"NANOELECTRONICS BEYOND CMOS: SPIN AND QUANTUM DEVICES"

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In this talk I will describe a vision for electronics that is based on fully exploiting the spin degree of freedom in electronics as Moore's Law approaches the end of it's cycle. Spintronics which was the name coined for the first DARPA project that started in 1995, had as it's charter the development of a radiation hard, high density, high speed, non-volatile, random access memory and associated sensors reached a successful conclusion with the emergence of a new MRAM chip based on spin dependent tunneling which is also being adopted for use as a radiation hard memory for space applications. A new direction for this effort emerged in 1998 with the start of the "SPins IN Semiconductors" or SPINS project which has been supporting research into many new aspects of spintronics as well as continuing the progress in magnetoresistive structures. Out of this effort came the development of many new ferromagnetic semiconductors, insulators and heterostructures which will be the key to a host of new spin devices including Spin-LEDs,Spin-Lasers, Spin-FETS, Spin-Resonant Tunneling Devices, Spin Switches and Single Spin Devices. Furthermore the novel spin momentum transfer (SMT) effect which provides both a pathway to switch nano-scale magnetoresistive structures and provide a nano-millimeter wave source has also been pursued vigorously. One of the more far reaching prospects is the research into the utilization of the electron spin as the quantum bit or qubit for quantum information processing. This aspect of spintronics has been pursued both as part of the SPINS project and the Quantum Information Science and Technology Project or QuIST which I helped initiate in 1999 and now co-manage. I believe that the prospects for a new paradigm of electronics based on spin are excellent. I will discuss many of the aspects of the aforementionned programs in this talk.