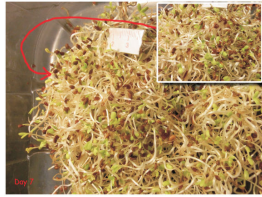
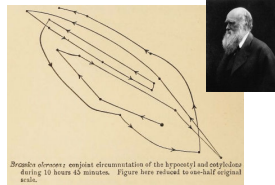


Motivation

“The power of movements in plants”
C. Darwin and F. Darwin, 1880

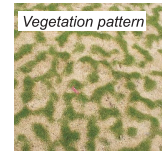


... lead to **self-organization?**

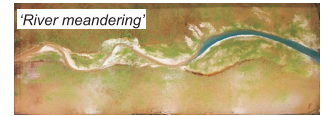


Shaded arrows: empirical reconstruction of the hypocotyl and cotyledon during 10 hours 45 minutes. Figure here reduced to one-half original width.

... lead to **environmental adaptation?**



J. von Hardenberg, et al., RPL (2001)



C. A. Braudrick, et al., PNAS (2009)

How does the **power...**

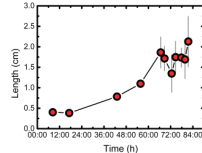
from Kitchen



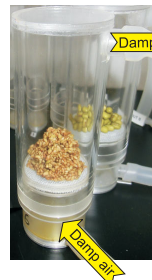
* We acknowledge Nian Chang for guidance and collecting the first data.

Essential for sprouting?

Water	✓
Temperature	✓
Light	✗
Soil	✗
Gravity	?



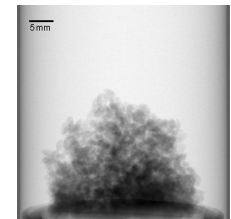
to Laboratory



X-Ray tomography

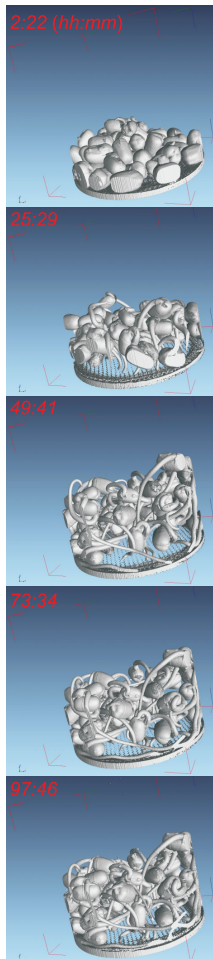


voxel size: ~ 2 μm
scan time: ~ 10 min

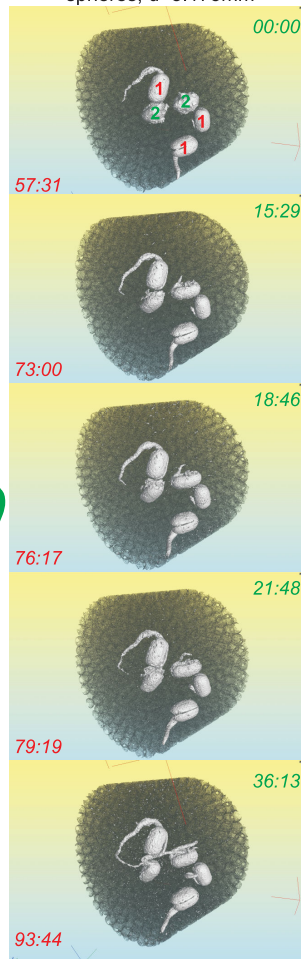


3D Reconstruction

Mung bean (*Vigna radiata*)
in Free space



in PTFE (Teflon) spheres, d=3.175mm

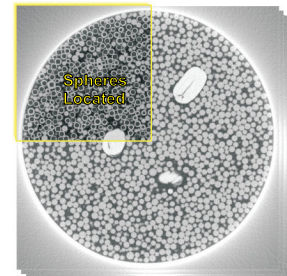


in Polypropylene (PP) spheres, d ~1mm

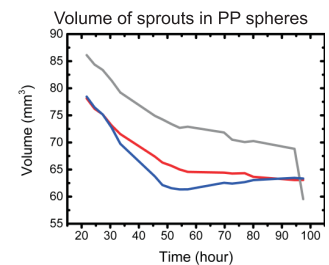


Qualitatively, the length growing rate of radicle **decreases** as the local packing density increases.

Image processing



Raw slices ⇒ Global + local thresholding ⇒ Binarize volume data
⇒ Separate { Spheres ⇒ positions ⇒ Local packing
Sprouts ⇒ morphology



Length grows, but **volume decreases**.

Outlook

Self-organized sprouts:
Network structure, curvature, length

Embedded sprouts:
Influence from local sphere packing

Mechanisms behind the dynamics:
Humidity? Local stress?
Temperature? Sunlight? ...

309:22