

April 2003

News and Views

Material witness: Foams of fancy

PHILIP BALL

doi:10.1038/nmat862

When young Agnes King went to visit her Uncle William, she found him blowing bubbles. But this was no charming frivolity: Uncle William was apparently studying soap bubbles "with some scientific end in mind", for he was none other than William Thomson, better known as Lord Kelvin.

The grown-ups were less than impressed. "George Darwin [Charles' son] characterises [this work] as utterly frothy", Kelvin confessed to Rayleigh in 1887, and the Irish scientist George Francis Fitzgerald advised him sternly that it was a "pure waste of time".

His fascination with bubbles, however, led Kelvin to make his famous conjecture about the structure of the 'ideal' foam: one in which all the cells are identical and have minimal surface area. This conjecture was still being tested in the 1990s (when it was found to have, at best, limited validity).

The most striking consideration about modern studies of foams is that they can still be pursued with apparatus not significantly more sophisticated than that used by Kelvin: soap and glycerine, a canister of compressed air (more reliable than human lungs), some sheets of glass, a slide projector to throw shadows on a screen — these are all the accoutrements needed for investigating new physics.

It wouldn't be too great an exaggeration to suggest that kitchen-table physics is back in vogue. You do not need to resort to heavy-fermion systems at liquid-helium temperatures to uncover new insights into the behaviour of materials. Foams, colloids, pastes, elastic sheets, powders: all are familiar fabrics of our everyday world, and yet all continue to elude a complete theoretical understanding. "These seemingly mundane problems are often anything but", says Lakshminarayanan Mahadevan of Cambridge University. "Yet their very ubiquity challenges us to explain them."

The processes by which sheets wrinkle and crumple have recently become the focus of bewildering mathematical analyses by Mahadevan and others. Crumpling is clearly highly nonlinear: when paper is screwed into a ball or the body of a car crumples into a lamp post, the stresses uniformly distributed through a sheet get localized into a web of ridges of extreme and generally inelastic bending.

Understanding that process might be the first step in designing sheets better able to resist impact — not to mention textiles that drape aesthetically. And clues about the physics involved can be gathered by the simple expedient of using a microphone to listen to the spectrum of pops as a piece of paper crumples, releasing acoustic energy.

It is humbling to find in a high-powered journal like *Physical Review Letters* that we have limped along for years without an understanding of what controls the wavelength and amplitude of wrinkling in a sheet — apparently, scaling laws connect them to a stiffness coefficient (**90**, 074302, 2003). Or to discover the gulf that has existed (and which is barely bridged now) between the macroscopic rheological behaviour and the underlying microscopic dynamics of pastes (**90**, 068303, 2003). And why does soapy water suddenly start to meander as it flows down a glass plate? There's plenty still to be learnt from the \$20 experiment.