Interactions hyphae/apex of the filamentous fungus *Podospora anserina.*

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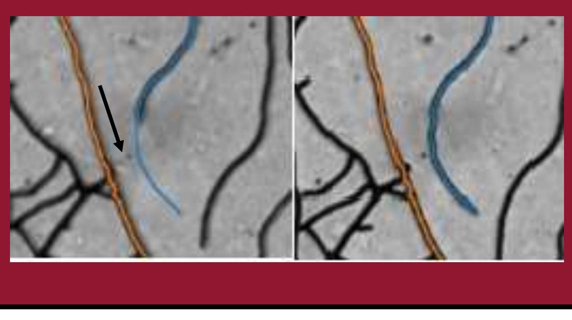
ABSTRACT

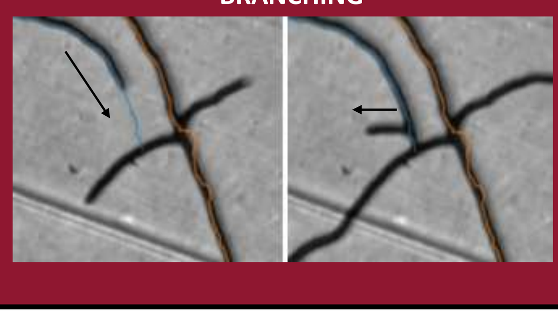
During their growth, fungi can create very dense and complex networks. In this work, we exploit the digital reconstruction of the mycelial network of *Podospora anserina* to analyze some of the typical behaviours of a free tip approaching a pre-existent hypha (obstacle) . The aim of the work is to catalogue the different behaviours and collect datas to eventually spot the existence of correlations among the typical parameters of the processes, to characterize its behaviour.

TYPE OF BEHAVIOURS

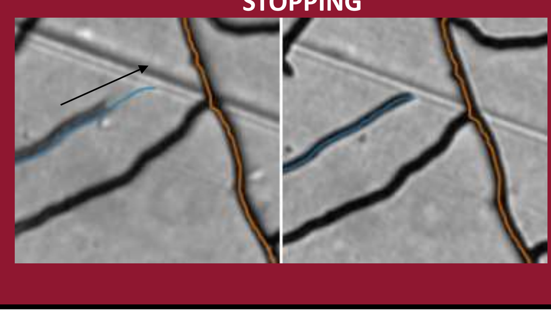
AVOIDMENT



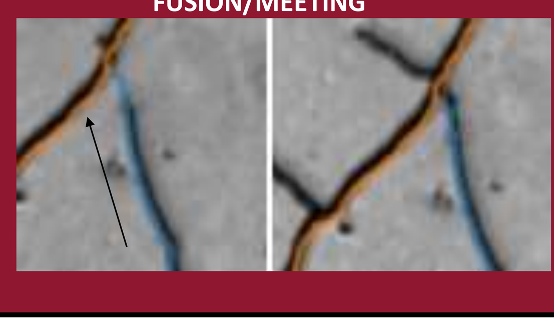
FUSION + MEETING INDUCED BRANCHING



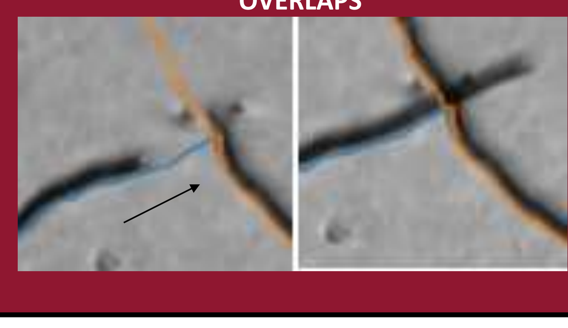
STOPPING



FUSION/MEETING



OVERLAPS



AVOIDMENT ANALYSIS

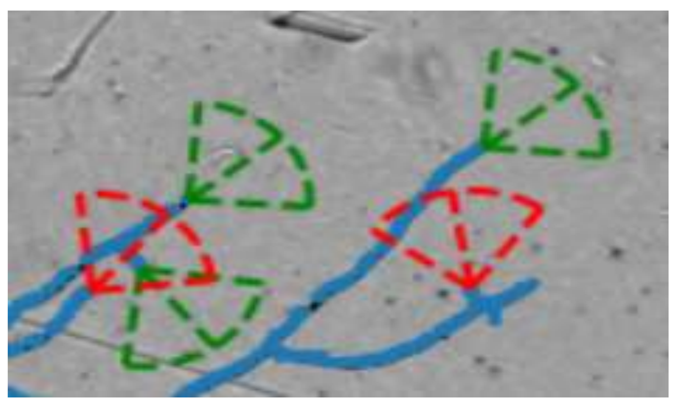
By simple observation of the branch we notice that there is some interaction among hyphaes for which they attract or repel each other. The aim of this section is to understand if there is an attraction law, and it case it exists, study its propierties.

Avoidment is sum of two evenements :

- speed of branch changes orientation of θ_{speed} (speed re – orientation)
- during branch re-orientation obstacle is present

1. Obstacles' definition

- Vision cone for all branches at all instants
- If a branch is in vision cone it's an *obstacle*
- Vision cone parameters :
  - r_{min} radius of the cone
  - α width of the cone



RED → OBSTACLE
GREEN → FREE

2. Speed re-orientation

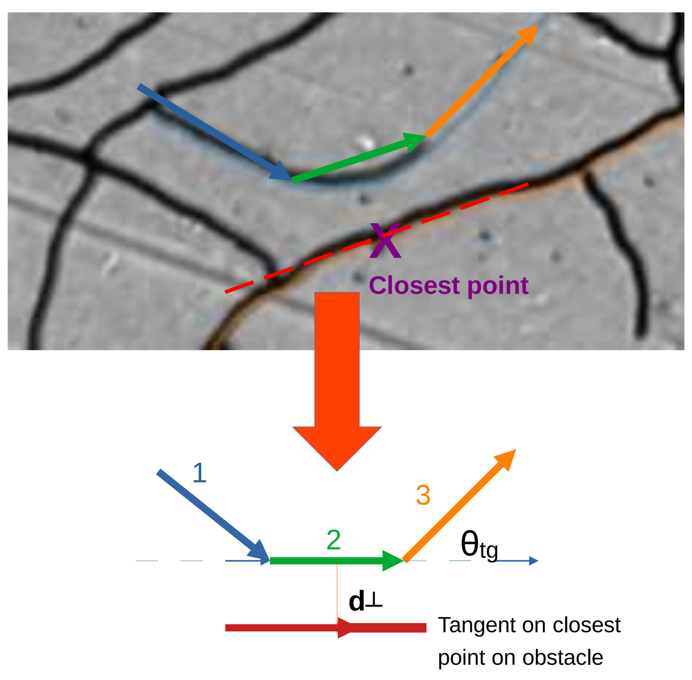
« Curve » divided into 3 instants :

We say there is a speed re-orientation when vector 1 makes an angle of $\boldsymbol{\theta_{speed}}$ with vector 2 or vector 3.

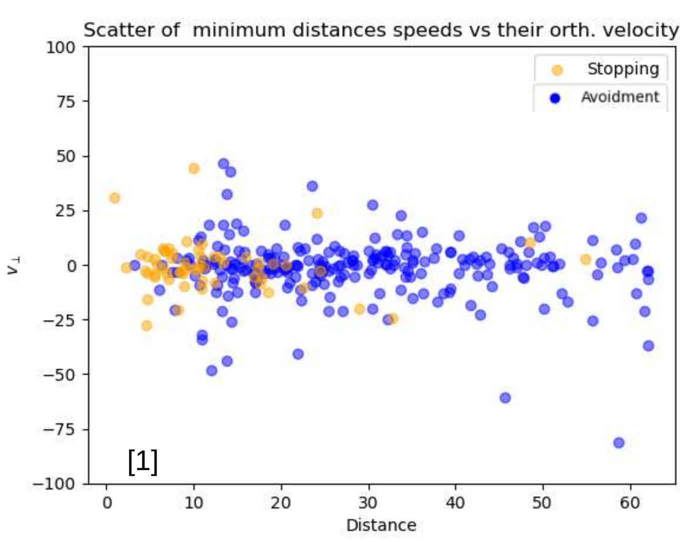
Find the couple of nodes on branch and obstacle whose distance is minimal ($\mathbf{d}_\perp$).

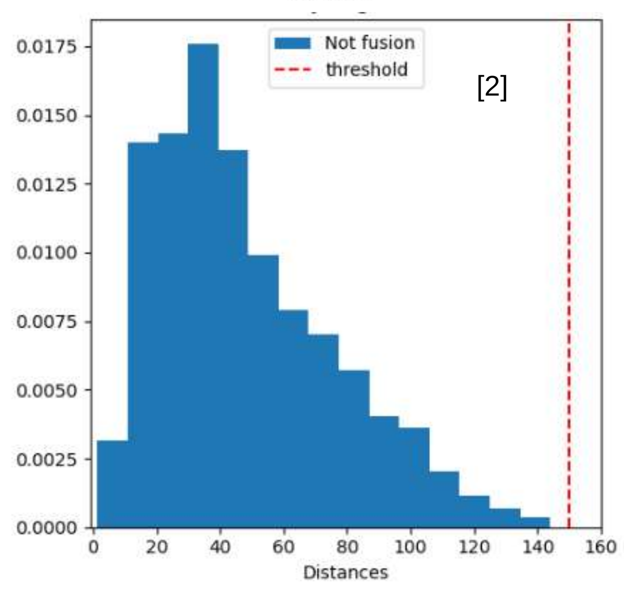
Calculate tangent on obstacle on closest point
Collect for each branch – obstacle :

- $\mathbf{d}_\perp$ minimum distance branch – obstacle
- $\boldsymbol{\theta_{tg}}$ **(t)** angle between speed vector and tangent.
- $\mathbf{v}_\perp$, $\mathbf{v}_{par}$ components of speed vector WRT tangent.



3. Results





- Of all re-oriented branches :
- 58% of re-oriented branches, is re-oriented because of an obstacle.
- 15 % is lost for datation errors
- 17 % of branches are born from obstacles so exclued.
- So true spontaneous re-orientation is 10 % only.

- [1] Separation between the minimum $\mathbf{d}_\perp$ if the branch stops or if it avoids it.
- In [2], using as r_{min} a big value of 150 *pixels* , get $\mathbf{d}_\perp$ for avoiding + stopping branches (not fusion).
- Closest obstacles' distances distibutions suggest that a value of rmin ≈ 100 pixels is a good parameter to define an obstacle.

MEETING INDUCED BRANCHINGS

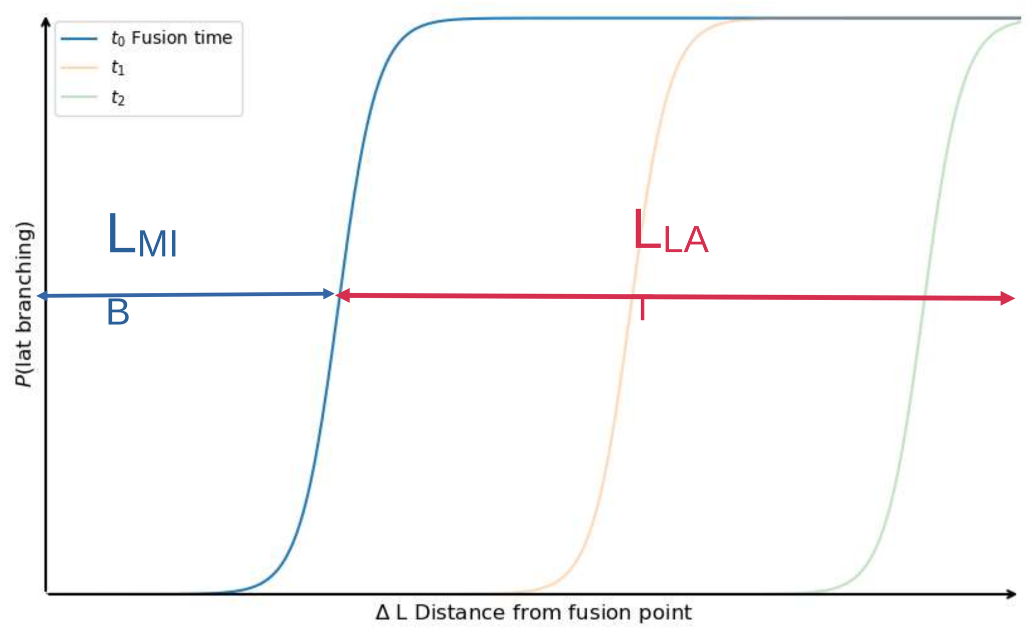
By « *Meeting Induced Branhcings* » we refer to the phenomena where a growing branch (*mother*) encounters a pre-existent branch and after their meeting a new branch (*son*) starts growing from the mother. Is this behaviour a typical branching process or is it a different process ?

MIB RECOGNITION & DATA ANALYSIS

We assume :

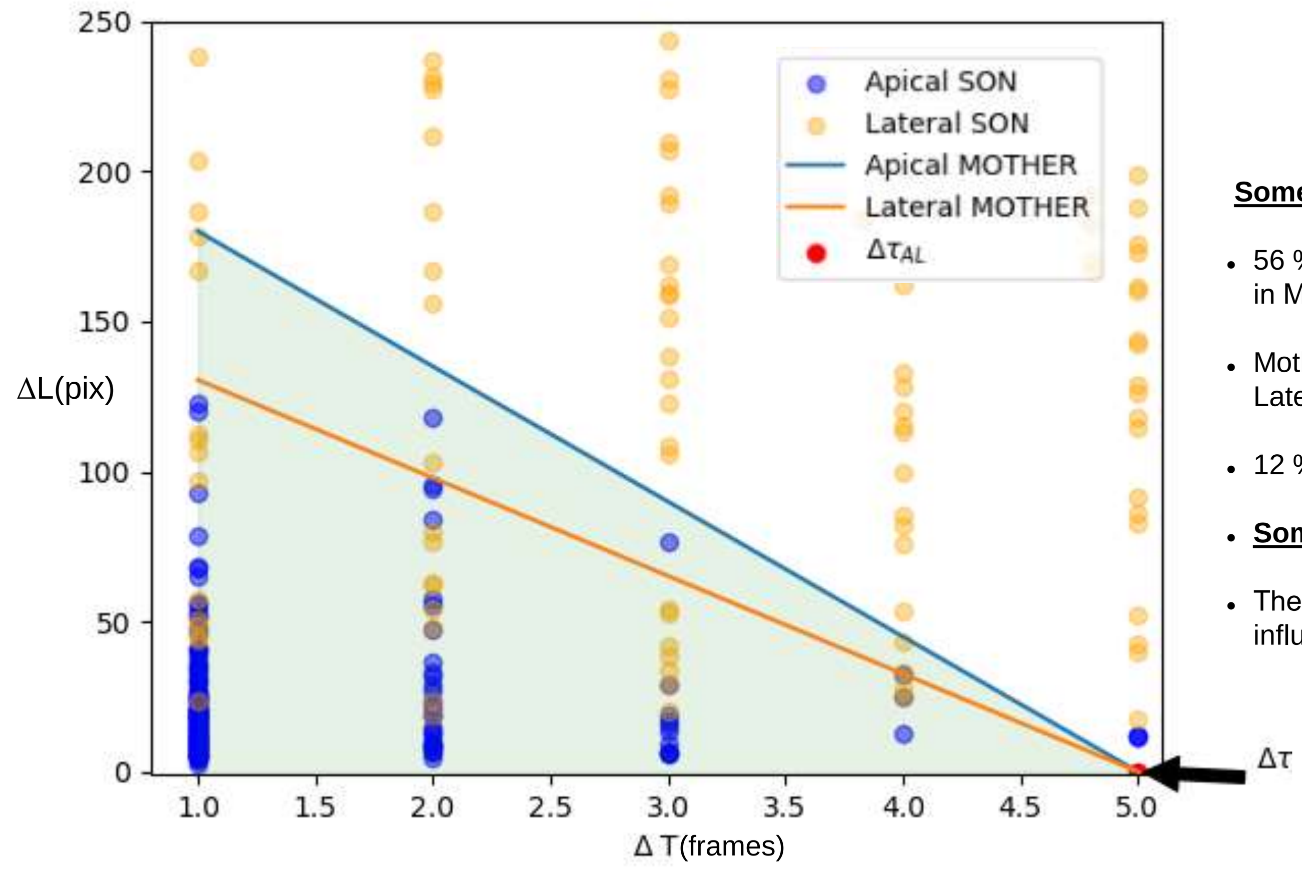
- If $\Delta t_{start} \leq \Delta\tau_{AL} \rightarrow APICAL$
- If $\Delta t_{start} > \Delta\tau_{AL} \rightarrow LATERAL$

- different speed ($\mathbf{v_{lat}}$ and $\mathbf{v_{ap}}$)
- latency time $\Delta\tau_{AL}$
- uniform growth speed ⟶ before that time we can't have lateral branchings
- No apical sons after fusion
- Only first in space and time occurrencies
- MIBs can only appear in the region of the phase diagram ΔT *vs* ΔL delimited by : $L_{MIB}(iT) = V_{AP/LAT}\,(\Delta\tau_{AL} - iT)$



- After fusion « normal » Lateral branches only in L_{LAT} region
- &
  - no « normal » apical sons

Branches living in L_{MIB} region **COME FROM A DIFFERENT BRANCHING PROCESS !**



= MIB REGION

Some number :

- 56 % of branches born after fusion live in MIBs' region .
- Mothers are in equal proportions Lateral or Apical
- 12 % of MIBs are lateral
- **Some comment :**
- The nature of the mother doens't influence the presence of MIB

Conclusion:

We have catalogued the different behaviours of a tip interacting with another hypha, and for each behaviour we collected the relative data of speeds, distances and angles that characterize the phenomena. The datas have been collected through different algoritms that identify the branches of intrest (filtering according to the behaviour of intrest) and their relative obstacles.

The obstained datas are still very noisy due to impurities present on the pictures, to network reconstruction issued and inaccuracy of the filtrages applied. The answers to the questions we were addressing at the beginning are still not definitive at the moment even though observations suggest the existance of phenomenas.

Better filtrage algorithms will help to clean data from noise and give more certain conclusions.