

**Conf. JBK@90, a Conference to Celebrate Mathematical Modelling  
on the occasion of the 90<sup>th</sup> Birthday of Joseph B. Keller**

**List of talks**

**Polarization fingerprints in the clear blue sky**

Prof. Michael Berry, Bristol University

Daylight is polarized, the strength being greatest at points in the sky at right angles to the sun, and zero at four points: above and below the sun and anti-sun. The zero-polarization points are ‘fingerprint’ singularities, around which the polarization direction makes a half-turn. Using elementary singularity theory, the polarization pattern across the whole sky can be described in a way that fits recent observations with accuracy comparable to that of conventional elaborate multiple-scattering calculations. This recent work is a contribution to a story that started in 1817 and has been central to our understanding of polarized light. There is an intriguing and controversial connection with Viking navigation.

**Dislocations in graphene**

Prof. Dr. Luis L. Bonilla, Universidad Carlos III de Madrid

Recent experiments have considered motion of dislocations (e.g., pentagon-heptagon defects in a hexagonal lattice) in suspended graphene sheets and have also revealed that the strain and rotation fields about them are qualitatively different from those provided by conventional elasticity. In two-dimensional crystal membranes such as graphene, strain and defects strongly affect electronic properties and are the subject of intensive research. Modifications of elasticity allow us to understand defects at the core of dislocations and dislocation pairs, their stability, evolution and the associated elastic fields. When coupled to stochastically flipping spins, the governing equations produce small randomly oriented ripples with wavelengths below 25 nm similar to those observed in graphene sheets.

**Time Reversal: Basics, and Flaw Identification**

Prof. Dan Givoli, Technion Israel Institute of Technology

## **Finite Element Heterogeneous Multiscale Methods for the Wave Equation**

Prof. Markus Grote, University of Basel

For limited time the propagation of waves in a highly oscillatory medium is well-described by the non-dispersive homogenized wave equation. With increasing time, however, the true solution deviates from the classical homogenization limit, as a large secondary wave train develops unexpectedly. Here, we propose a new finite element heterogeneous multiscale method (FE-HMM), which captures not only the short-time macroscale behavior of the wave field but also those secondary long-time dispersive effects.

## **Multi-scale sequence-dependent mechanics of DNA**

Prof. John H. Maddocks, EPFL

## **Hydrodynamic modelling of Faraday wave and bouncing droplet coupling**

Prof. Paul Milewski, University of Bath

Recent experiments by two groups, Yves Couder (Paris) and John Bush (MIT) have shown experimentally that droplets will bounce on the surface of a vertically vibrated bath (instead of coalescing with it), generating a Faraday-type wavefield at every bounce. From this state, a pitchfork symmetry breaking bifurcation leads to a "walking" state whereby the bouncing droplet is steadily "guided" by the self-generated wavefield - the droplet's pilot wave. Once this state is achieved a large array of interesting dynamics ensues with surprising analogies to quantum mechanical behaviour. I will present a coupled particle-fluid model that can be used to simulate the dynamics of this problem. This is joint work with John Bush, Andre Nachbin (IMPA) and Carlos Galeano (IMPA).

## **Freeform optical design**

Prof. Jacob Rubinstein, Technion Israel Institute of Technology

## **Numerical evidence for the existence of pure gravity waves in water of infinite depth**

Prof. Jean-Marc Vanden-Broeck, University College London