Correlated emission of electrons and XUV harmonics via relativistic surface plasmons

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Experiments of laser-solid interaction at ultra-high contrast have recently demonstrated the possibility of exciting resonant propagating surface plasmons at relativistic intensities ($> 10^{18}$ $\mathrm{W/cm^2}$) on solid grating targets [1]. Not only this encourages the development of a suitable theoretical description of plasmonic phenomena in such a non-linear regime, but it also allows exploring the properties of the radiation sources raised by SP excitation.

In particular, the SP field accelerates dense bunches of collimated electrons up to few MeV of energies along the surface of the laser-irradiated target [2]. This process is correlated in the same direction with a bright emission of high order harmonics of the laser frequency [3]. Experimentally, we have investigated some of the parameters of the laser-grating interaction that optimize both emissions (shape and material of the grating, formation of a controlled pre-plasma at its surface). 2D PIC simulations not only reproduce the experimental results but also highlight a spatio-temporal correlation between accelerated electrons and harmonics that gives insight on the generation mechanism of the XUV beam. Future work is now centred both on the optimization of the radiation sources in view of possible applications, and on the adaptability of new concepts and plasmonic configurations from the linear to the relativistic regime. In this context, a scheme for exciting few-cycles SPs with rotating wavefront laser pulses has been demonstrated numerically [4].

References

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