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Attosecond Physics - Probing and Controlling Matter on Its Natural Time Scale[1]

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The goal of attosecond physics is to probe and control matter on its natural time scale, which for electronic motion in atoms, molecules, and solids is measured in attoseconds ($= 10^{-18}$ sec). Both single attosecond pulses and attosecond pulse trains can be produced. Such pulses have opened new avenues for time-domain studies of multi-electron dynamics in atoms, molecules, and solids on their natural time scale and at dimensions shorter than molecular and even atomic dimensions. They promise a revolution in our microscopic knowledge and understanding of matter. At present the intensities of isolated attosecond pulses are very weak, so that perturbation theory is sufficient to describe the interaction of attosecond pulses with matter. Consequently, they can only be used either to initiate ("pump") a physical process or to probe a process already under way by other means. Experimental efforts currently aim to increase the intensities of isolated attosecond pulses by orders of magnitude. Intense attosecond pulses will open the regime of nonlinear attosecond physics, in which pump/probe processes with isolated attosecond pulses will become possible and in which the broad bandwidth of isolated few-cycle attosecond pulses will enable significant control over electron motion.

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