

## **Waves and Wrinkles in Soft Solids**

*Michel Destrade, NUI, Galway*

### **Abstract**

Biological soft tissues and soft gels are difficult to study and model mathematically. Bioengineers often see tissues as engineering materials and try to evaluate their mechanical properties by relying on standard testing protocols, such as tensile testing, simple shear, torsion, etc. These processes take place in the laboratory, where a sample is cut out of a cadaver and placed into a testing machine. Of course the mechanical properties of living tissues are highly sensitive to environment and the destructive testing protocols only give a first indication of their order of magnitude.

To test them properly, non-destructively, and non-invasively, we can rely on the propagation of elastic waves. Just like a piano tuner can infer some information simply by tapping a cord while changing its state of stress, we can study the influence of pre-stress on the speed of elastic waves travelling in a soft solid. This idea forms the basis of the theory of acousto-elasticity, which can be dated back to early works of Brillouin, and has been used successfully in the past for "hard" elastic solids such as rocks and metals. With this talk we will explore its extension to "soft" elastic solids, which can be subjected to large deformations in service. We will look at theoretical, numerical, and experimental results, generated in particular on human skin and porcine brain matter.

Finally we will look at the effect of extremely large deformations on the propagation of waves: at some high level to be determined, the speed could drop to zero, signaling the onset of static wrinkles on the surface of the solid.