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Extended Kramers-Moyal analysis applied to optical trapping

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(Submitted on 7 May 2012)

The Kramers-Moyal analysis is a well established approach to analyze stochastic time series from complex systems. If the sampling interval of a measured time series is too low, systematic errors occur in the analysis results. These errors are labeled as finite time effects in the literature. In the present article, we present some new insights about these effects and discuss the limitations of a previously published method to estimate Kramers-Moyal coefficients at the presence of finite time effects. To increase the reliability of this method and to avoid misinterpretations, we extend it by the computation of error estimates for estimated parameters using a Monte Carlo error propagation technique. Finally, the extended method is applied to a data set of an optical trapping experiment yielding estimations of the forces acting on a Brownian particle trapped by optical tweezers. We find an increased Markov-Einstein time scale of the order of the relaxation time of the process which can be traced back to memory effects caused by the interaction of the particle and the fluid. Above the Markov-Einstein time scale, the process can be very well described by the classical overdamped Markov model for Brownian motion.

Comments:	14 pages, 18 figures
Subjects:	**Data Analysis, Statistics and Probability (physics.data-an)**
Journal reference:	Phys. Rev. E 86, 026702 (2012)
DOI:	10.1103/PhysRevE.86.026702
Cite as:	**arXiv:1205.1380 [physics.data-an]**
	(or **arXiv:1205.1380v1 [physics.data-an]** for this version)

Submission history

From: Christoph Honisch [view email]
[v1] Mon, 7 May 2012 13:30:11 GMT (597kb)

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