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Amplification of gene-expression noise with high-cooperativity feedback in burst size

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Burst-like synthesis of protein is a significant source of cell-to-cell variability in protein levels. Negative feedback is a common example of a regulatory mechanism by which such stochasticity can be controlled. Here we consider a specific kind of negative feedback, which makes bursts smaller in the excess of protein. Increasing the strength of the feedback may lead to dramatically different outcomes depending on a key parameter, the noise load, which is defined as the squared coefficient of variation the protein exhibits in the absence of feedback. Combining stochastic simulation with asymptotic analysis, we identify a critical value of noise load: for noise loads smaller than critical, the coefficient of variation remains bounded with increasing feedback strength; contrastingly, if the noise load is larger than critical, the coefficient of variation diverges to infinity in the limit of ever greater feedback strengths. Interestingly, feedbacks with lower cooperativities have higher critical noise loads, suggesting that they can be preferable for controlling noisy proteins. Feedbacks with higher cooperativities, on the other hand, can amplify noisy gene expression.

Short Bio

Pavol Bokes is an applied mathematician working in research and lecturing at the Department of Applied Mathematics and Statistics, Comenius University, in Bratislava. He obtained his PhD in Nottingham, UK, on modelling gene regulatory networks. Pavol‘s research interests are in stochastic gene expression and mathematical biology.