Accepted Manuscript

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PII: S0378-4371(14)00727-4
DOI: http://dx.doi.org/10.1016/j.physa.2014.08.042
Reference: PHYSA 15502

To appear in: *Physica A*

Received date: 10 June 2014
Revised date: 29 July 2014

Please cite this article as: Y. Xu, Y.-n. Zhu, J. Shen, J. Su, Switch dynamics for stochastic model of genetic toggle switch, *Physica A* (2014), http://dx.doi.org/10.1016/j.physa.2014.08.042

Switch dynamics for stochastic model of genetic toggle switch

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Abstract

Recently, more and more biological experiments have indicated that noise plays an important role in bistable systems, such as the case of the bimodal population distribution in the genetic toggle switch. In this paper, we further verify that noises in degradation rates can indeed induce switching in the genetic toggle switch. Meanwhile, we apply the theory of mean first passage time($MFPT$) in high dimensional system to the above stochastic model. According to our assumption, the high order finite difference method is used to compute the $MFPT$ (that the average time switching from one steady state to the other) and we find that the relationship between the $MFPT$ and noise intensity is negative correlation. The result is also verified through another numerical simulation method.

Key Words. Toggle switch; Bistable systems; $MFPT$; Noise intensity; finite difference method

Introduction

Bistability arises within a wide range of biological systems from the λ phage switch in bacteria to cellular signal transduction pathways in mammalian cells[1]. A system is termed bistable if it can switch from one steady state to the other under a set of external

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