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Novel zero vector potential mechanism of absorption in strongly relativistic plasmas

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In this talk we introduce a new mechanism of fast electron generation at the vacuum-solid boundary of intense laser pulse interaction with overdense plasma. We demonstrate that for a sharp plasma profile laser energy is first stored into the plasma as electrostatic energy (via compression of the electrons) and then released into fast electron energy by the zeroes of the electromagnetic vector potential. In this zero vector potential (ZVP) mechanism the generation of fast electron bunches and coherent x-rays (high harmonics from overdense plasma) are intrinsically connected. The new mechanism leads to scalings for the fast electron energy, which explicitly depend on the plasma density, thus providing a new insight into relativistic laser-matter interaction. It is shown that for sharp plasma density profiles the new mechanism provides the dominant contribution to the laser-plasma interaction by the injection of energy into the overdense plasma delivered by attosecond-duration electron bunches. This new understanding will allow the future generation of single ultra-bright attosecond x-ray pulse by suitable control of the laser pulse polarization. The process will also allow single pulse attosecond fast electron bunches to be generated that can be further accelerated in laser wakefield accelerators.