Random noise helps make signals clearer

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Scientists have shown the energy conditions, under which a weak signal supplied to a physical system emerges as a stronger signal at the output thanks to the presence of random noise (a process known as stochastic resonance), in a paper that has just been published in *European Physical Journal B*.

Stochastic resonance goes against the intuitive idea that where noise is present, the signal tends to fade. It occurs in systems where the response is not proportional to the applied input signal, known as nonlinear systems.

The authors, Shubhashis Rana, Sourabh Lahiri and Arun M. Jayannavar from the Institute of Physics, in Bhubaneswar, India, used a model consisting of a symmetric double-well energy potential in which a particle moves randomly. They studied the effect of the steepness of the walls of the confining energy potential by observing the movement of the particle, which they subjected to an external sinusoidal signal that alternately lowers either of the wells.

The authors selected a quantifier – the average work done on the system by the signal – to determine the conditions under which the particle moving from one well to the opposite side well and back at every cycle of the signal reaches stochastic resonance. They found that it only occurs when the potential is "hard", meaning that it has sufficiently steep walls, but breaks down otherwise. Previous work used different quantifiers and found similar results, confirming their findings using numerical simulations.

This study contributes to improving scientists' understanding of stochastic resonance. It could, ultimately, contribute to gaining deeper insights into physics-related phenomena such as the processing of unclear images to increase their resolution* and biological systems, including mechanoreceptor cells in crayfish and the functioning of sensory neurons in humans.

More information: Rana S, Lahiri S, Jayannavar A M (2011). The role of soft versus hard bistable systems on stochastic resonance using average cycle energy as a quantifier. *European Physical Journal B* (EPJ B) 84, 2. DOI 10.1140/epjb/e2011-20802-9

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