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Anomalous diffusion and scaling in the dynamics of coupled stochastic processes. GOLAN BEL, CNLS and CCS-3 LANL, ILYA NEMENMAN, CCS-3 and CNLS LANL — Stochastic processes are ubiquitous in nature, and multiple dynamical variables in the same physical system can be stochastic simultaneously. Common mathematical treatement of such cases limit the interactions among multiple stochastic variables to simple correlations. However, more complicated couplings are possible as well. For example, for many biochemical reactions, the rate (stochastic) of creation of one substance may depend on the presence of another one, itself stochastic variable. Here we present a theoretical study of one class of such coupled stochastic processes. We observe that, contrary to traditional modeling frameworks, even very weak coupling yields anomalous diffusion. Interestingly, the diffusion exponent cannot be predicted by simple scaling arguments, and anomalous scaling appears as well. Further, we show that even weak inhibitive coupling between the two processes may result in dynamics equivalent to that of the celebrated comb model, where the coupling between the two stochastic variables is so strong that one is able to diffuse only when the other is within a certain range. We compare the model to various mechanisms for generating anomalous diffusion and show that coarse-graining yields behavior equivalent to that of the non-ergodic continuous time random walk. We end with brief discussion of applications of the developed theory to biochemical systems.

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