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Higher-order resonance as the main energy gain mechanism during direct laser acceleration of electrons

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Ultra-high intensity laser-plasma interactions are known to generate forward-directed ultra-relativistic electrons through direct laser acceleration (DLA) of electrons. The electron energy gain is assisted by the quasi-static azimuthal plasma magnetic field driven by the laser. The energy gain is prolonged if the frequency of the transverse oscillations induced by the magnetic field matches the Doppler-shifted laser frequency. A higher-order resonance (e.g. the Doppler-shifted frequency being three times higher than the frequency of transverse oscillations), is also possible, but this regime has remained relatively unexplored. We have examined DLA via higher-order resonances with the help of a test particle model and found that one of these resonances can become the primary energy gain mechanism. The criteria for achieving this regime in terms of laser beam width and plasma density will be presented.

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