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Controlling how atoms respond to ultra-intense x-ray radiation[1]

LINDA YOUNG, Argonne National Laboratory

With the advent of the Linac Coherent Light Source, the world's first hard x-ray free electron laser, an era of exploration using ultrafast, ultra-intense x-ray pulses has arrived. One can deposit 100,000 x-ray photons into one square Angstrom within 100 fs, producing an electric field strength that exceeds that binding the electron in a hydrogen atom. How does matter respond under these conditions? Using neon atoms, we investigated the electronic response as the x-ray interaction is tuned from the outer to the inner shell. At photon energies above all inner-shell edges, fully stripped neon is produced via six-photon absorption. The route to bare neon proceeds through photoejection of 1s electrons that produces hollow atoms and an intensity-induced x-ray transparency. X-ray transparency can be induced in all atomic, molecular and condensed matter systems. Going beyond non-resonant x-ray atom interactions, we investigated the atomic response at inner-shell resonances and find evidence for x-ray induced Rabi cycling. These investigations provide a framework for understanding ultra-intense x-ray interactions with matter.

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