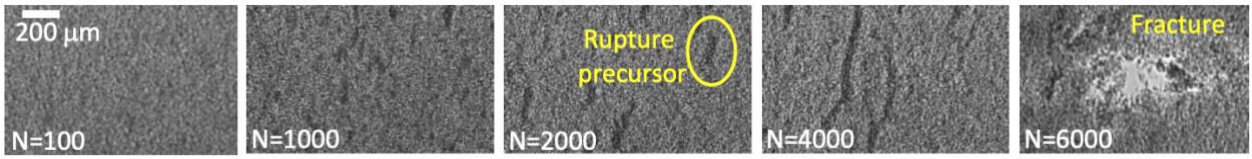
Master 2 internship and PhD position opening

Advisors: Thomas Gibaud, Thibaut Divoux & Sébastien Manneville
Location: Laboratoire de Physique, École Normale Supérieure de Lyon & CNRS, France

Rupture precursors in protein gels under fatigue

Protein gels consist of micron-sized protein assemblies dispersed in water and linked by attractive interactions into a space-spanning network of strands. Such soft solids are involved in a wide range of applications, from foodstuff to personal care and pharmaceutical products, and their mechanical resistance to an oscillatory load is key to their practical use. Despite substantial recent progress [1,2], the fundamental mechanisms underlying gel rupture remain poorly understood. **This internship aims to identify microscopic rupture precursors in protein gels thanks to experiments combining rheology and confocal microscopy under oscillatory shear or compression**. We will quantify how damage accumulates through particle rearrangements and how local variations of the protein concentration eventually lead to fracture (see preliminary images below).



Successive bright-field microscopy images of a protein gel damaged by accumulation of *N* strain oscillations of amplitude 80%.

This internship may continue with a **PhD funded by the "MICROFAT" ANR project** (2023-2027), which general goal is to characterize, model, and predict the rupture of protein gels. Our team will collaborate with (i) the SayFood research unit at AgroParisTech (Paul Menut and Cassandre Leverrier) for the design of protein gels with tunable strand structures based on milk and plant proteins, (ii) CEA Marcoule (Arnaud Poulesquen) for microstructural characterization through light and x-ray scattering, and (iii) the 3SR lab at Université Grenoble Alpes (Mehdi Bouzid) for numerical simulations.

Skills – We are looking for a candidate trained in soft matter science with a general background in physics, physical chemistry, or material sciences. Prior knowledge of rheology, microscopy, and image analysis (ImageJ, Matlab, or Python) will be a good asset. Additional experience in formulation or scattering will be appreciated.

Dates – M2 internship: 3 to 6 months between Feb. 2023 and Aug. 2023
PhD thesis: 3 years starting between Sept. 2023 and Oct. 2024 (gross salary: 2135 € per month)

Contact – The candidate will be supervised by Thomas Gibaud, Thibaut Divoux, and Sébastien Manneville at the Physics Laboratory at ENS Lyon. Please send an email to thomas.gibaud@ens-lyon.fr with your CV, a motivation letter and one or two letters of recommendation.

References

[1] S. Aime, L. Ramos, L. Cipelletti, Microscopic dynamics and failure precursors of a gel under mechanical load, *Proceedings of the National Academy of Sciences*, **115**(14), 3587-3592 (2018)
[2] T. Gibaud, T. Divoux, S. Manneville, Nonlinear mechanics of colloidal gels: creep, fatigue, and shear-induced yielding, in *Encyclopedia of Complexity and Systems Science*, Springer (2020), arXiv link