

Attosecond Science: From Basic Research to Cancer Detection

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Born around the turn of the new millennium, attosecond meteorology has provided real-time insight into atomic-scale electron motions and light-field oscillations, previously inaccessible by human observation. Until recently, this capability has relied on attosecond extreme ultraviolet pulses, generated and measured in complex vacuum systems. Next-generation attosecond meteorology is now about to change this state of matters profoundly. Sub-femtosecond current injection into wide-gap materials can directly probe ultrafast electron phenomena in condensed matter systems and can also be used for sampling the electric field of light up to ultraviolet frequencies. Peta-Hertz field sampling draws on a robust solid-state circuitry and routine few-cycle laser technology, opening the door for complete characterizations of electromagnetic fields all the way from the far infrared to the vacuum ultraviolet. These fields, with accurately measured temporal evolution, serve as a unique probe for the polarization response of matter. Field-resolved spectroscopy will access valence electronic as well as nuclear motions in all forms of matter and constitutes a generalization of pump-probe approaches. Its implementation with a solid-state instrumentation opens the door for real-world applications, such as early cancer detection by measuring miniscule changes of the molecular composition of blood via field-resolved vibrational molecular fingerprinting.