

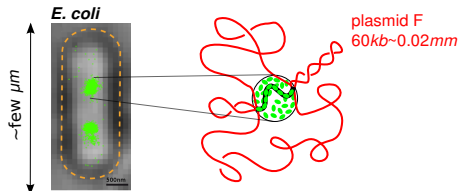
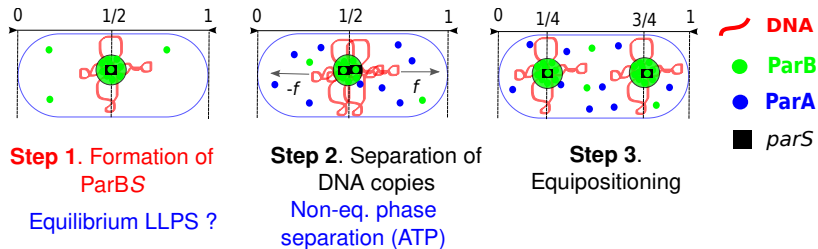
Physical modeling of the ParBS complex: insight into Liquid-Liquid Phase Separation

Jean-Charles WALTER

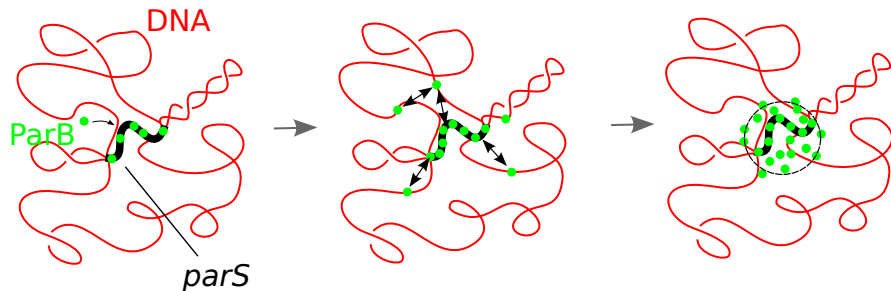
*Laboratoire Charles Coulomb (L2C)
CNRS & Université de Montpellier*

*BioPhyChrom 21
April 29*

Bacterial DNA segregation: the ParABS system

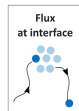
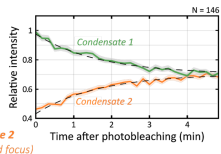
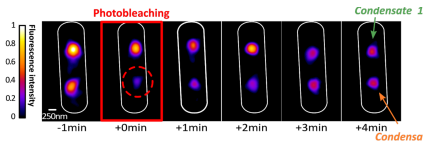
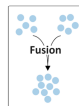
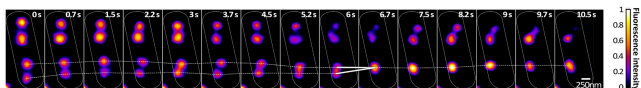


Formation of the ParBS complex



- 1 Does the partition complex ParBS display a LLPS ?
- 2 Clusters of ~ 300 ParB and typical size ~ 40 nm
- 3 *parS*: 10 binding sites \rightarrow rôle of Clamping and sliding (ParB-CTP) ?

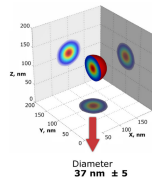
Liquid-like behaviour of ParBS complexes



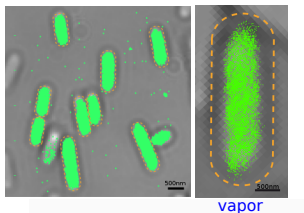
Baptiste Guilhas
Nollmann's Lab, CBS, Montpellier



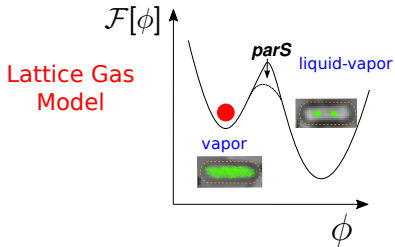
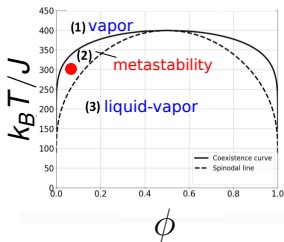
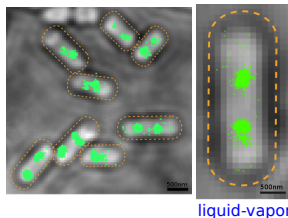
Antoine Le Gall



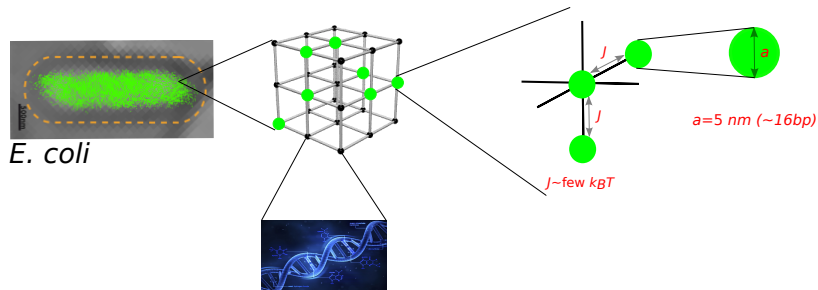
Liquid-like behaviour of ParBS complexes



specific binding
 \longrightarrow
ParB/parS



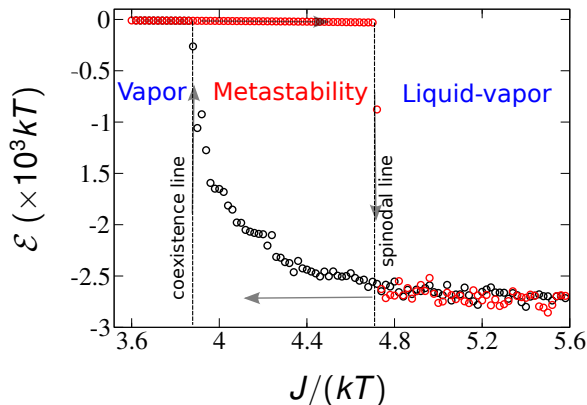
Modeling the nucleoid as a Lattice Gas



$$\mathcal{E} = -J \sum_{\langle i,j \rangle} \phi_i \phi_j + \varepsilon_{parS} \sum_i \phi_i$$

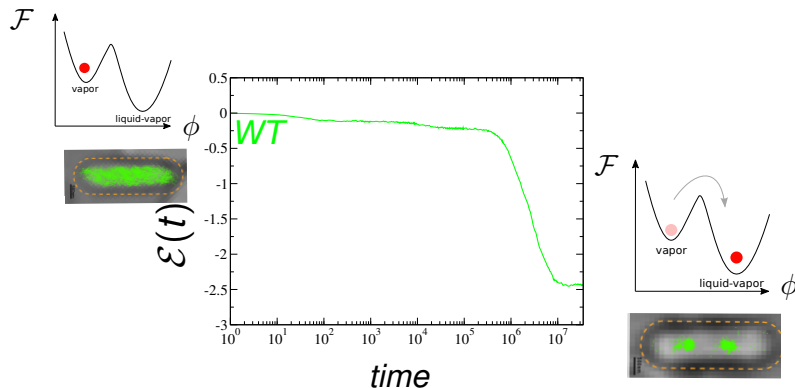
- 1 2 parameters: Diffusion $D \sim 1 \mu m^2 \cdot s^{-1}$ + interaction J

Phase diagram for the ParBS system



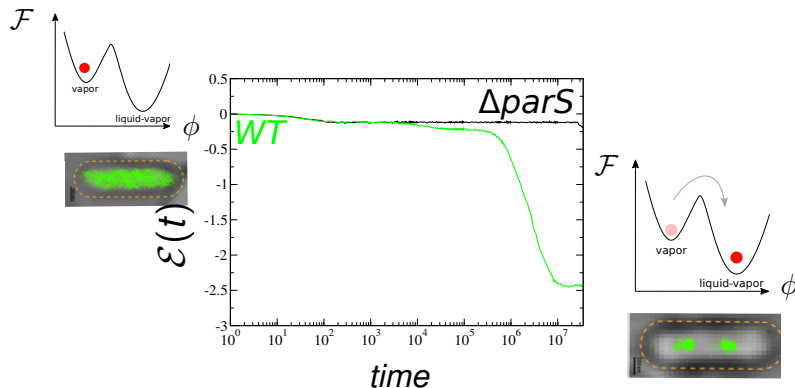
- 1 1st order phase transition (jump in the energy & hysteresis)
- 2 Metastable region for $J \sim \text{few } k_B T$

Kinetic of nucleation



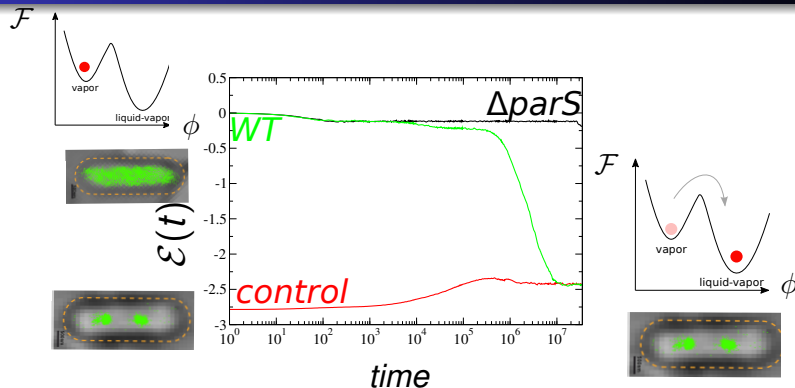
Guilhas, JCW,...Le Gall, Nollmann **ATP-driven separation of liquid phase condensates in bacteria** *Mol. Cell* '20

Kinetic of nucleation



Guilhas, JCW,...Le Gall, Nollmann **ATP-driven separation of liquid phase condensates in bacteria** *Mol. Cell* '20

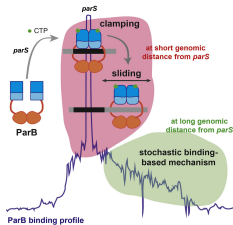
Kinetic of nucleation



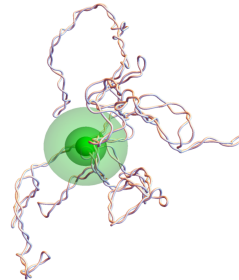
- 1 *parS* is needed to catalyze LLPS
- 2 Nucleation rate increases linearly with the length of *parS* → ParB CTP activity ?
- 3 Nucleation is lost for cryptic sequences with affinities $< J$

Conclusion

- 1 The partition complex ParBS displays a LLPS tuned in the metastable regime
- 2 *parS* catalyzes the LLPS
- 3 Opening: Rôle of CTP in the LLPS & interaction of clusters with supercoiled DNA



JCW, ..., Bouet **Physical modeling of a sliding clamp mechanism for the spreading of ParB at short genomic distance from bacterial centromere sites** *Science* 2020



JCW, ..., Bouet, Junier **Supercoiled DNA and non-equilibrium formation of protein complexes: A quantitative model of the nucleoprotein ParBS partition complex** *PLOS Comp. Biol.* 2021

Thank you for your attention!

G. David J. Palmeri
 J. Dornnac A. Parmeggiani
 F. Geniet N-O. Walliser

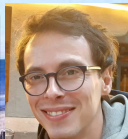
Biophysical modeling



B. Guilhas

A. Le Gall
 M. Nollmann

Super resolution microscopy



C. Mathieu-Demazière
 J. Rech
 J.-Y. Bouet

Molecular biology

