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Buffering gene expression noise by microRNA based feedforward regulation. (English)

Summary: Cells use various regulatory motifs, including feedforward loops, to control the intrinsic noise that arises in gene expression at low copy numbers. Here we study one such system, which is broadly inspired by the interaction between an mRNA molecule and an antagonistic microRNA molecule encoded by the same gene. The two reaction species are synchronously produced, individually degraded, and the second species (microRNA) exerts an antagonistic pressure on the first species (mRNA). Using linear-noise approximation, we show that the noise in the first species, which we quantify by the Fano factor, is sub-Poissonian, and exhibits a nonmonotonic response both to the species lifetime ratio and to the strength of the antagonistic interaction. Additionally, we use the Chemical Reaction Network Theory to prove that the first species distribution is Poissonian if the first species is much more stable than the second. Finally, we identify a special parametric regime, supporting a broad range of behaviour, in which the distribution can be analytically described in terms of the confluent hypergeometric limit function. We verify our analysis against large-scale kinetic Monte Carlo simulations. Our results indicate that, subject to specific physiological constraints, optimal parameter values can be found within the mRNA-microRNA motif that can benefit the cell by lowering the gene-expression noise.

For the entire collection see [Zbl 1397.92008].

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