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Microwave and hard X-ray emission from solar flares: comparison of theory and observations for a few flares

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Abstract

During solar flares, a large number of electrons are accelerated up to subrelativistic and relativistic energies. Those electrons then produce electromagnetic radiation in a broad wavelength range. Such types of emission as hard X-ray emission (which is produced due to thick-target bremsstrahlung) and microwave emission (which is produced mainly due to incoherent gyrosynchrotron mechanism, at the frequencies $\gtrsim 5$ GHz) are considered to be the best diagnostic tools for the solar energetic electrons. Analysis of simultaneous microwave and X-ray observations is of special interest because it is able (potentially) to provide us with complementary information about the parameters of the accelerated electrons and about the conditions in the active regions. However, interpretation of simultaneous microwave and X-ray observations meets some difficulties now. In particular, a number of accelerated electrons inferred from the different observations can differ considerably (microwaves require much more particles than X-rays do). In our opinion, this is because most of investigators neglect the anisotropy of the electron distributions in the corona.

In this work, we perform a combined analysis of the microwave and hard X-ray observations for a few flares. The distribution functions of the accelerated electrons are obtained by solving the kinetic (Fokker-Planck) equation. In the kinetic simulation, we consider such factors as the particle collisions, convergence of the magnetic field, and return current. Parameters of microwaves and X-rays are calculated using the exact expressions (without approximations). We show that in such a case the same electron beams can account for the observed emission in the different spectral ranges. We estimate the parameters of the accelerated particles for the considered events.