Fluctuation and Noise Letters
Vol. 4, No. 1 (2004) v–vi

World Scientific
www.worldscientific.com

NOISE IN BIOPHYSICAL SYSTEMS

PETER HÄNGGI
Institut für Physik, Universität Augsburg, Universitätsstr. 1, D-86135, Augsburg, Germany

PETER JUNG and ALEXANDER NEIMAN
Department of Physics and Quantitative Biology Institute
Ohio University, Athens, OH 45701, USA

LUTZ SCHIMANSKY-GEIER
Institute für Physik, Humboldt Universität zu Berlin
Newtonsstr. 15, D-12489, Berlin, Germany

The subject of the special issue — NOISE IN BIOPHYSICAL SYSTEMS — embraces a wide variety of topics that are in the limelight of current research in nonlinear and statistical physics. During the recent years, these topics of research have seen a rapid development and the emergence of new and exciting directions relevant to Physics, Biology, Chemistry and related sciences.

A main impetus of this special issue is to honor Frank Moss on the occasion of his 70-th birthday. Frank has repeatedly made pioneering contributions (with over 200 publication) to physics and biophysics. Starting out from early work on fluctuations in turbulent superfluid helium, he was the first to apply the analog simulation technique to explore fundamental theoretical problems in nonlinear and statistical physics, such as the role of multiplicative noise and colored noise. These studies in turn inspired him to co-edit with P.V.E. McClintock a unique collection of articles which make up the three, well-known volumes [*Noise in Nonlinear Dynamical Systems*, Vols. 1-3, Cambridge University Press, 1989] which are still very much in use by all practitioners of nonlinear stochastic physics.

In the early nineties Frank moved into the field of biological physics. Being one of the pioneers of Stochastic Resonance (SR), his most prominent contributions have been the applications of the phenomenon of SR to various biological processes. The beginning of this era is marked by a joint publication [A. Longtin, A. Bulsara, F. Moss, *Phys. Rev. Lett.* 67: 656 (1991)], wherein the link between neuronal dynamics and SR has been made for the first time. This paper, in which the physics that underpins SR was applied to inter-spike interval measurements from the auditory nerve system of a squirrel monkey, has inspired a whole wave of interdisciplinary

studies on the role of noise for neuronal dynamics. Ever since this pioneering paper he has engaged himself into research on the fundamental question whether nature's biologic machinery has evolved to take advantage of omnipresent noise to optimize its function. In 1993 he published the first experimental evidence of SR in a biological system, the crayfish mechanoreceptor [J. Douglass, L. Wilkens, E. Pantazelou, and F. Moss, *Nature* 365: 337 (1993)]. In this pioneering study, Frank Moss and his colleagues have demonstrated the ability of primary sensory neurons to use noise for the enhancement of weak stimuli via SR. One year later, he launched a first work to demonstrate SR on the subcellular level, i.e. in ion channels [D. Petracchi, M. Pellegrini, M. Pelligriono, M. Barbi, and F. Moss, *Biophys. J.* 66:1844 (1994)]. In a series of papers that appeared over the years in first rate journals such as Nature and Physical Review Letters he demonstrated the beneficial role of environmental noise for the SR-like optimization of neuronal information encoding in crayfish. Besides being a pioneer in studies in SR, he reached out to a larger community popularizing the concept of SR through papers in Nature [*Stochastic Resonance and the benefits of noise — from ice ages to crayfish and SQUIDs*, K. Wiesenfeld and F. Moss, *Nature* 373: 33-36 (1995)] and many stimulating tutorial talks and overviews.

His latest achievements refer to the proof of the beneficial role of noise for the behavioral function in an animal, paddlefish [D.F. Russell, L. Wilkens, and F. Moss, *Nature* 402:291 (1999)]. This is again pioneering work which clearly demonstrates that SR may be actually used by biological organisms for vital functions: feeding behavior, in the case of paddlefish. Without any doubt, Frank Moss has been the driving force in quest of the beneficial role of noise for biologic function; it should also be emphasized that from this very role all of us practitioners of stochastic physics — and of Stochastic Resonance in particular — have deeply profited over the last two decades.

We mentioned here only few areas of nonlinear physics where Frank Moss made significant contributions. However, almost every paper published by him can be considered as unique and guiding. Frank Moss has established the Center for Neurodynamics at University of Missouri — St. Louis, a unique interdisciplinary institution which many of us have visited and enjoyed inspiring, fruitful discussions and collaboration. This Center is unique because of the atmosphere of research enthusiasm and broad vision which Frank has cultivated.

The guest editors share the belief that this representative collection of research articles provides a snapshot of the current activities in nonlinear dynamics and fluctuation phenomena applied to physical biology and that the readers will be invigorated in pursuing future research by the contributions selected herein. We all congratulate Frank on his 70th birthday and we hope that this special issue will be a source of inspiration for Frank Moss to carry on with his scientific mission. We wish him all the best for many more fruitful and enjoyable years among his friends, colleagues and students in St. Louis and worldwide.

Augsburg, Athens and Berlin, February 2004