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Structure and stability of finite sphere packings via exact enumeration[1] ROBERT S. HOY, Departments of Mechanical Engineering & Materials Science, and Physics, Yale University, JARED HARWAYNE-GIDANSKY, Department of Electrical Engineering and Integrated Graduate Program in Physical and Engineering Biology, Yale University, COREY S. O'HERN, Departments of Mechanical Engineering & Materials Science, and Physics, Yale University — We analyze the geometric structure and mechanical stability of complete sets of isostatic and hyperstatic sphere packings obtained via exact enumeration techniques. The number of nonisomorphic isostatic packings grows exponentially with the number of spheres N, and the fraction of packings possessing soft modes (for "sticky" spheres with contact attractions) grows faster. The diversity of structure and symmetry increases with N and decreases with the degree of hyperstaticity. We further show that maximally contacting packings are in general neither the densest nor the most symmetric. Our studies of the geometry of complete sets of sphere packings provide a basis for future work on ground and metastable states in systems with hard-core plus short-range attractive interactions including attractive colloids, collapsed proteins, and jammed particulate media.

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