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STOCHASTIC RESONANCE AND INFORMATION TRANSFER IN VOLTAGE DEPENDENT ION CHANNELS

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We identify a unifying measure for stochastic resonance (SR) in voltage-dependent ion channels, which comprises periodic (conventional), aperiodic and nonstationary SR. Within a simplest setting, the gating dynamics is governed by two-state conductance fluctuations, which switch at random time points between two values. The corresponding continuous time point process can be characterized by the voltage-dependent opening and closing switching rates and is analyzed by virtue of information theory. In pursuing this goal we evaluate for our dynamics the t-information, the mutual information and the rate of information gain. As a main result we find an analytical formula for the rate of information gain that solely involves the probability of the two channel states and their noise averaged rates. For small voltage signals it simplifies to a handy expression. Our findings are applied to study SR in a potassiumselective Shaker channel. We find that SR occurs only when the closed state is predominantly dwelled. Upon increasing the probability for the open channel state the application of an extra dose of noise monotonically deteriorates the rate of information gain, i.e., no SR behavior occurs. We connect this type of behavior with the steep, thresholdlike dependence of the channel's opening rate on the applied voltage.
[I. Goychuk and P. Hänggi, Phys. Rev. E 61, 4272 (2000)].

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