Geophysical Research Abstracts
Vol. 15, EGU2013-12197, 2013
EGU General Assembly 2013

Collisional particle-in-cell simulation of electron acceleration by Langmuir waves in an inhomogeneous plasma in the context of solar flares

Roman Pechhacker and David Tsiklauri

School of Physics and Astronomy, Queen Mary University of London, United Kingdom (r.pechhacker@qmul.ac.uk)

The so-called "number problem" in the context of solar flares refers to the high number of accelerated electrons necessary in order to explain spectral observations of hard X-ray (HXR) radiation from the solar corona. For a number density of $n = 10^16m^{-3}$ and a solar flare particle acceleration volume of $\approx 1 - 10Mm^3$, the acceleration mechanism must be operating at 100% efficiency. No such mechanism is known. However there are a number of theories that have been put forward in an attempt to solve this problem: i) re-acceleration of already slowed down electrons in the chromosphere. However, observations show that a large part of the accelerated electrons drifts towards the coronal loops rather than the chromosphere; ii) formation of an electric circuit of precipitating and returning electrons; iii) dispersive Alfven waves propagating towards loop foot points and accelerating particles in plasmas with transverse density inhomogeneities [1,2]; iv) acceleration by Langmuir waves in non-uniform plasmas, as the Langmuir spectrum drifts to smaller wave-numbers [3].

Ref.[3] confirms that in the case of an inhomogeneous plasma, the generated Langmuir waves show a drift in k-space, which results in an increased number of electrons carrying higher energies. The results of Ref.[3] were re-analysed and broadly confirmed. Collisional, fully relativistic and electromagnetic particle-in-cell (PIC) simulations of superposed maxwellian and power-law electron velocity distributions in a magnetised, non-uniform plasma are performed. The total distribution is shown to become unstable to the bump-on-tail instability, which is responsible for Langmuir wave generation. The relaxation was found to be very sensitive to simulation parameters. Further we investigate a deviation from the quasilinear theory by studying sizeable beam-to-background number density ratios in a full PIC simulation, which is not possible when self-consistent electromagnetic field effects are neglected.

References:

D. Tsiklauri, "Particle acceleration by circularly and elliptically polarised dispersive Alfven waves in a transversely inhomogeneous plasma in the inertial and kinetic regimes", Phys. Plasmas 18, 092903 (2011)

D. Tsiklauri, "Three dimensional particle-in-cell simulation of particle acceleration by circularly polarised inertial Alfven waves in a transversely inhomogeneous plasma", Phys. Plasmas 19, 082903 (2012)

E. Kontar et al., "Wave-particle interactions in non-uniform plasma and the interpretation of hard X-ray spectra in solar flares", AA 539, A43 (2012)

R. Pechhacker, D. Tsiklauri, "Collisional particle-in-cell simulation of electron acceleration by Langmuir waves in an inhomogeneous plasma in the context of solar flares", Phys. Plasmas, in preparation (2013)