The Interaction of Intense Light with Wavelength-Scale Objects

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Intense laser fields interact very differently with micrometric rough surfaces than with flat objects. The interaction features high laser energy absorption and increased emission of MeV electrons, ions, and of hard x-rays. I will report on how we revealed the underlying reason for this phenomenon by irradiating isolated, micrometric, translationally-symmetric objects. The interaction resulted in the emission of two forward-directed electron jets having a small opening angle, a narrow energy spread in the MeV range, and a positive angle to energy correlation. We studied the correlations between these emission characteristics, and the dimensions of the target, and the laser field polarization using numeric tools. The interaction takes place in two steps. First, electrons that are ionized and pulled into vacuum through the vacuum heating mechanism near the edge of the object, manage to circumvent it because of the combined action of the transverse electric field and their cyclotron motion under the magnetic field of the laser. Second, after they pass the object, the electrons form attosecond duration bunches and interact with the laser field over large distances in vacuum. The diffraction of the laser fields obscured by the target creates confined volumes that trap and accelerate electrons within a narrow range of initial momentum. The selectivity in energy of the interaction, its directionality, and the preservation of the attosecond duration of the electron bunches over large distances, may be applied to the design of future laser-based light sources.