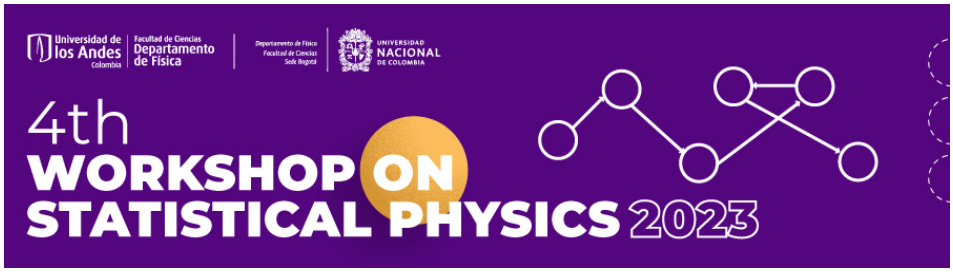


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# How to join the force and volume ensembles of granular media

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Granular media consist of a large number of discrete particles interacting mostly through contact forces that, being dissipative, jeopardizes a classical statistical equilibrium approach based on energy. Instead, two independent equilibrium statistical descriptions have been proposed: the Volume Ensemble and the Force Network Ensemble. Hereby, we propose a procedure to join them into a single description, using Discrete Element simulations of a granular medium of monodisperse spheres in the limit state of isotropic compression as testing ground. By classifying grains according to the number of faces of the Voronoï cells around them, our analysis establishes an empirical relationship between that number of faces and the number of contacts on the grain. In addition, a linear relationship between the number of faces of each Voronoï cell and the number of elementary cells proposed by T. Aste and T. Di Matteo in 2007 is found. From those two relations, an expression for the total entropy (volumes plus forces) is written in terms of the contact number, an entropy that, when maximized, gives an equation of state connecting angoricity (the temperature-like variable for the force network ensemble) and compactivity (the temperature-like variable for the volume ensemble). So, the procedure establishes a microscopic connection between geometry and mechanics and, constitutes a further step towards building a complete statistical theory for granular media in equilibrium.

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