

# Distribution of liquid clusters inside a granular packing by LBM

V. Richefeu<sup>1\*</sup>, F. Radjai<sup>2,3</sup> and J.-Y. Delenne<sup>4</sup>

<sup>1</sup> 3SR UMR 5521 CNRS-UJF, Grenoble 1-Grenoble INP, 38041 Grenoble, France

<sup>2</sup> LMGC UMR 5508 CNRS-UM2, Place E. Bataillon, 34095 Montpellier, France

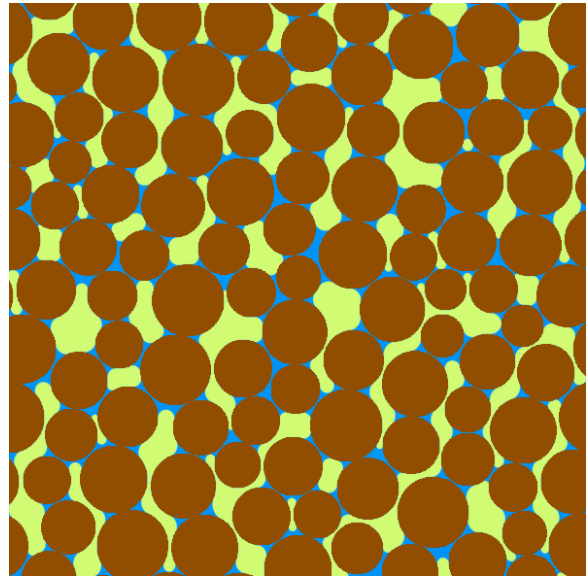
<sup>3</sup> <MSE><sup>2</sup> UMI 3466 CNRS-MIT, CEE, Massachusetts Institute of Technology,  
77 Massachusetts Avenue, Cambridge CA 02139, USA

<sup>4</sup> IATE UMR 1208 INRA-CIRAD-SupAgro-UM2, 2 place Pierre Viala - 34060 Montpellier, France

e-mail: Vincent.Richefeu@3sr-grenoble.fr, web page: <http://www.cgp-gateway.org>

## ABSTRACT

Partially wetted granular materials have remained largely unexplored because of the intricate texturing of water in the pore space [1] in spite of its essential role in many natural and industrial processes. We investigate the distribution of liquid in a granular material and its relationship with capillary stresses as the liquid fills gradually and homogeneously the pore space of a 2D granular packing. The distribution of liquid is computed using a single-component multiphase Lattice Boltzmann Method (LBM) [2]. The thermodynamics of phase change is based on Carnahan-Starling's equation of state from which the interactions between liquid, gas and solid are derived using nonlocal potentials. These potentials are calculated between the fluid particles and neighbouring lattice nodes that control the surface tension and contact angle between fluid and solid. A homogeneous grain-liquid mixture is obtained allowing for detailed investigation of the statistics of liquid distribution inside the packing at increasing degree of saturation. A percolation algorithm is employed to identify the liquid clusters and to determine their volume and connectivity with the surrounding grains. The internal pressure of the clusters is analysed as a function of liquid content [3]. We are thus able to obtain the global liquid-retention curve as well as the forces acting on the grains. The tensile stress carried by the grains as a function of the amount of condensed liquid reveals four distinct states with a peak stress occurring at transition from a primary coalescence process, where the cohesive strength is carried mostly by the grains, to a secondary process governed by the increase of the liquid cluster volumes. Finally, we show that the evolution of capillary states is correctly captured by a simple model accounting for the competing effects of the Laplace pressure and grain-liquid interface.



## REFERENCES

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