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Emergent noise control mechanism stabilizing gap gene pattern in Drosophila embryo

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In developing embryo cells determine their fate by reading diffusing chemical signals called morphogens. Yet, as the initially imposed morphogens wear out, the corresponding pattern of gene expression remains self-sustained in cells. In order to achieve this, the pattern-maintaining mechanism must be robust enough to overcome significant amounts of noise, inherent to the gene expression dynamics and the competition between interacting genes. The system in which this problem is studied is the 'four gap gene' pattern, forming around cycle 13 of Drosophila embryo development. In this talk, I will show how massive, molecular-level accurate simulations of the entire embryo [1] were combined with a recently found exact solution in the theory of pattern stabilization [2]. This revealed the emergent noise-control mechanism [1], providing both qualitative explanation for the pattern longevity as well as the quantitative prediction of the highest-stability regime, in which the pattern survival time increases by two orders of magnitude. The study provides insight into the principles of robust patterning systems design.

Bibliography

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