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(G*) POS-D21 – Trade-offs between fluctuations and efficiency in stochastic complex formation processes

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Understanding the physical limitations and trade-offs related to suppressing fluctuations in stochastic cellular processes is of great importance for systems and synthetic biology applications. We show that a generic class of complex formation processes in which two subunits associate to form a complex is constrained by a trade-off between the subunit fluctuations and the efficiency of complex formation. Previously this trade-off has been demonstrated in the special case that the subunit production rates are equal regardless of closed-loop feedback control. Here, we extend this result for asymmetric subunit production and arbitrary complex formation kinetics. We show that this trade-off can only be overcome with closed-loop feedback control in this case. However, preliminary numerical results suggest that the subunit fluctuations are supressed by the control mechanism at the expense of increasing fluctuations in the controlling variables, suggesting a general uncertainty principle in stochastic processes.

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