Keynote Address

Controlling Events at the Atomic and Molecular Scales through Hamiltonian Manipulation

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Since the development of the laser some 40 years ago, a long standing dream has been to utilize this special source of radiation to manipulate dynamical events at the atomic and molecular scales. Hints that this goal may become a reality began to emerge in the 1990's, due to a confluence of concepts and technologies involving (a) control theory, (b) ultrafast laser sources, (c) laser pulse shaping techniques, and (d) fast pattern recognition algorithms. These concepts and tools have resulted in a high speed instrument configuration capable of adaptively changing the driving laser pulse shapes, approaching the performance of thousands of independent experiments in a matter of minutes. Each particular shaped laser pulse acts as a "Photonic Reagent" much as an ordinary reagent would at the molecular scale. Although a Photonic Reagent has a fleeting existence, it can leave a permanent impact. Current demonstrations have ranged from manipulating simple systems (atoms) out to the highly complex (biomolecules), and applications to quantum information sciences are being pursued. In all cases, the fundamental concept is one of adaptively manipulating quantum systems. The principles involved will be discussed, along with the presentation of the state of the field.