Abstract Submitted
for the MAR13 Meeting of
The American Physical Society

From Kepler to Ulam: searching for the optimal packing in the space of object shapes ROMAIN MARI, Levich Institute, City College of New York, ADRIAN BAULE, Levich Institute, City College of New York, and School of Mathematical Sciences, Queen Mary University of London, LIN BO, Levich Institute and Physics Department, City College of New York, MAXIMILIEN DANISCH, Levich Institute, City College of New York, and Laboratoire d'Informatique de Paris 6, Université Pierre et Marie Curie, HERNAN MAKSE, Levich Institute and Physics Department, City College of New York — The quest for the best packing of particles has been guided by two notorious conjectures. Kepler stated that the optimal sphere packing is the face-centered-cubic lattice, while Ulam conjectured that all convex shapes pack better than spheres. While the former was proved by Hales, there is yet no theoretical framework to predict the density of non-spherical particles. Here, we present a formalism to describe packings of objects of arbitrary shape in random configurations by reducing the particle interactions to simple sets of points, and lines. The framework predicts the optimum packing fraction of a large class of shapes as an analytical continuation from the spherical point, thus paving the way for a proof of Ulam's conjecture. In particular, the formalism predicts that spherocylinders pack better than both spheres and dimers. Ellipsoids and tetrahedra can be studied, highlighting the universality 1of the framework to search for optimal packings.

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Date submitted: 04 Dec 2012 Electronic form version 1.4