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PIC simulations of electromagnetic emissions by solar radio bursts: a study of polarization characteristics of radiated waves

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Electromagnetic waves emitted in the solar wind and corona during type III solar radio bursts are studied owing to data provided by PIC simulations computed using the 2D/3V version of the code SMILEI. In a 2D simulation box modeling a plasma with random density fluctuations of average level ΔN of several percent of the ambient plasma, an electron beam generates Langmuir wave turbulence which in turn radiates electromagnetic waves at the plasma frequency and its harmonics. Several challenging tasks have to be achieved simultaneously : (i) to reduce the numerical noise below ΔN, (ii) to use a box involving both electrostatic and electromagnetic scales, and (iii) to compute very long time series of fields and densities in order to identify the low frequency waves participating in the processes of electromagnetic wave generation.
Nowadays, there is a growing interest in the polarization characteristics of electromagnetic emissions, which are crucial for understanding the processes generating them and diagnosing the solar wind and coronal plasmas. The conducted research consists in modeling virtual satellites moving in a 2D simulation box and recording waveforms of fields and particle densities. Several methods to analyze the waveforms recorded have been implemented, tested, used and compared, enabling us to identify the wave modes emitted (in particular, the electromagnetic waves emitted at frequencies ω_p and $2\omega_p$) and to determine their polarization characteristics (sense and ellipticity). Statistical studies using 256 virtual satellites have been performed to determine the distributions of ellipticity as a function of time, as well as of magnetic field amplitude and average level of density fluctuations of the ambient plasma. Results obtained show a good agreement with space observations.

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