

A fluctuating environment as a source of periodic modulation

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ABSTRACT

We discuss a physical condition where the intermittent fluorescence of a single molecule is a modulated Poisson process, with a rate changing in time due to the influence of a fluctuating environment. We explore the condition where the Poisson rate is a deterministic and continuous function of time, interrupted by abrupt changes. We prove that under the condition that the occurrence of abrupt jumps is limited to a time set of vanishing measure, a significant deviation from the exponential waiting time distribution is compatible with a periodic and deterministic evolution of the Poisson rate, and we estimate the time period on the basis of the waiting time distribution. We argue that additional information on the system's aging or lack of aging might help to settle the ambiguities remaining after the experimental determination of the waiting time distribution. We discuss in the light of this perspective some recent experimental results, where the stretched exponential waiting time distribution is thought to afford information on the enzymatic activity.

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- [1] E. Barkai, Y. Jung, R.J. Silbey, *Ann. Rev. Phys. Chem.* **55**, 457 (2004).
 - [2] O. Flomembon, K. Velonia, D. Loos, S. Masuo, M. Cotlet, Y. Engelborghs, J. Hofkens, A. E. Rowan, R. J. M. Nolte, M. van der Auweraer, F. C. de Schyver, and J. Klafter, *Proc. Natl. Acad. Sci. USA* **102**, 2368 (2005).
 - [3] C. Beck, *Phys. Rev. Lett.* **87**, 180601 (2001).
 - [4] D.R. Cox, *Renewal Theory* (Methuen, London, 1962).
 - [5] S. Bianco, P. Grigolini, P. Paradisi, *J. Chem. Phys.* **123**, 174704 (2005).
 - [6] F. Barbi, M. Bologna, and P. Grigolini, *Phys. Rev. Lett.* **95**, 220601 (2005).
 - [7] M. Kuno, D.P. Fromm, H.F. Hamann, A. Gallagher, and D.J. Nesbitt, *J. Chem. Phys.* **112**, 3117 (2000).
 - [8] K.T. Shimizu, R.G. Neuhaser, C.A. Leatherdale, S.A. Empedocles, W.K. Woo, and M.G. Bawendi, *Phys. Rev. B*, **65**, 205316 (2001).
 - [9] X. Brokman, J.P. Hermier, G. Messin, P. Desbiolles, J.-P. Bouchaud, and M. Dahan, *Phys. Rev. Lett.* **90**, 120601 (2003).
 - [10] G. Margolin and E. Barkai, *Phys. Rev. Lett.* **94**, 080601 (2005).
 - [11] P. Allegrini, G. Aquino, P. Grigolini, L. Palatella, A. Rosa, and B.J. West, *Phys. Rev. E* **71**, 066109 (2005).

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