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Memory effects in nanoscale systems

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Memory emerges quite naturally in systems of nanoscale dimensions: the change of state of electrons and ions is not instantaneous if probed at specific time scales, and it generally depends on the past dynamics. This means that the resistive, capacitive and/or inductive properties of these systems generally show interesting time-dependent (memory) features when subject to time-dependent perturbations. In other words, nanoscale systems behave as a combination of (or simply as) memristors, memcapacitors or meminductors, namely circuit elements whose resistance, capacitance and inductance, respectively, depend on the past states through which the system has evolved. After an introduction to the theory and properties of memristors, memcapacitors and meminductors, I will discuss several memory phenomena in nanostructures associated to charge, ion and spin dynamics and their far-reaching applications ranging from information storage to computation to biologically-inspired systems. Work supported in part by NSF, NIH, and DOE.