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Physics of Sand: Emergent Behavior in the Macro World[1]

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Diversity in the natural world emerges from the collective behavior of large numbers of interacting objects. The origin of collectively organized structures over the vast range of length scales from the subatomic to colloidal is the competition between energy and entropy. Thermal motion provides the mechanism for organization by allowing particles to explore the space of configurations. This well-established paradigm of emergent behavior breaks down for collections of macroscopic objects ranging from grains of sand to asteroids. In this macro-world, thermal motion is absent, and mechanical forces are all important. Surprisingly, we lack understanding of the basic, unifying principles that underlie the emergence of order in this world that we encounter in our everyday life. In this talk, I will explore the Statistical Mechanics of sand, and present a new paradigm for emergence of rigidity in these athermal systems.

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