

Kinetics of Cell Sorting

Lidune Kampschöer, Wout Hartel | Leiden



**Universiteit
Leiden**
The Netherlands

Index

1. Article 1: Kinetics of the cellular Potts model revisited (by Nakajima and Ishihara)
2. Article 2: Cell Sorting in Three Dimensions (by Hutson, Brodland, Yang and Viens)
3. Conclusion

Article 1

- Kinetics cell sorting are studied with Cellular Potts Model (CPM)

- Reminder: CPM based on minimizing the effective energy:

$$\mathcal{H}_{\text{CPM}} = \sum_{\langle ii' \rangle} J_{\tau\tau'}(1 - \delta_{\sigma\sigma'}) + \frac{K_v}{2} \sum_{\sigma} (V_{\sigma} - V_0)^2 + \frac{K_l}{2} \sum_{\sigma} (L_{\sigma} - L_0)^2.$$

- Goal: Investigate the speed of kinetics of cell sorting
- Two quantities of the kinetics of growth process: Domain boundary length and domain size
- Two cases are studied: Even mixture (50:50) and uneven mixture (20:80)

Article 1

- **Results:**

- Even mixture: (50:50)

- Interconnected structures
- Kinetics: Smoothing the interface
- Process obeys power-law growth

- Uneven mixture: (20:80)

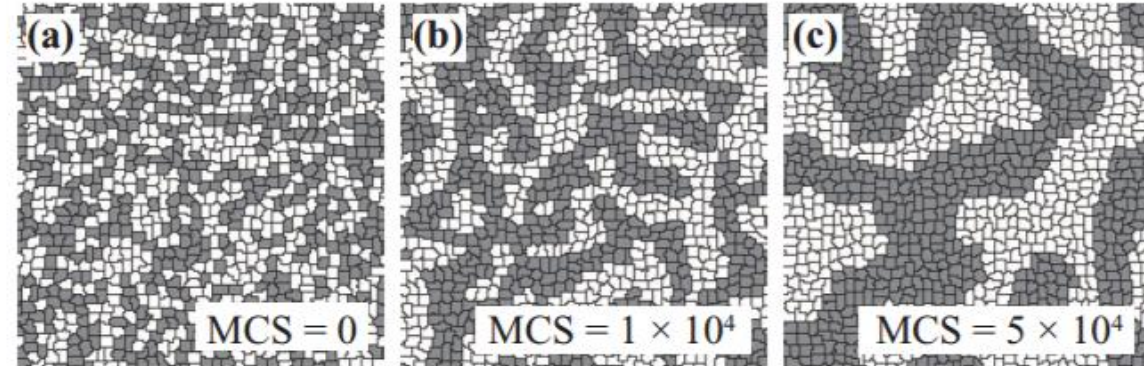
- Circular shapes
- Kinetics: Diffusion
- Process obeys power-law growth

- **Conclusion:**

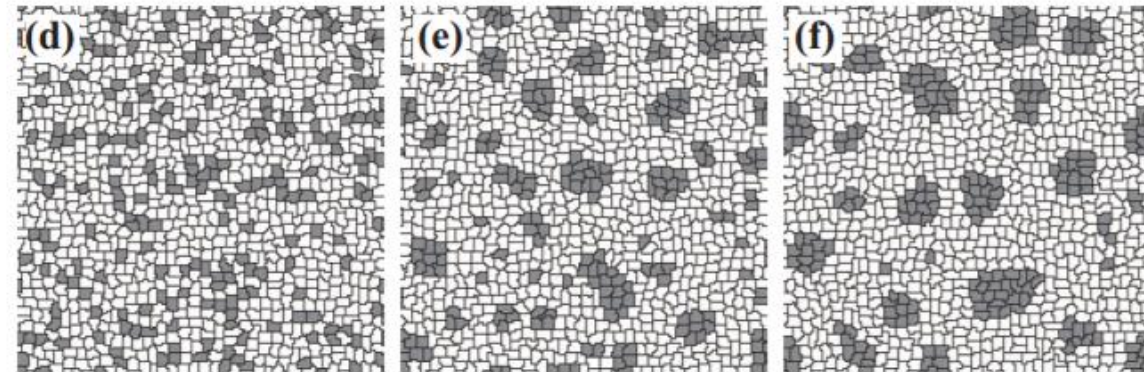
The CPM cell sorting obeys power law (other articles: log)

Even mixture:

Example:



Uneven mixture:

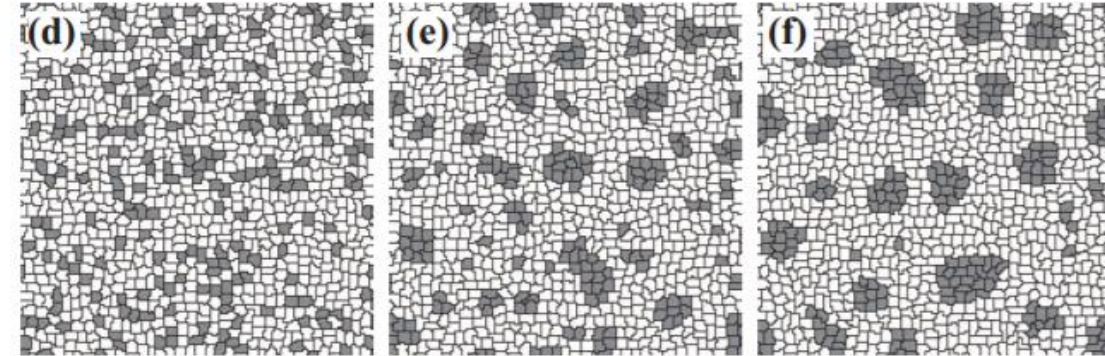


$$J_{++} = J_{--} = -0.05$$

$$J_{+-} = J_{-+} = +0.05$$

Article 2

- Goal: Discuss kinetics of cell sorting in 3D
- Types of kinetics in 3D:
 - Fluctuation (diffusion/coalescence)
 - Untangling (not in 2D)
- Two models that examine 3D cell sorting:
 - 3D CPM: covers fluctuation and untangling
 - Finite-Element method (FEM): covers only untangling



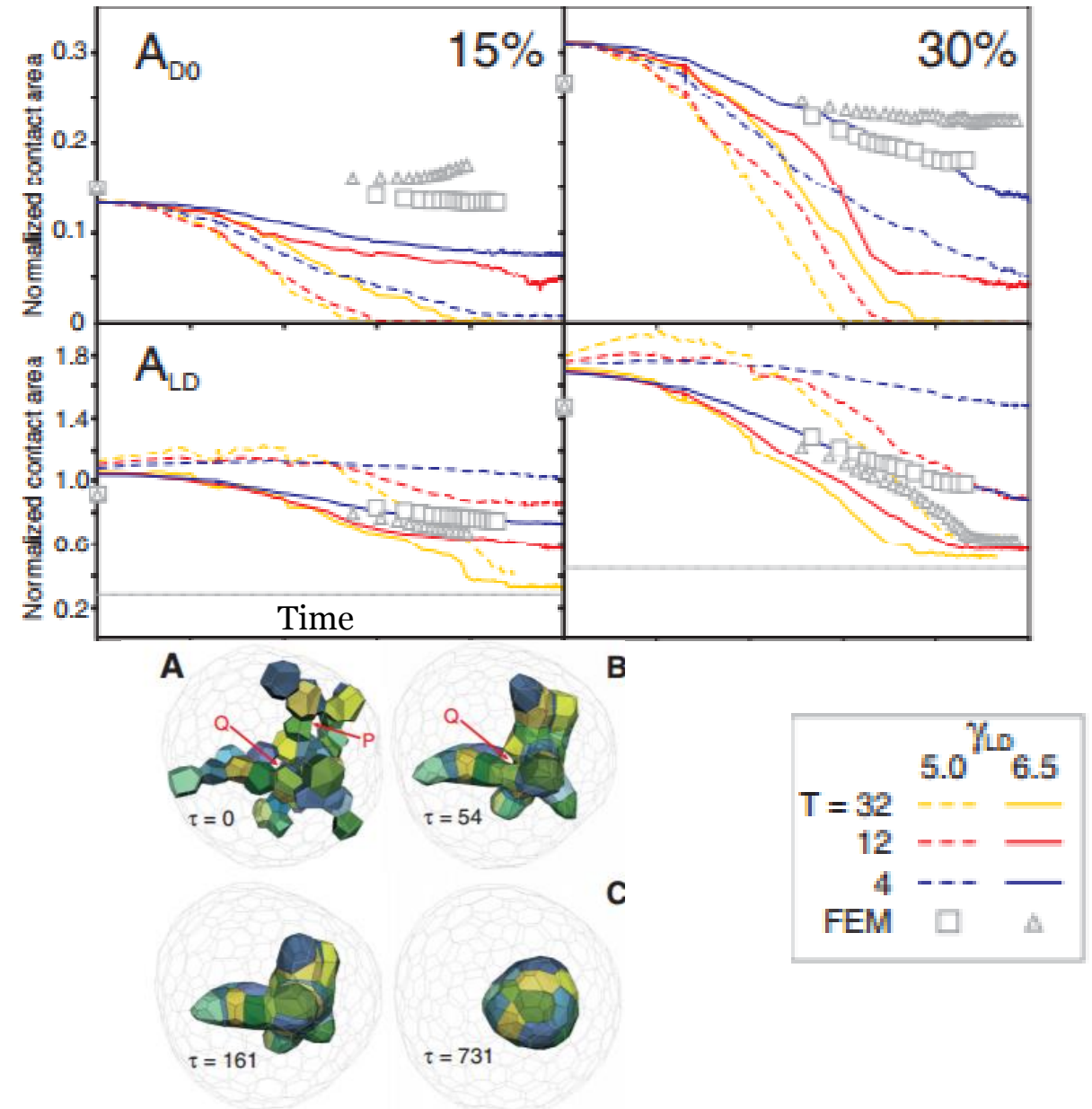
Article 2

- **Results:**

- Mixture 15:85: Fluctuation but no untangling
 - Caused by isolated domains of the minority
 - No complete cell sorting for FEM
 - Complete cell sorting for CPM
- Mixture 30:70: Fluctuation and untangling
 - Caused by more minority cells
 - Better cell sorting for FEM
 - Complete cell sorting for CPM

- **Conclusion:**

Untangling is a big part of the kinetics of cell sorting



Conclusion

- **Similarities :**

- CPM is used for cell sorting
- The fluctuations are the same
- The kinetics of the cell sorting is comparable in 2D and 3D with 15:85 mixture in 3D (no tangling)

- **Differences :**

- Tangling is not taken in account in 2D CPM while it is in 3D models

- **Conclusion**

3D processes can't be modelled with 2D models. This is due to lack of information about tangling.

Questions or feedback?



Universiteit
Leiden
The Netherlands