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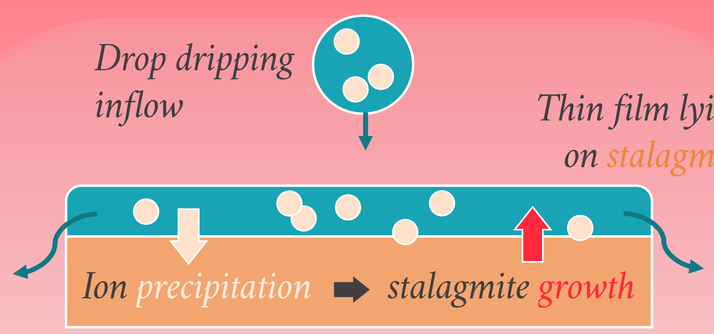
Gravity-driven drainage of a thin film on a stalagmite

Context



- Film **drainage** ➡ influence on ion distribution?
- Stalagmite growth reconstruction models: film drainage not considered
- Various stalagmite shapes ➡ drainage regimes?

Experiments

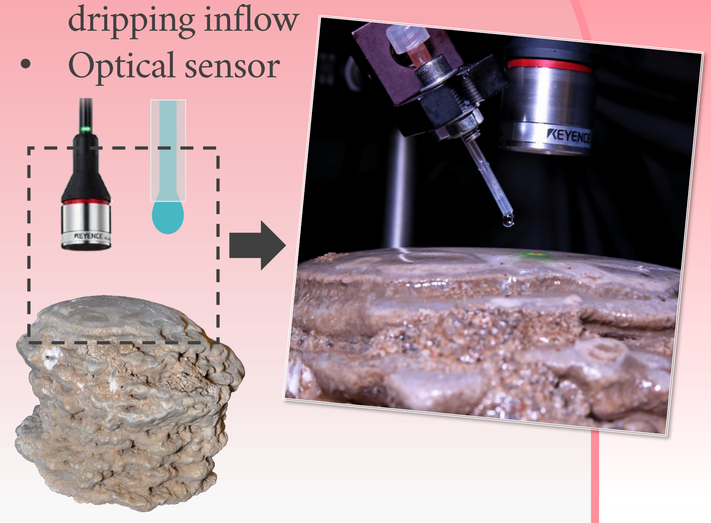
Caves

- Dripping inflow interruption
- Dial gauge measurements

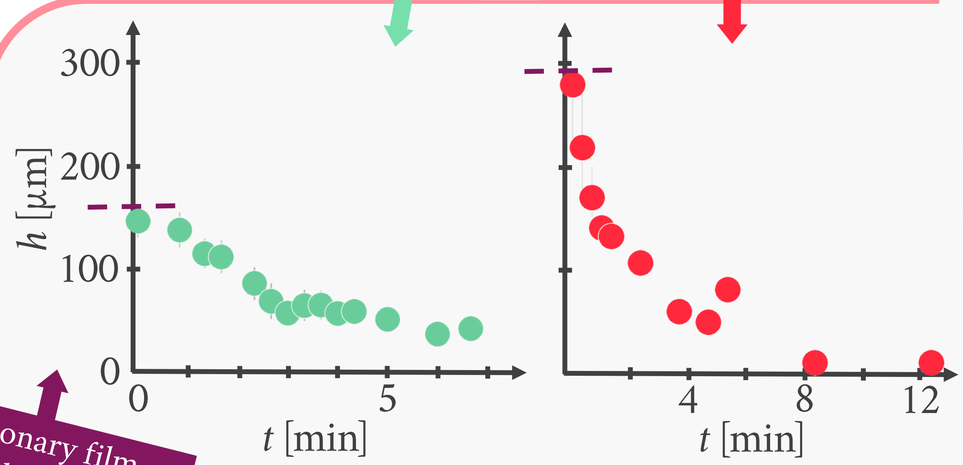
- Stalagmite shape variability
- Dripping inflow variability

Lab

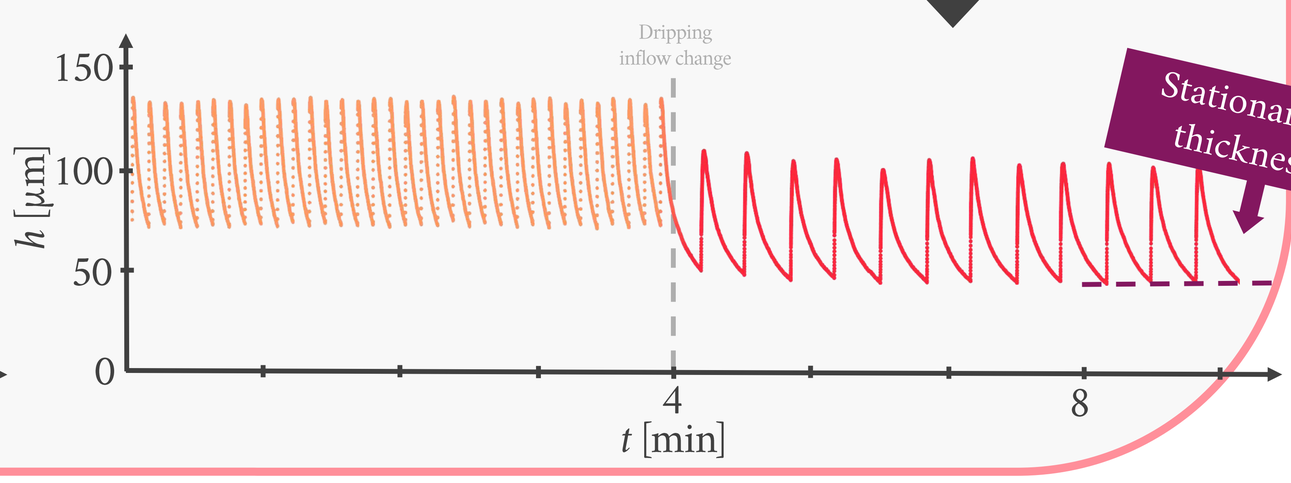
- Recording with or without dripping inflow
- Optical sensor



- Fixed stalagmite shape
- Dripping inflow variability



Stationary film thickness h_s



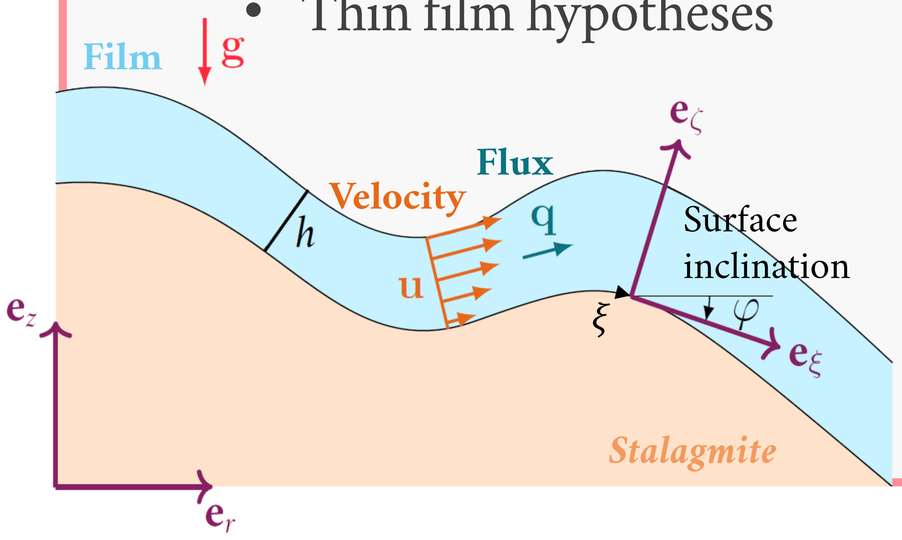
Stationary film thickness h_s

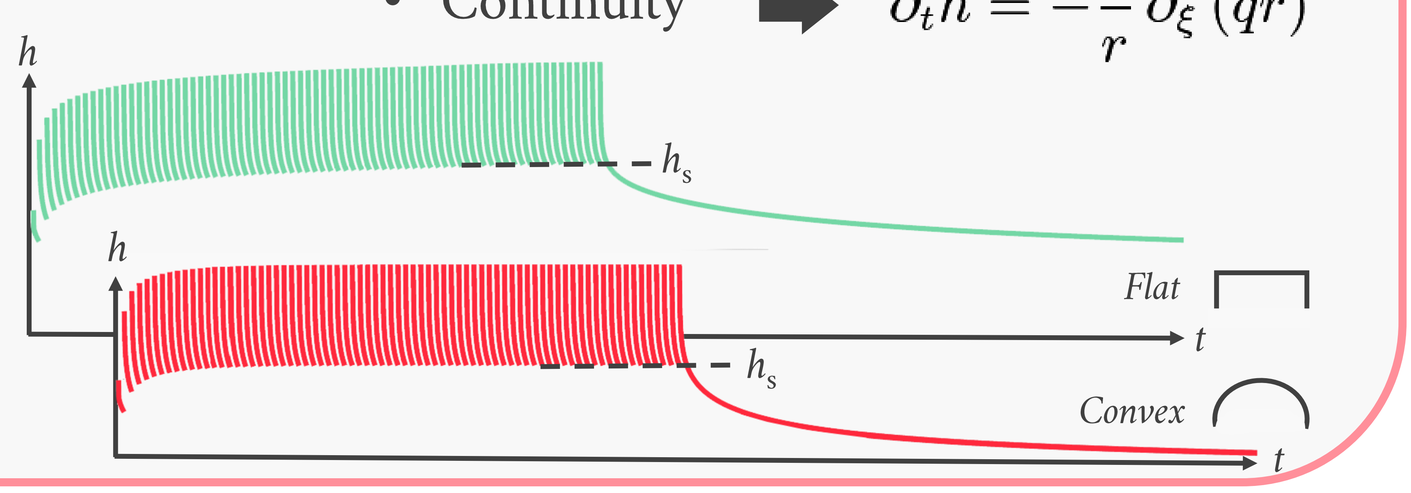
Modelling and numerical resolution

- Navier-Stokes momentum
- Axisymmetric coordinates
- Thin film hypotheses

➡ $$q = \int_0^h u \, \mathrm{d}\zeta = \frac{-gh^3}{3\nu} \left[(\partial_\xi h) \cos\varphi - \sin\varphi \right]$$

- Continuity ➡ $$\partial_t h = -\frac{1}{r} \partial_\xi (qr)$$





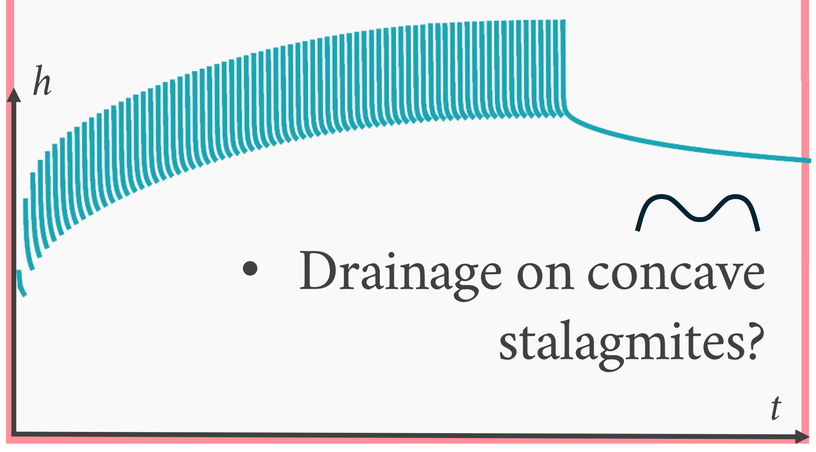
Two drainage regimes

Stalagmite shape	Dominating mechanism	Stationary film thickness
Flat	*Film thickness gradients*	$h_s \sim t_0^{-1/4} \times r_{sm}^{1/4}$
Convex	*Surface inclination*	$h_s \sim t_0^{-1/3} \times f(\xi, \varphi)$

t_0 drop dripping period
r_{sm} stalagmite radius

Future work

- Film drainage and ion precipitation competing effects on stalagmite growth?



- Drainage on concave stalagmites?

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Supplemental Material available online

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