

Master 2 internship proposal

Physique et Mécanique des Milieux Hétérogènes

Contact: Philippe Marcq philippe.marcq@espci.fr
Anne Mongruel anne.mongruel@sorbonne-universite.fr

<https://blog.espci.fr/pmarcq/>

Internship location: Laboratoire PMMH, Jussieu campus
This internship can be followed by a thesis.

How do tubular stalactites form?

Tubular, or “soda straw” speleothems [1] are often observed in limestone caves (Fig. (a)), thanks to the precipitation of calcium carbonate CaCO_3 in a natural environment. However, the very long timescales involved often make their study impractical (typical growth velocity $100 \mu\text{m}\cdot\text{yr}^{-1}$!).

A much faster analogue system of stalactite formation has been designed and investigated in the lab. It uses instead a saturated solution of liquid strontium hydroxyde $\text{Sr}(\text{OH})_2$, dripping in an atmosphere containing gaseous CO_2 , and forming centimeter-scale pendant elastic shells with a tubular shape within a few hours by precipitation of solid strontium carbonate SrCO_3 at the interface with the atmosphere (Figs. (b) and (c)).

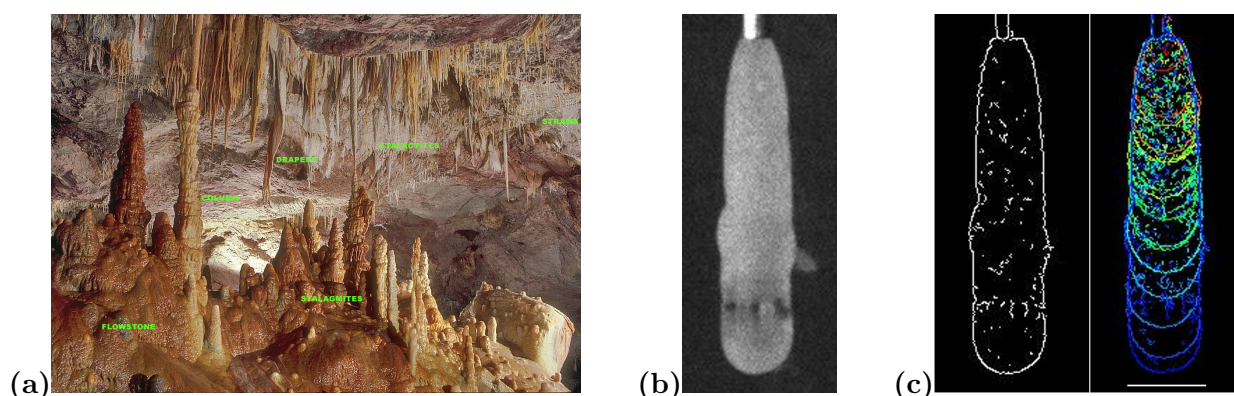


Figure: (a) Cave labeled with the six most common types of speleothems: flowstone, columns, drapery, stalagmites, stalactites and “soda straws” (Source: [Wikipedia](#)). (b) Snapshot of the dripping flow. (c) Successive segmented snapshots ($\Delta t = 13 \text{ min}$). Scale bar: 5 mm

The goal of this internship is to understand quantitatively the growth of in-lab tubular stalactites, using a combination of data analysis, analytical and numerical tools.

Two broad research questions may be considered, depending on the intern’s interests and preferences:

- what determines the shape of the pendant elastic shells?
- what determines their growth velocity?

as a function of relevant physical parameters: injection flow, injection needle diameter, CO_2 concentration, CO_2 diffusion constant, strontium hydroxyde viscosity, strontium carbonate stiffness, etc.

[1] National Speleological Society’s web page on [soda straws](#)

Expected skills: The project requires both analytical and computational skills, as well as a strong desire to collaborate with experimentalists.