Detachment transition in a model of convexification of clusters of discs

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Adhesion controlled by the roughness of the surfaces in contact, or by third bodies at the interface, is a recurring problem in contact physics, with applications ranging from geophysics to nanosciences. Inspired by experimental observations [1] of a detachment transition when one increases the density of nanoparticles intercalated between a graphene sheet and a flat substrate, we propose a simple statistical model which displays a similar transition. Experimental observations reveal that the observed transition results from collective effects that expand the detachment zones in the regions where its boundary is concave. Thus, we build a model based on the convexification of percolation clusters associated to individual detachment areas induced by each particle. Numerical simulations reveal that this model exhibit a discontinuous transition (i.e., the transition occurs discontinuously when we bring it about by adding new particles). Our model therefore shares similarities with explosive percolation and bootstrap percolation models. We also propose a quantitative interpretation of the unbinding transition of graphene with intercalated nanoparticles based on this model.

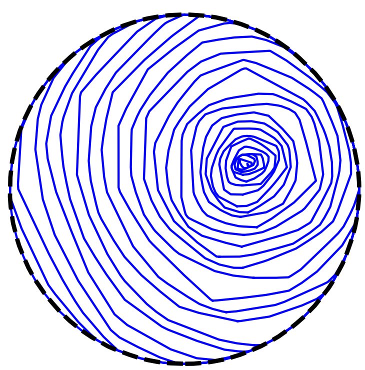

Figure 1. Steps of the avalanche of convexifications, at transition. A single cluster is growing, invading the whole domain.

Références

1. M. Yamamoto, O. Pierre-Louis, J. Huang, M. Fuhrer, T. Einstein, and W. Cullen. *"The Princess and the Pea" at the Nanoscale : Wrinkling and Delamination of Graphene on Nanoparticles.* Phys. Rev. X 2, 041018 (2012)