Modelling cellular organelles with non-equilibrium dynamics.

Q. Vagne[1,2], J.-P. Vrel[1] and P. Sens[1]

[1] *Institut Curie, Paris, France*
[2] *MPI-CBG, Dresden, Germany*
pierre.sens@curie.fr

Membrane-bound cellular organelles perform many essential functions, among which the sorting and biochemical maturation of cellular components. Organelles along the secretory and endocytic pathways are strongly out-of-equilibrium structures, which display large stochastic fluctuations of composition and shape resulting from inter-organelle exchange and enzymatic reactions. Understanding how the different molecular mechanisms controlling these processes are orchestrated to yield robust fluxes of matter and to direct particular components to particular locations within the cell is an outstanding problem of great interest for cell biologist, but also for physicists. In this talk, I will discuss a conceptual model of organelle biogenesis and maintenance that include vesicular exchange (budding, transport, and fusion) and biochemical maturation, i.e. the change of identity of an organelle over time (early to late endosomes, cis to trans Golgi cisternaeâĂę). I will show how the non-equilibrium steady-state of an organelle or a network of organelles may be varied in a controlled manner by modifying a limited number of coarse-grained parameters (essentially, the budding, fusion and maturation rates) [1, 2] and discuss the relevance of these results for the structure of the Golgi apparatus [3].

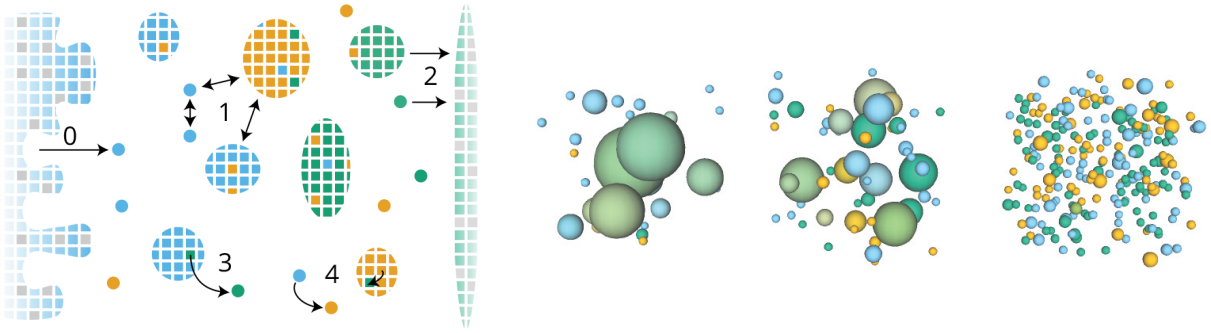

Fig. 1: *Left: Stochastic self-organisation model for the Golgi apparatus. Right: three examples of non-equilibrium steady-states*

[1] Q. Vagne and P. Sens, Biophys. J. **114** (2018), 947-957
Stochastic Model of Maturation and Vesicular Exchange in Cellular Organelles

[2] Q. Vagne and P. Sens, Phys. Rev. Let. **120** (2018), 058102
Stochastic Model of Vesicular Sorting in Cellular Organelles

[3] Quentin Vagne, Jean-Patrick Vrel & P. Sens, eLife, **9** (2020) e47318
A Minimal Self-Organized model for the Golgi Apparatus