Peeler regime of laser-plasma interaction: electron and ion acceleration, X-ray emission

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We discuss relativistic laser interaction with overdense plasmas, where the laser pulse is incident parallel to the plasma surface, the so-called "peeler" regime [1]. In this scheme, the laser pulse impinges on an edge of a tape or on a sharp edge of a bulk target. The edge allows for an efficient conversion of the laser pulse into a surface plasma wave (SPW). The SPW propagates along the target surface. Its transverse electric field extracts dense buckets of electrons into the nearby vacuum region. The longitudinal electric field of the SPW accelerates the se electrons along the surface. Thus, a large fraction of electrons (tens of nC) from the target skin layer can be "peeled" off and accelerated to high energies.

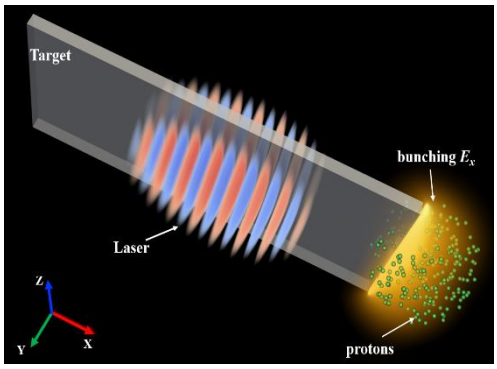

Figure 1: Schematics of peeler scheme.

These electrons wiggle in the combined quasistatic transverse electric and magnetic fields at the target surface and emit bright betatron radiation. Using fully three-dimensional particle-in-cell simulations, we show that a tabletop 100 TW class femtosecond laser can produce an ultrabright hard x-ray pulse with 10^{11} photons, flux up to 10^7 photons/eV and brilliance about 10^{23} photons/s/mm^2/mrad^2/0.1%BW by irradiation of an edge of a microtape target.

When these peeled off energetic electrons arrive at the rear edge of the tape, a longitudinal bunching field is established. Protons are simultaneously accelerated and bunched by this field, leading to a highly monoenergetic proton beam [2].

Acknowledgments

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References

[1] X. F. Shen, A. Pukhov, B. Qiao Phys. Rev. X **11** 041002 (2021)
[2] X. F. Shen, A. Pukhov, B. Qiao, **arXiv:2212.14329** (2022)