Langmuir turbulence in the solar wind : numerical simulations

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Observations performed in the solar wind by different satellites show that electron beams accelerated in the low corona during solar flares can propagate up to distances around 1 AU, that Langmuir waves' packets can be clumped into spikes with peak amplitudes three orders of magnitude above the mean and that the average level of density fluctuations in the solar wind plasmas can reach several percents. A Hamiltonian model is built describing the properties of Langmuir waves propagating in a plasma with random density fluctuations by the Zakharov's equations and the beam by means of particles moving self-consistently in the fields of the waves. Numerical simulations, performed using parameters relevant to solar type III conditions at 1 AU, show that when the average level of density fluctuations is sufficiently low, the beam relaxation and the wave excitation processes are similar to those in a homogeneous plasma and can be described by the quasilinear equations of the weak turbulence theory. On the contrary, when the average level of density fluctuations overcomes some threshold depending on the ratio of the thermal velocity to the beam velocity, the plasma inhomogeneities crucially influence on the characteristics of the Langmuir turbulence, the wave-particle interactions and the beam dynamics. In this case, fluxes of accelerated particles are observed, whose density and kinetic energy are calculated as a function of the beam and plasma characteristics. Langmuir waveforms are presented in the form they would appear if recorded by a satellite moving in the solar wind. Comparison with recent measurements by the STEREO and WIND satellites shows that their characteristic features are very similar to the observations. Moreover, wave-wave coupling and three wave decay processes are studied as a function of the average level of plasma density fluctuations.