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Attosecond electron sheets and attosecond light pulses from relativistic laser wakefields

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We present a new regime of laser wakefield acceleration from which dense (overcritical density) attosecond (nanometers thick corresponding to attosecond duration) electron sheets (few microns in width determined by the laser focal spot) can be obtained and accelerated. The essential new features are a driving spot greater than the plasma wave length and an upramp-to-plateau density transition that enable disklike density wake wave crests to be trapped as a whole in a very short timescale. We show remarkable radiative properties of the accelerating sheets, including giant half-cycle attosecond pulses from a coherent synchrotronlike radiation and attosecond kilo-electronvolt x-rays via coherent Thomson backscattering. Scalings of these radiations with the laser-plasma parameters will be discussed, indicating attosecond light sources at unprecedented peak powers with the state-of-the-art high-power lasers available now or in the near future. These studies shall enable new opportunities for wakefield acceleration and attosecond applications, and provide vital guide for near-term experiments.

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