Type II Radio Bursts and Related Emissions from Shock-Accelerated Particles

Urs Ganse^(1,2), Felix Spanier ⁽²⁾, and Rami Vainio⁽³⁾ (1) University of Helsinki, Finland (2) North-West University Potchefstroom, South Africa (3) University of Turku, Finland

Solar Type II radio bursts are transient radio phenomena occurring in connection with heliospheric shock propagation. Assumed to be a byproduct of electron acceleration at shocks, Type II bursts are an important signature of shock propagation, and one of the few remotemeasurement quantities available to space weather prediction. The characteristic spectral shape of these bursts show a fundamental (at the local ω_p) and one harmonic emission band (at $2\omega_p$), drifting towards lower frequencies as the emission region propagates outwards from the sun, into regions of decreasing plasma frequency.

While analytic theories of the emission processes through nonlinear plasma wave interaction have been around since the early 70ies, confirmation of these posed an immense problem: due to the pointwise nature of satellite measurements, only insufficient data of the participating plasma waves could be obtained observationally, and the numerical obstacles of full-fledged kinetic plasma simulations made exploration from that domain difficult.

Now, with recent advances in kinetic plasma simulation codes and simultaneous growth in computing power, we have created a simulation model that self-consistently recreates the microphysical processes leading to Type II radio burst emission. Using the ACRONYM particle-in-cell code, both electrostatic wave generation from electron beams and their subsequent nonlinear interaction to create electromagnetic emission is modeled.

Results from these simulations show that parametric decay and coalescence of generalized Langmuir waves appears to indeed be the emission process of these bursts. Furthermore, our model predicts that only regions with counterstreaming electron beams are kinematically able to create the two-banded emission morphology commonly observed in Type II bursts.

Further studies of the effects of different electron beam distribution functions on the resulting radio emissions are now underway, with the aim of identifying further diagnostic quantities that can be derived from the radio spectra.