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Title:

What can we learn about the acceleration and transport of relativistic electrons from solar microwave observations?

Abstract:

In this review talk we will discuss how modern radio instruments, theoretical modelling, and numerical simulations can be used for studying the physics of acceleration and transport of relativistic electrons in solar flares.

The well known Nobeyama Radioheliograph (NoRH), Siberian Solar Radio Telescope (SSRT), and Owens Valley Solar Array (OVSA) can take images of flares and flaring loops with relatively high spatial resolution (~5-20 arcsec), and with good time resolution (~0.1-1 s). In recent years, these capabilities allowed us to discover very interesting and unexpected phenomena like: a) bright microwave sources in the loop top where the magnetic field is weakest in a flare loop, b) frequency spectral index dependence on position along a loop, c) ordinary mode emission from some parts of a loop, d) shrinkage and expansion of microwave loops, and others. These observational properties have stimulated developments of theoretical and numerical simulation tools such as the codes for: a) modeling the dynamics of various electron distributions along a loop on the base of nonstationary Fokker-Plank kinetic equation; b) fast gyrosynchrotron emission calculations on the base of general expressions of emission and absorption coefficients; c) calculations of spatial distributions of microwave characteristics in magnetic loops (GX-simulator). In its turn, the development of these codes made it possible to elaborate new automated methods for the microwave diagnostics of emitting electrons using the forward fitting with various algorithms of parameters recovering (simplex, genetic, etc).

Utilization of the above mentioned tools give the possibility to determine the following parameters of accelerated relativistic electrons: position of the acceleration/injection site in a flaring loop, their number density, energy spectrum, and even the pitch-angle distribution in different parts of a magnetic loop. However, to provide sufficient precision of the diagnostics we need new instruments with at least the same spatial resolution as NoRH but with much better spectral covering (similar to OVSA) and the ability of polarization measurements in the whole microwave frequency range. The forthcoming brand new Chinese Spectral Radio Heliograph, Radioheliograph Badary, and Expanded Owens Valley Solar Array fit well to these requirements and we hope they will open a new era in solar radio physics.