Modelling extrinsic and intrinsic noise by means of Langevin description

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Fluctuations in gene expression can produce a loss of precision in reg- ulatory processes. The importance (and consequences) of the effects in- troduced by noise not only depend on the amplitude of the fluctuations. In this regard, a persisting fluctuation can have more serious effects[1]. Re- cent single cell experiments pointed out that noise can be decomposed in two types: extrinsic and intrinsic[2]. On the one hand, extrinsic noise produces different effects in the same gene over different cells. On the other hand, intrinsic noise affects differently the expression of two identical genes within the same cell. In this work we have modeled a system where one gene is expressed when the concentration of its repressor decreases by dilution (cell division). Our approach makes use of the chemical master equation formalism. A Kramers-Moyal expansion allows for an effective description in terms of Langevin equations. Our results, in agreement with experiments, show that extrinsic fluctuations are long-correlated (of the order of the cell cycle) whereas intrinsic ones are memory-less.

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