CEA/DRF/Joliot/I2BC-S/Service de Biologie Intégrative et Génétique Moléculaire/Régulation transcriptionnelle des génomes

Modelling of DNA repair process

The aim

Maintaining genome integrity throughout the cell cycle is a crucial challenge for eukaryotic cells, as they are constantly exposed to both internal and external stresses that can cause genomic damage. In order to survive and thrive, organisms have developed control mechanisms to remediate these issues without compromising their ability to adapt to their environment.
From a physicist's perspective, this means that the cell state configuration must be both stable and responsive to external stimuli. The complexity of the biochemical interactions network involved in this process cannot be easily reduced to simple principles. However, we propose to use techniques from out-of-equilibrium statistical physics and numerical simulations to study the Nucleotide Excision Repair (NER) mechanism in budding yeast *Saccharomyces cerevisiae*.
After UV radiation, the yeast genome contains randomly distributed lesions that the NER pathway repairs. We will model the genome as a one-dimensional array, where damages are distributed following a Poisson process. Using the dynamic Monte Carlo algorithm, we will simulate the spatiotemporal pattern of NER process, encoding it as the concomitant action of 2 dynamical processes, one purely stochastic and the other regulated by transcription. Our work will be validated by quantitatively comparing it with existing experimental measurements.
An interdisciplinary internship opportunity is available at the biology laboratory of CEA-Saclay (Régulation transcriptionnelle des génomes), which specialises in the transcriptional regulation of genomes. This project involves collaboration between biologists, mathematicians and physicists. It is a joint effort between our team at CEA, the Computer Science Laboratory of ENS Paris-Saclay (Computer Science Laboratory) and Maison de la simulation at CEA (Maison de la Simulation). The internship provides a unique opportunity to exchange ideas and knowledge across these fields.

Used techniques

Statistical physics, Optimization methods, Numerical simulation, High performance computing

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