



Tissue growth couples temporal and spatial fluctuations

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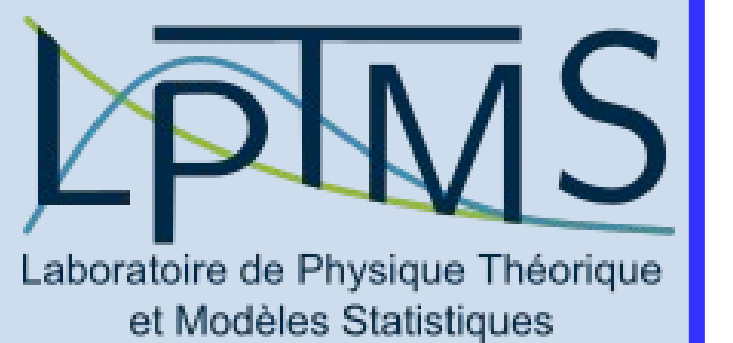
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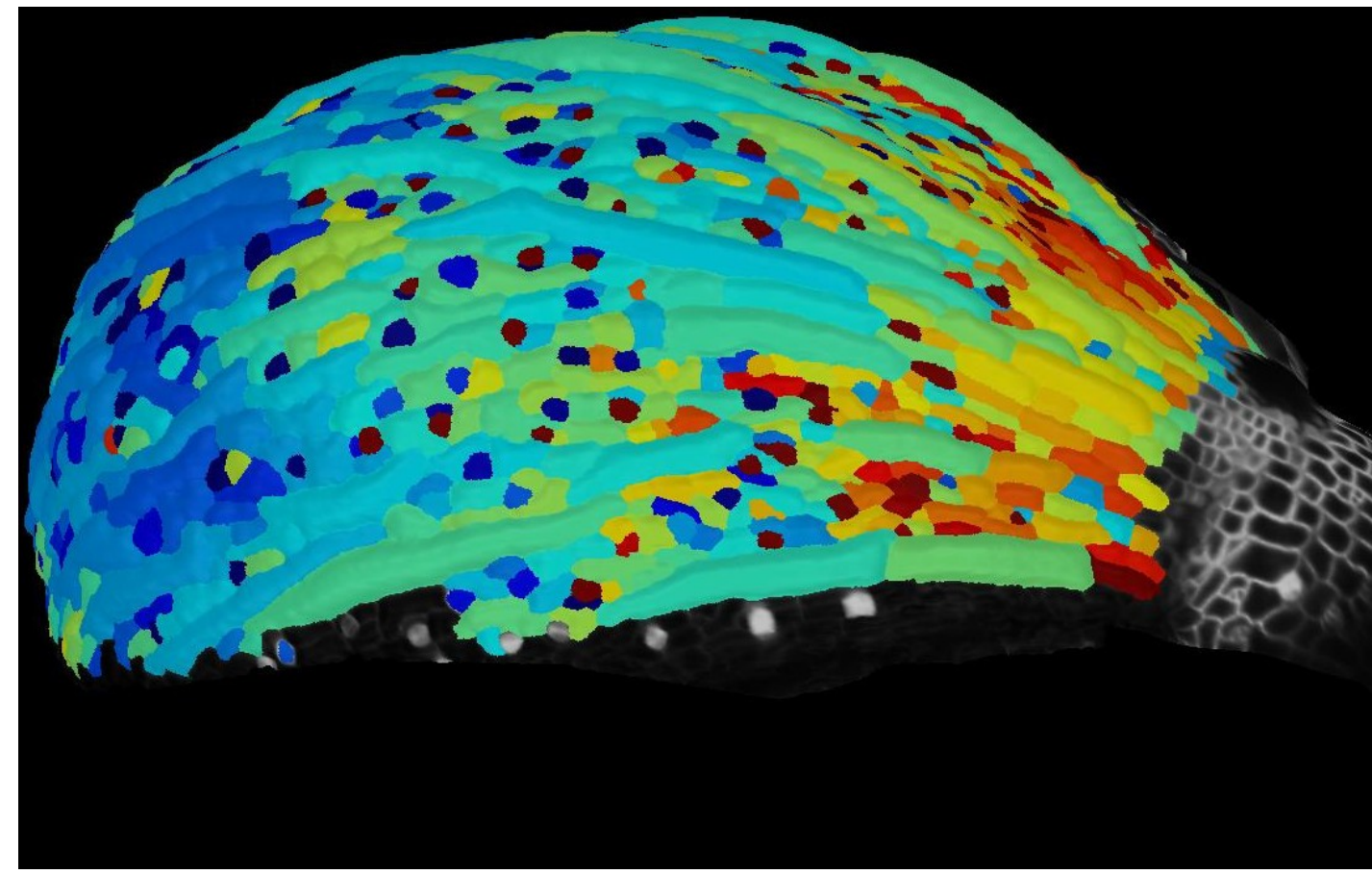
Tissue growth couples temporal and spatial fluctuations

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Cellular variability v.s. organ robustness



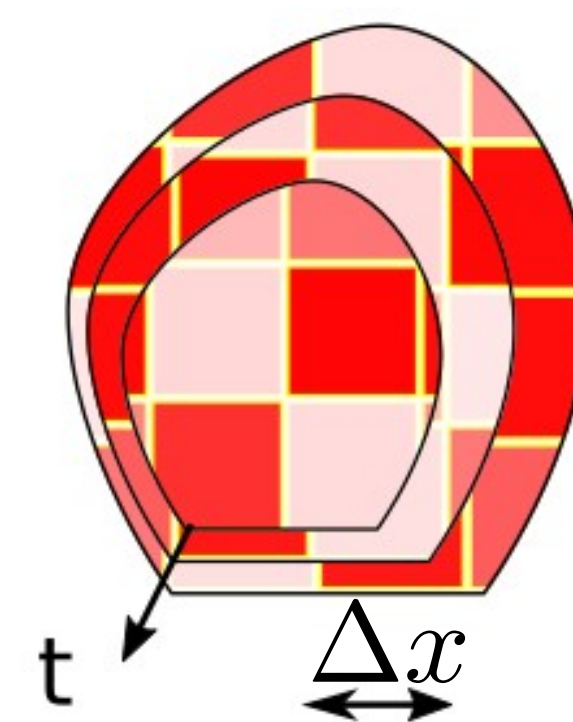
Cell growth is heterogeneous in space and time.

→ how to grow robust organ shapes ?

cellular variability
↕
robust organ shapes

Spatiotemporal averaging

Morphogenesis sums growth over space & time



growth
spatiotemporal averaging
↓ Law of large numbers
robust organ size/shape

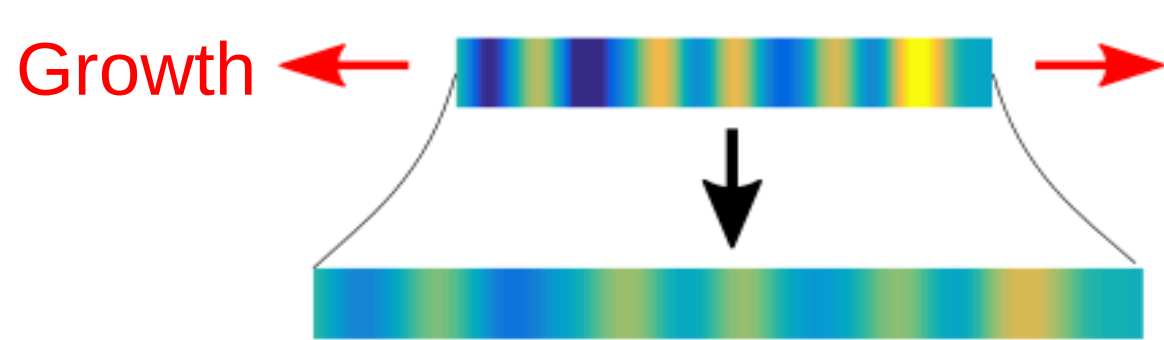
e.g. area increase:

$$\Delta A \simeq t \langle \gamma \rangle A \pm \Delta \gamma \sqrt{\frac{At \Delta t}{\Delta x^2}}$$

Δx , fluctuations' spatial extend
 $1/\Delta t$, fluctuations' renewal rate

But, are growth fluctuations stretched toward large space scales ?

Growth + time persistence = fluctuation stretching



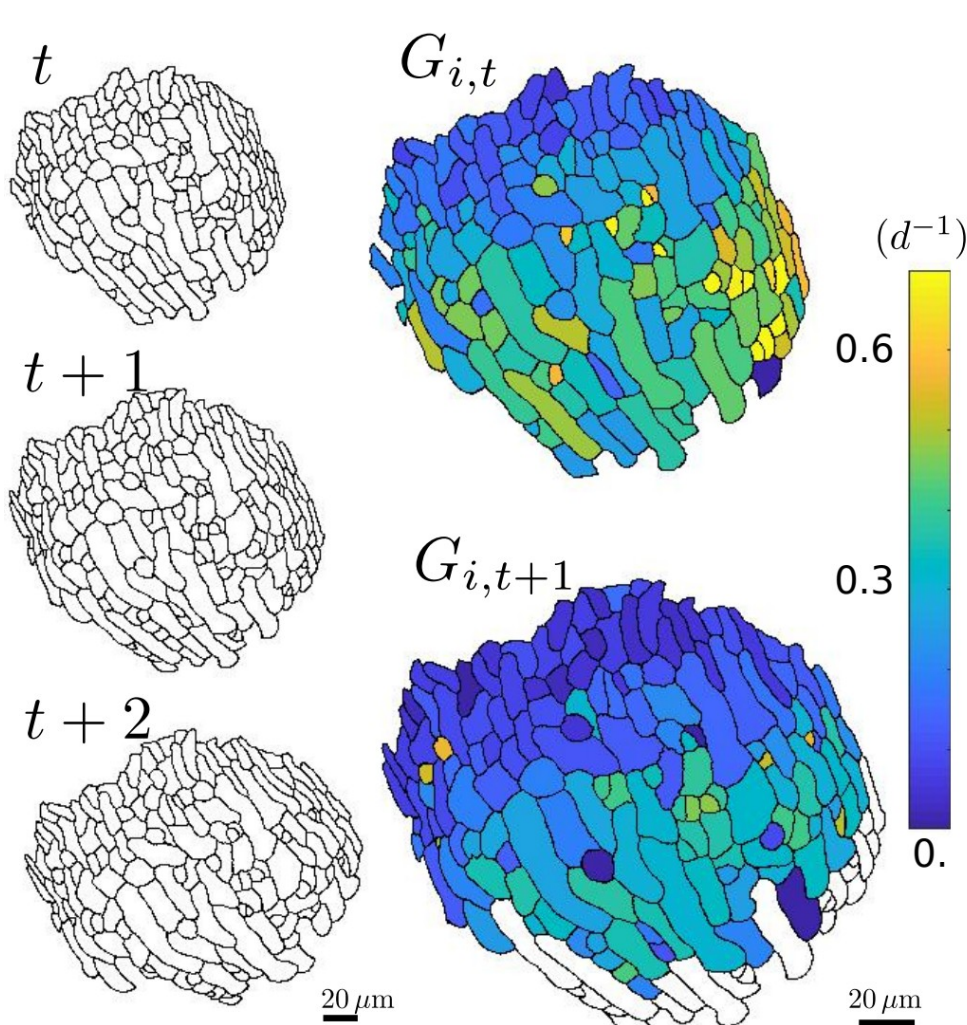
→ Enlargement of fluctuation's space scale

Consequences on morphogenesis

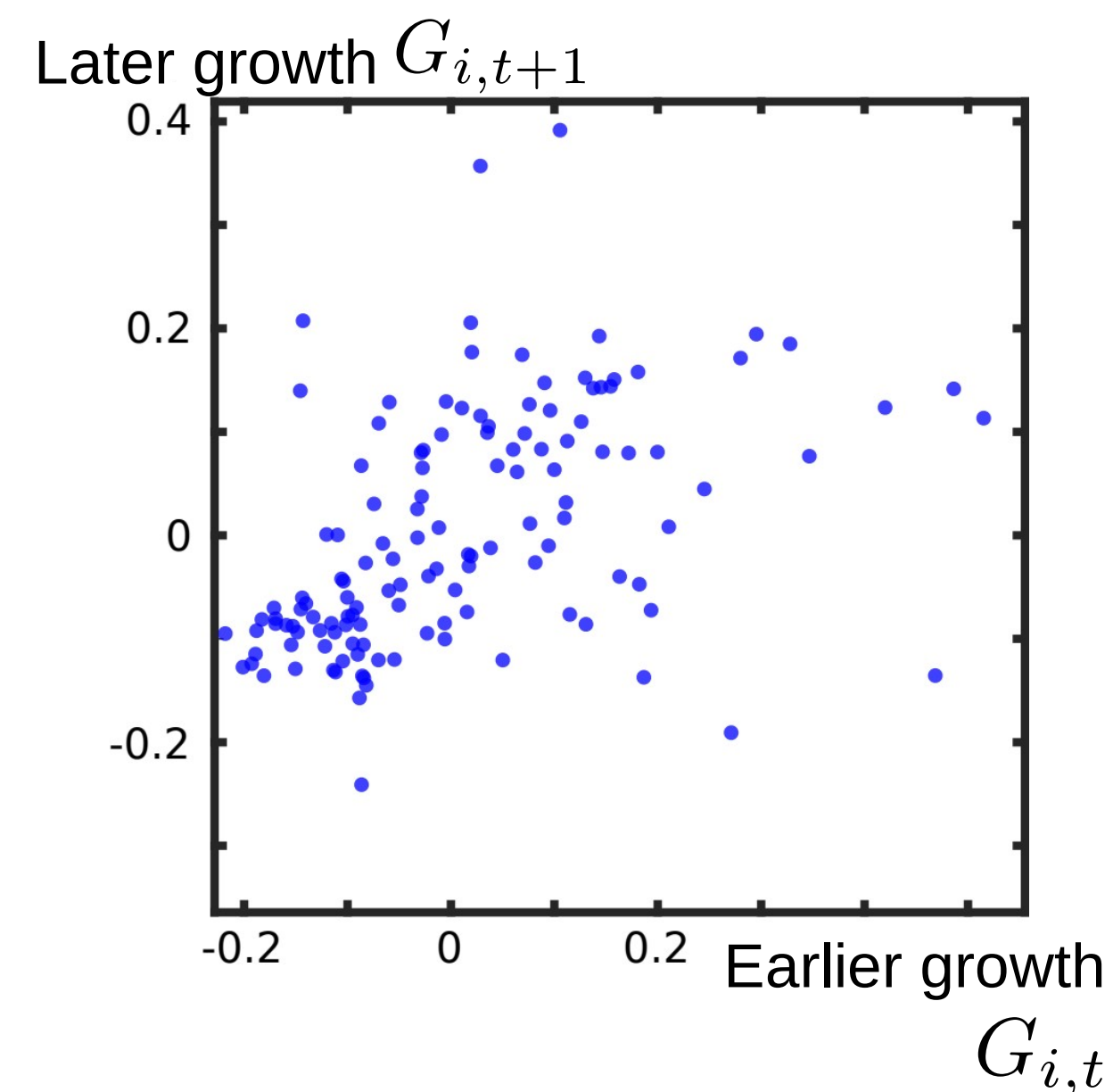
- Spatiotemporal averaging to be reconsidered
- Coupling between level of growth, and growth fluctuations' renewal rate & spatial extend

Assessing growth time variability

Cells' areal growth rate



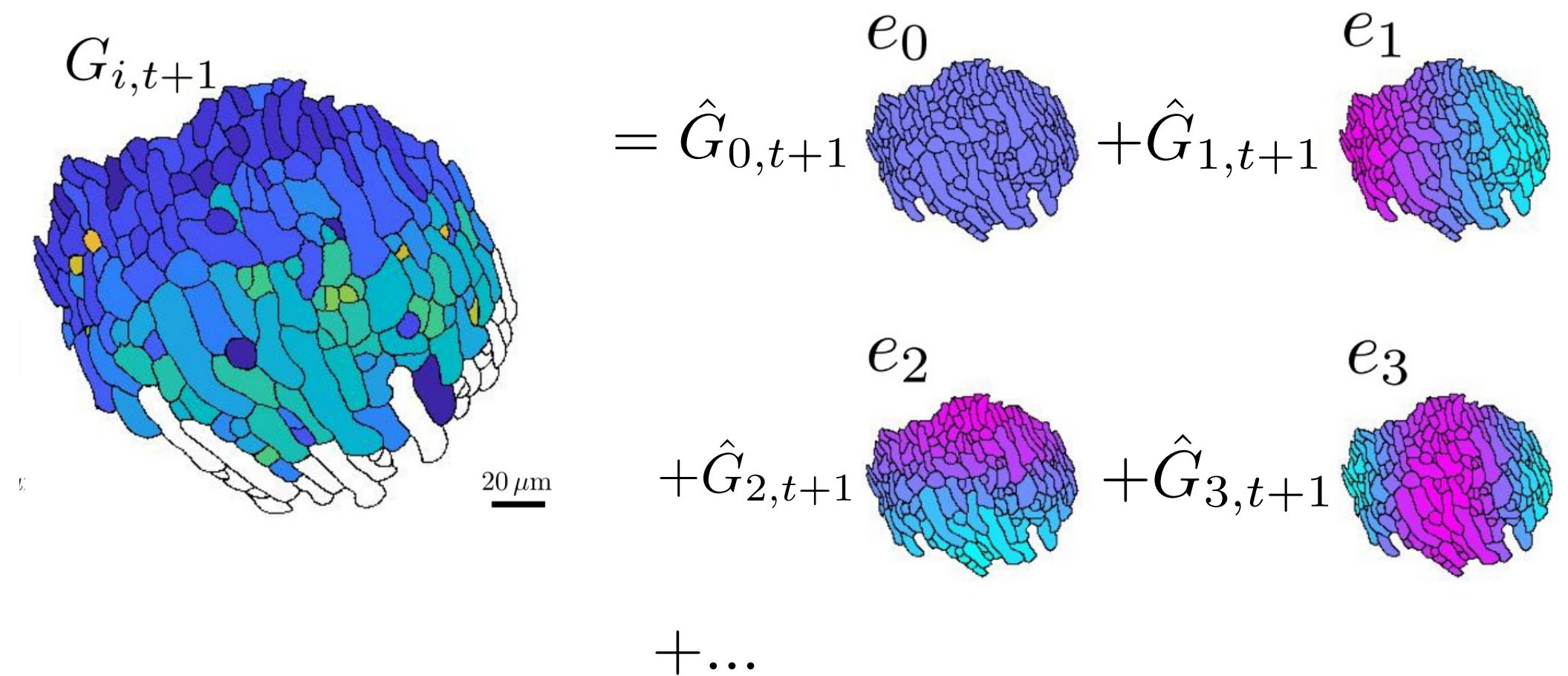
Time correlation



→ Γ_t , time correlation coefficient

Assessing growth space variability

Harmonic decomposition of growth space variations



- $\bar{G}_t$, tissue's growth rate
- ΔG_t , amplitude of growth fluctuations
- α_t , space correlation exponent

Data statistics

Data sets

Lighting condition 1

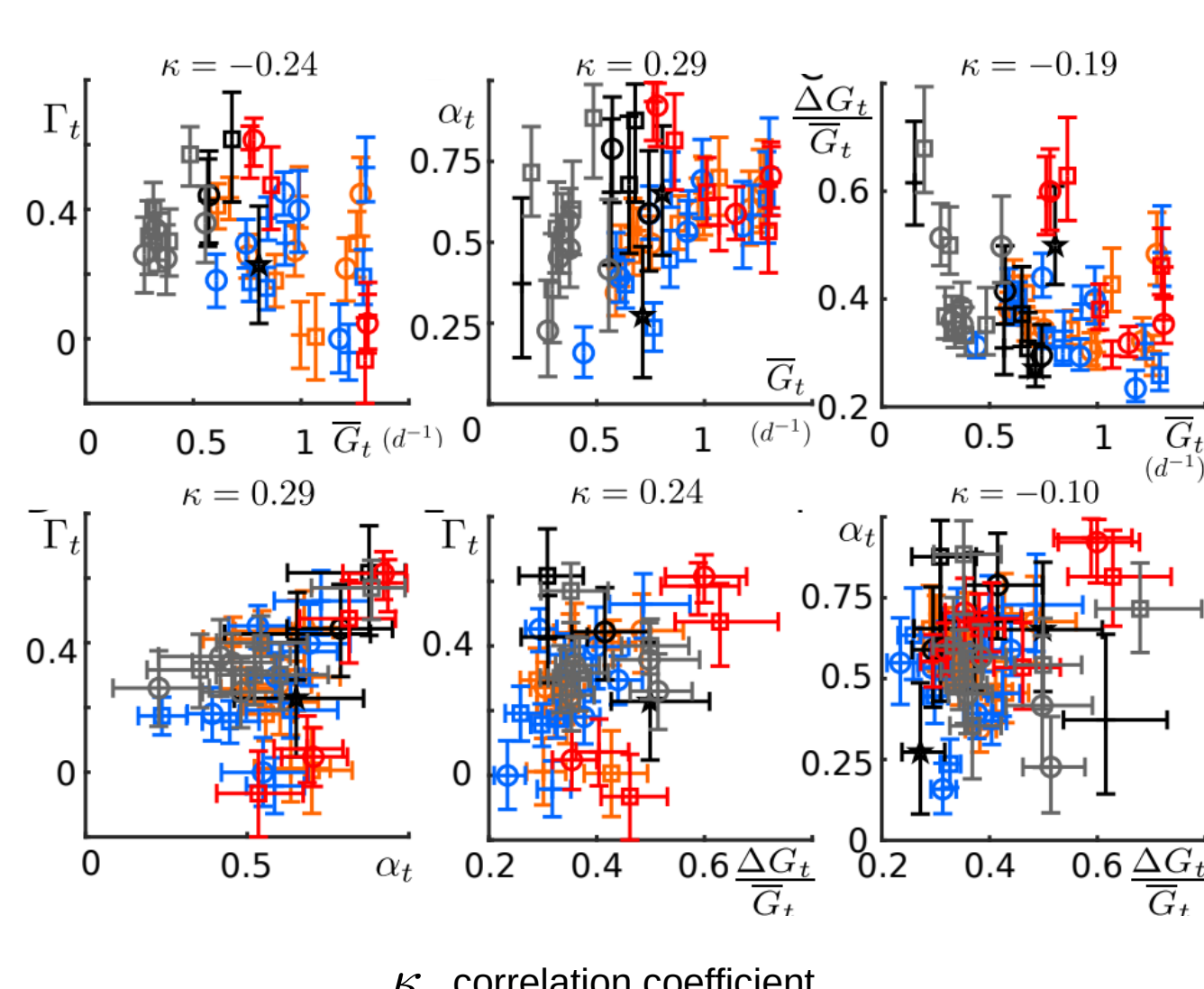
WT: a b c d
spr2: a b c
mad5: a b c
bot1: a b c

Cell wall mutants

Lighting condition 2

WT: a b
Distinct tissues followed in time

Generic correlation analysis



→ no clear pairwise correlations among growth parameters

Testing fluctuation stretching

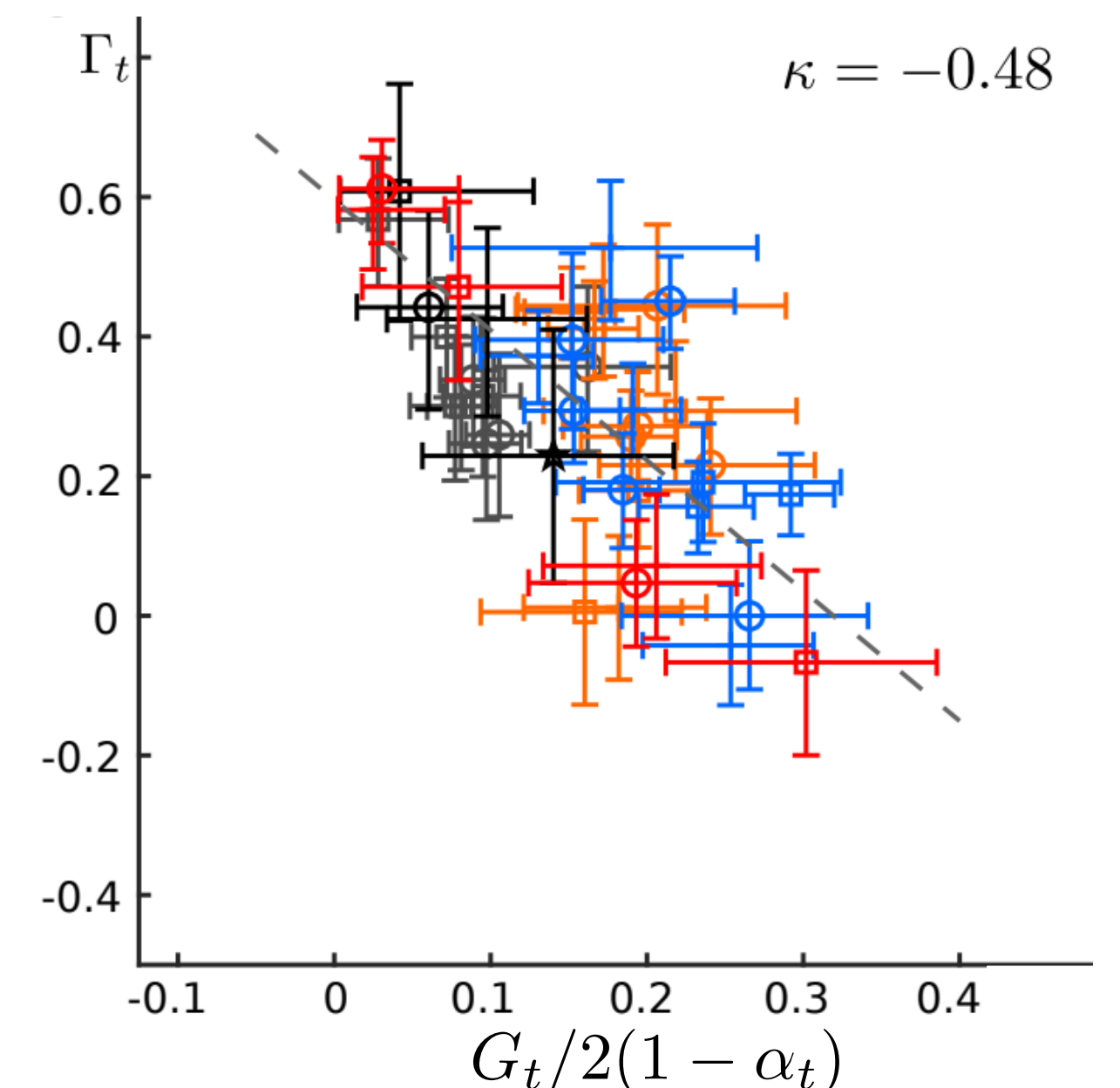
In theory

- $\bar{G}_t$, tissue's growth
- α_t , space correlation



induced renewal rate :
 $1/\Delta t = G_t/2(1 - \alpha_t)$

Time correlation v.s. renewal rate



→ evidence for fluctuation stretching

Results :

- quantification of space & time variability
- coupling between level of growth and its space & time variability
- evidence for fluctuation stretching

Perspectives :

- Considering different tissue types
- Compare plant & animal tissues
- Limiting scale ?