way to do it. This conjecture took almost 400 years to prove, and the proof of Hales and Ferguson consists of 6 papers and tens of thousands of lines of computer code.

Given an infinite number of coins of 3 fixed radii, how to place them on an infinite table to maximize the proportion of the covered surface? Triangulated disc packings are those where each "hole" is bounded by three pairwise tangent discs. Connelly conjectured that for the sets of disc radii where triangulated packings exist, one of them maximizes the proportion of the covered surface; this holds for unary and binary disc packings.

In this talk, we will discuss various techniques used in the proof of the Kepler conjecture and other important results in the domain of disc and sphere packings. They allow us to prove the statement of the Connelly conjecture for 31 triangulated triplets of disc radii and disprove it for 45 other triplets. Besides that, we obtain tight bounds on the local density of simplicial cells in 2-sphere packings.

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