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Why is the bulk modulus of jammed solids and granular packings much larger than the shear modulus? ALESSIO ZACCONE, Cavendish Laboratory, University of Cambridge, DENIS WEAIRE, School of Physics, Trinity College Dublin — In granular packings and metallic glasses, the rigidity to compression is much more pronounced than with respect to shear, resulting in the bulk modulus being much larger than the shear modulus. This state of affairs becomes dramatic in marginal jammed solids which are solid-like to compression but not to shear (Ellenbroek, Zeravcic, van Saarloos, van Hecke, EPL 87, 34004 (2009)). For metallic glasses, it was argued by Weaire et al. some time ago (Acta Metall. 19, 779 (1971)) that this effect might be due to the nonaffinity of the particle displacements. These arise because the force acting on a particle upon strain as a result of the strain-induced motion of its neighbors is not balanced in the absence of local order. Hence the particles undergo nonaffine displacements to relax these forces to the expense of the elastic storage energy, leading to lower values of the elastic moduli. Using the nonaffine theory of Zaccone and Scossa-Romano (PRB, 83, 184205 (2011)) we found a conclusive solution to this long standing problem. We show that in packings and related materials the excluded volume between neighbors induces geometric correlations which significantly reduce the nonaffinity under compression but leave the nonaffinity in shear substantially unaltered.

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