Abstracts APS meeting

Rahman Prize 03/06/2018 11:15 AM:

“Fluids and Deforming Surfaces”

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Interesting feedback effects occur, when fluids deform their own boundary conditions. The first example I will show is laminar flow through a porous medium. Here large scale LBM simulation show that wall erosion and sediment deposition can produce power-law distributed bursts in flux and pressure. I will also elucidate the similarities to “campylotic” media, i.e. randomly curved spaces. The second example concerns dune formation in turbulent winds. The numerical solution of equations of motions for the granular surface allows reproducing shapes and velocities of dunes. Insight about the Aeolian transport of grains due to saltation and about the resulting electric charges can be obtained through a coupled fluid –particle simulation. The third example is electronic flow on deforming graphene sheets, which can be calculated using relativistic LBM on curved surfaces obtained from large scale MD simulations at fixed temperature.

03.1.5 Athermal Systems and Statistical Mechanics (GSNP):

“Percolation on correlated landscapes”

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Random landscapes with power-law height-height correlations are described by a Hurst exponent H and can be generated by the Fourier filtering method. The isoheight lines at the percolation threshold and their accessible perimeter as well as the shortest path on the percolation cluster are fractals for $-1 < H < 0$ with dimensions that depends on H. Exact results are recovered for $H = -1$ and $H = 0$. Analyzing numerically the winding angle, the left passage probability, and the driving function of these curves, it is found that for negative H there statistical properties are compatible with a Schramm-Loewner evolution (SLE) and therefore can be mapped to random walks, their fractal dimension determining the diffusion constant. By contrast, for positive H, we find that the random walk is not Markovian but strongly correlated in time. The watershed dividing drainage basins of the landscape can also be obtained from percolation by suppressing systematically the occupation of bridges, i.e. those sites or bonds which if occupied would create the spanning cluster. This delays the percolation threshold and produces at the end a connected line of bridges which is identical to the watershed, exhibiting trivially a first order percolation transition. At p_c, bridge percolation exhibits theta point scaling with a new tricritical exponent.

Watersheds also are found to be compatible with SLE. For uncorrelated surfaces, i.e. H = -1, the corresponding diffusivities are $\kappa = 1.734 +/- 0.005$ for the watershed and $\kappa = 1.04 +/- 0.02$ for the shortest path, being the only examples known up to now with $\kappa < 2$. Both watershed and shortest path result from a global optimization process and identifying them, requires exploring an entire area. The perimeters of multi-layered and directed percolation clusters at criticality are the scaling limits of the Loewner evolution of an anomalous Brownian motion, being superdiffusive and subdiffusive, respectively.