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**Miranda Holmes-Cerfon\***, holmes@cims.nyu.edu, and **Yoav Kallus**. *The statistical mechanics of singular sphere packings*.

What are all the ways to arrange  $N$  hard spheres to form a rigid cluster? The answer brings insight to a number of phenomena in materials science, from nucleation, to emergence, to self-assembly. We enumerate packings of  $N \leq 19$  spheres using a deterministic numerical algorithm, whose completeness could be addressed using geometrical methods.

We next ask: what is the free energy of the clusters when the spheres interact with a very short-range potential? For all so-called “regular” clusters, this can be evaluated using a harmonic approximation for the energy. However, the list contains a great many “singular” clusters, which correspond to singular solutions to a set of algebraic equations. These are also the clusters one sees with unusually high probability in experiments. We show how to compute the leading-order contribution to their free energy, and discuss implications for problems in materials science. (Received March 20, 2017)