

Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Jamming and chaotic dynamics in different granular systems

HOMAYOON MAGHSOODI, ERIK LUIJTEN, Northwestern University — Although common in nature and industry, the jamming transition has long eluded a concrete, mechanistic explanation. Recently, Banigan *et al.* (Nat. Phys. **9**, 288–292, 2013) proposed a method for characterizing this transition in a granular system in terms of the system’s chaotic properties, as quantified by the largest Lyapunov exponent. They demonstrated that in a two-dimensional shear cell the jamming transition coincides with the bulk density at which the system’s largest Lyapunov exponent changes sign, indicating a transition between chaotic and non-chaotic regimes. To examine the applicability of this observation to realistic granular systems, we study a model that includes frictional forces within an expanded phase space. Furthermore, we test the generality of the relation between chaos and jamming by investigating the relationship between jamming and the chaotic properties of several other granular systems, notably sheared systems (Howell, D., Behringer R. P., Veje C., Phys. Rev. Lett. **82**, 5241–5244, 1999) and systems with a free boundary. Finally, we quantify correlations between the largest Lyapunov vector and collective rearrangements of the system to demonstrate the predictive capabilities enabled by adopting this perspective of jamming.

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Date submitted: 06 Nov 2015

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