Attosecond Science

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An electron that multiphoton ionizes is immediately subject to the electric field of the light that freed it, and this field will control the electron's short-time future. Since we can precisely control an infrared light beam, we can manipulate the electron, forcing it to re-collide with its parent ion. This collision enables us to synthesize 50-attosecond duration pulses – the shortest events that we, as humans, can systematically produce. Attosecond photon (or the electrons that produce the photons) pulses allow us to measure electron dynamics within atoms, molecules or solids – the fastest measurements ever made. I will discuss how the re-collision electron – a precursor of attosecond pulse generation – gives us a unique probe of multi-electron dynamics.

When high intensity, light irradiates a metal we gain control over conduction band electrons – a pre-existing electron population. In TiN, a refractory metal, the electrons complex path through the solid leads to coherent radiation – a non-plasma source of VUV radiation in which pre-existing electrons are used. As we increase the intensity, we expect to observe the transition from the damage-free regime where our current measurements are made, to single-shot damage regime to inertially-confined plasmas to plasma harmonics. At some point we will observe the contribution of solid state harmonics together with plasma harmonics.