Master 2 internship and Ph.D. proposal

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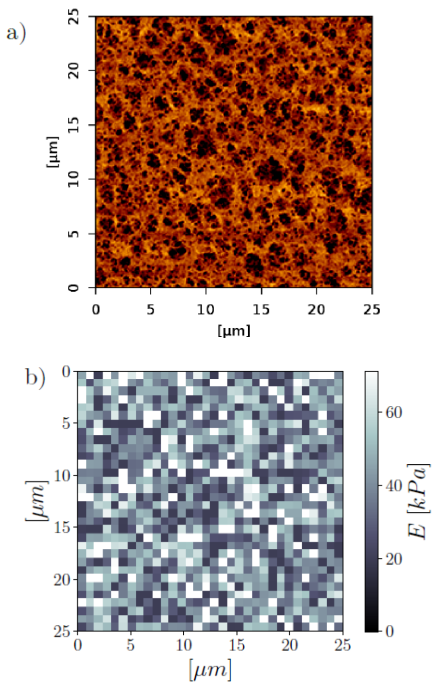
Role of frozen-in stresses on the mechanical response of colloidal gels

Colloidal gels are crucial in biological networks, cell mechanics, food science, and building materials [1]. They result from the aggregation of sub-micron particles such as polysaccharide coils, actin filaments, attractive globular proteins, or cement particles, forming a percolated network (see Fig. a) that confers solid-like properties under small deformations.



(a) Topography and (b) map of the local elastic properties of an agar gel. Results determined by atomic force microscopy.

In addition, these gels display remarkable nonlinear behavior featuring stress- or strain-stiffening and fractures before irreversible rupture [2,3]. Recent experiments have shown that the frozen-in stresses that develop during the sol-gel transition strongly impact the nonlinear response of these gels [4]. However, these internal stresses were only evidenced indirectly at the macroscale. Moreover, there is no clear link between the microscale stress heterogeneities inside a colloidal gel and its macroscopic failure time.

The internship aims to make the handshake between the frozen-in stresses at the microscopic scale and the gel nonlinear mechanical response at the macroscale. In practice, the candidate will measure the local mechanical properties of colloidal gels using atomic force microscopy and a state-of-the-art nano-indenter (Optics 11) to quantify the frozen-in stresses (Fig. b). Subsequent creep experiments with larger diameter probes (~100µm) will allow measuring the nonlinear gel response on these regions of interest and link the frozen-in stresses with the failure scenario.

Duration – 4 to 6 months at Master 2 level between February and August 2022. Possibility to apply for Ph.D. funding at the Lyon Physics & Astrophysics graduate school.

Keywords – Gels, creep, Atomic Force Microscopy, Nanoindentation, Rheology, Confocal microscopy

References

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