Shock driven jamming and periodic fracture of particulate rafts
MAHESH BANDI, SEAS, Harvard Univeristy. CNLS & MPA-10, Los Alamos National Laboratory, TUOMAS TALLINEN, L. MAHADEVAN, SEAS, Harvard University — A tenuous monolayer of hydrophobic particles at the air-water interface often forms a scum or raft. When such a monolayer is disturbed by localized surfactant introduction, a radially divergent shock emanates and packs the particles into a jammed, compact, annular band that grows with time. The resulting two-dimensional, disordered, elastic solid locally has a packing fraction that saturates at random close packed density ($\phi_{RCP}$) and fractures as it is driven radially outwards, to form periodic triangular cracks with robust geometrical features. We find that the number of cracks $N$ varies monotonically with the initial particulate packing fraction $\phi_{init}$, as does the compaction band radius $R^*$ at fracture onset. However, its width $W^*$ is constant across all $\phi_{init}$. A simple geometric theory that treats the compaction band as an elastic annulus, and accounts for mass conservation allows us to deduce that $N \simeq 2\pi R^*/W^* \simeq 4\pi \phi_{RCP}/\phi_{init}$, a result that we experimentally verify over the range $(0.1 \leq \phi_{init} \leq 0.64)$. 

Mahesh Bandi
SEAS, Harvard Univeristy

Date submitted: 12 Nov 2010