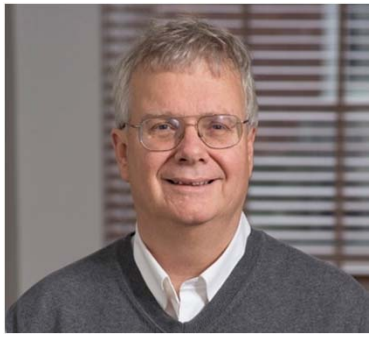
Physikalisches Festkolloquium

Universität Konstanz

celebrating
Prof. Georg Maret



Prof. Dr. David R. Nelson
Lyman Laboratory of Physics
Harvard University

Di 14.11.17
15:15 Uhr
14:45 Uhr, Kaffee/Tee
R 513
Im Anschluss Sektempfang

Perforations, curvature and thermal fluctuations in free-standing graphene

Understanding deformations of macroscopic thin plates and shells has a long and rich history, culminating with the Foeppl-von Karman equations in 1904, characterized by a dimensionless coupling constant (the "Foeppl-von Karman number") that can easily reach $vK = 10^7$ in an ordinary sheet of writing paper. However, thermal fluctuations in thin elastic membranes fundamentally alter the long wavelength physics. We discuss the remarkable properties of free-standing graphene sheets (with $vK = 10^{13}$!) at room temperature, where enhancements of the bending rigidity by factors of ~4000 compared to T = 0 values have now been observed. Thermalized elastic membranes can undergo a crumpling transition when the microscopic bending stiffness is comparable to kT. We argue that the crumpling temperature can be dramatically reduced by inserting a regular lattice of laser-cut perforations. These expectations are confirmed by extensive molecular dynamics simulations, which also reveal a remarkable "frame crumpling transition" triggered by a simple large hole inserted into a graphene sheet. We show finally that thin amorphous spherical shells with a background Gaussian curvature are inevitably (in the absence of a stabilizing pressure difference) crushed by thermal fluctuations beyond a critical size, of order 160nm for graphene at room temperature.