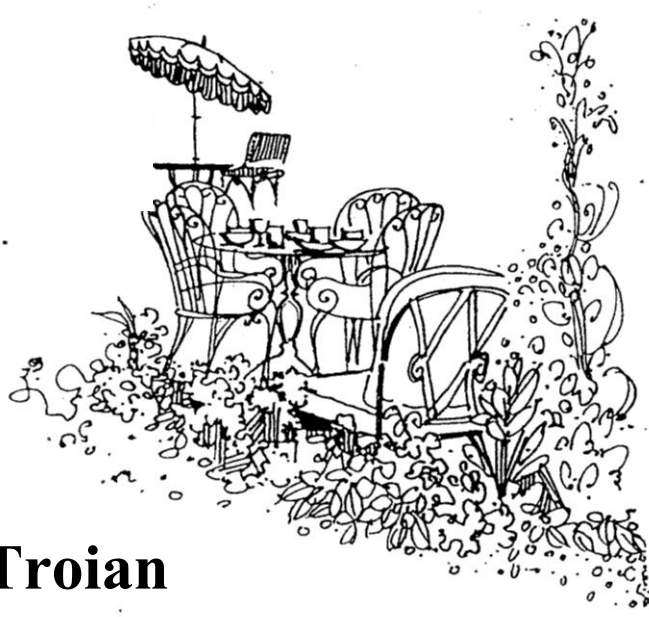
Chez Pierre

Presents ...

Monday, December 6, 2010
12:00pm
MIT Room 4-331



Sandra M. Troian
California Institute of Technology

"Modulated Interface Lithography: The Nanoworld Beyond Bénard Instability"

Experiments by several groups during the past decade have shown that molten nanofilms in close proximity to a cooler substrate undergo spontaneous formation of pillar microarrays. There is considerable excitement over these findings since the instability can be harnessed to generate arbitrary-shaped, 3D nanostructures in a single step by direct modulation of the thermal gradient. Once solidified, the resulting structures exhibit ultrasmooth interfaces suitable for the most demanding optical applications. There are currently two prevailing explanations for this phenomenon: (i) electrostatic attraction between the molten film and overlying substrate due to induced surface image charge proposed by Chou et al. in 2002 and (ii) coherent reflections of acoustic phonons which generate an internal radiation pressure as proposed by Steiner et al. in 2003. In this talk, we demonstrate instead that the fluid elongations are due to a deformational instability in which thermocapillary forces arising from perturbations in the interfacial thermal gradient play a dominant role in fluid structuring. The linear stability analysis of the interface equation corresponds to an extreme limit of Bénard flow peculiar to films of nanoscale dimensions. The Lyapunov free energy for the full nonlinear equation confirms that pillarlike structures are energetically preferred. We will discuss results of numerical simulations and optical measurements of the in-plane symmetry, array pitch and time-dependent height useful in constructing nanoscale components for photonic applications