Self-Absorption of Synchrotron Radiation in a Laser-Irradiated Plasma

T G Blackburn[1], A J Macleod[2], A Ilderton[2], B King[2], S Tang[2], and M Marklund[1]

[1] *Department of Physics, University of Gothenburg, Gothenburg, Sweden*
[2] *Centre for Mathematical Sciences, , University of Plymouth, Plymouth, UK*
Contact Email: tom.blackburn@physics.gu.se

Electrons at the surface of a plasma that is irradiated by a laser with intensity in excess of 10^{23} Wcm^{-2} are accelerated so strongly that they emit bursts of synchrotron radiation. Although the combination of high photon and electron density and electromagnetic field strength at the plasma surface makes particle-particle interactions possible, these interactions are usually neglected in simulations of the high-intensity regime. Here we demonstrate an implementation of two such processes: photon absorption [1] and stimulated emission. We show that, for plasmas that are opaque to the laser light, photon absorption would cause complete depletion of the multi-keV region of the synchrotron photon spectrum, unless compensated by stimulated emission, as shown in Figure 1 [2]. Our results motivate further study of the density dependence of quantum electrodynamics phenomena in strong electromagnetic fields.

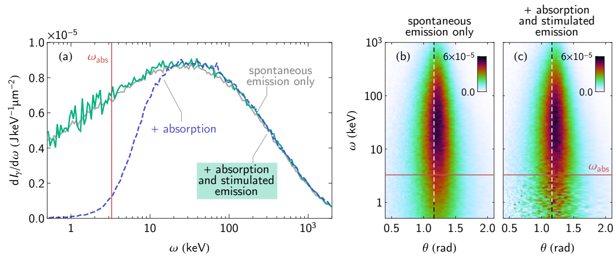

Figure 1: Angularly integrated (a) and resolved (b, c) photon energy spectra when plasma with density $n_e = 100 n_{\mathrm{cr}}$ is irradiated by a circularly polarized laser with peak amplitude $a_0 = 400$. Vertical red lines give the expected frequency at which absorption becomes important; horizontal dashed lines give the expected angle of emission, which is related to the hole-boring velocity

References

[1] A Ilderton, B King and A J Macleod, Phys. Rev. D **100**, 076002 (2019)

[2] T G Blackburn, A J Macleod, A Ilderton, B King, S Tang and M Marklund, Phys. Plasmas **28**, 053103 (2021)