Liquid-solid-like transition in quasi-one-dimensional driven granular media

M.G. Clerc[1], P. Cordero[1], J. Dunstan[1], K. Huff[2], N. Mujica[1], D. Risso[3] & G. Varas[1]

[1] Departamento de Física, Facultad de Ciencias Físicas y Matemáticas, Universidad de Chile, Av. Blanco Encalada 2008, Santiago, Chile
[2] Department of Physics, James Franck Institute, The University of Chicago, 5640 S. Ellis Avenue, Chicago, Illinois 60637, USA
[3] Departamento de Física, Facultad de Ciencias, Universidad del Bío-Bío, Av Collao 1202, Concepción, Chile
german.varas@ens-lyon.fr

The theory of non-ideal gases in thermodynamic equilibrium, for instance the van der Waals gas model, has played a central role in the understanding of coexisting phases as well as in the transition between them. Granular matter contrasts with these gases because the collisions between grains dissipate energy, and their macroscopic size renders thermal fluctuations negligible. If a mass of grains is subjected to mechanical vibration, it can make a transition to a fluid state. In this state, granular matter exhibits patterns and instabilities that resemble those of molecular fluids. Here, we report a granular solid-liquid phase transition in a vibrating granular monolayer. The transition is mediated by waves and is triggered by a negative compressibility as in van der Waals phase coexistence, although the system does not satisfy the hypotheses used to understand atomic systems. The dynamic behaviour that we observe—coalescence, coagulation, wave propagation—is common to a wide class of phase transitions. We have combined experimental, numerical and theoretical studies to understand the different features of this transition.

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