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Small-scale Inhomogeneity Effects on Coherent Solar Radio Emission

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The coherent radio emission mechanism of solar radio bursts (SRBs) is one of the most complicated and controversial topics in solar physics. To clarify the mechanism(s) of different types of SRBs, (radio-) wave excitation by energetic electrons in homogeneous plasmas has been widely studied via particle-in-cell (PIC) code numerical simulations. The solar corona is, however, inhomogeneous over almost all spatial scales. Due to the kinetic nature of SRBs, small-scale inhomogeneities in the plasma could influence the excitation and emission properties of SRBs. In this paper, we thus investigate the effects of small-scale inhomogeneity (in the magnetic field as well as plasma density or temperature) of plasmas in the solar corona on radio-wave emission by ring-beam distributed energetic electrons utilizing 2.5-dimensional PIC simulations. The typical length scale of the small-scale inhomogeneity we consider in this study is on the order of the proton gyroradius. Both beam and electron-cyclotron maser instabilities can be triggered with the presence of energetic ring-beam electrons. The resultant spectrum of the excited electromagnetic waves presents a zebra-stripe pattern in the frequency space. The inhomogeneous density or temperature in plasmas influences the frequency bandwidth and location of these excited waves. Our results can hence help to diagnose the plasma properties at the emission sites of SRBs. Applications of our results to SRBs with a zebra-stripe pattern are discussed.

References

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