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Random close packing of polydisperse jammed emulsions[1]

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Packing problems are everywhere, ranging from oil extraction through porous rocks to grain storage in silos and the compaction of pharmaceutical powders into tablets. At a given density, particulate systems pack into a mechanically stable and amorphous jammed state. Theoretical frameworks have proposed a connection between this jammed state and the glass transition, a thermodynamics of jamming, as well as geometric modeling of random packings. Nevertheless, a simple underlying mechanism for the random assembly of athermal particles, analogous to crystalline ordering, remains unknown. Here we use 3D measurements of polydisperse packings of emulsion droplets to build a simple statistical model in which the complexity of the global packing is distilled into a local stochastic process. From the perspective of a single particle the packing problem is reduced to the random formation of nearest neighbors, followed by a choice of contacts among them. The two key parameters in the model, the available space around a particle and the ratio of contacts to neighbors, are directly obtained from experiments. Remarkably, we demonstrate that this "granocentric" view captures the properties of the polydisperse emulsion packing, ranging from the microscopic distributions of nearest neighbors and contacts to local density fluctuations and all the way to the global packing density. Further applications to monodisperse and bidisperse systems quantitatively agree with previously measured trends in global density. This model therefore reveals a general principle of organization for random packing and lays the foundations for a theory of jammed matter.

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