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Drift-kinetic modeling of particle acceleration and transport in solar flares

Takashi Minoshima

Solar-Terrestrial Environment Laboratory, Nagoya University

Satoshi Masuda

Solar-Terrestrial Environment Laboratory, Nagoya University

Yoshizumi Miyoshi

Solar-Terrestrial Environment Laboratory, Nagoya University

Abstract. It is evident from many observations such as hard X-rays, microwaves, and gamma-rays, that a large fraction of energy is expended for the production of non-thermal particles in solar flares. However, a mechanism for producing these particles is not well understood yet. The aim of this study is to theoretically understand the particle acceleration and transport processes in the flare.

In the solar corona, the temporal and spatial scales of particles are much smaller than the flare scale, due to the strong magnetic field strength. Therefore it is a good approximation to apply a guiding-center approach (drift kinetics) to describe the particle dynamics in a flaring region. We perform a numerical simulation of the drift-kinetic Vlasov equation, to model the variation of the particle distribution function in association with the evolution of electromagnetic fields in flares.

From the simulation, we find two distinct mechanisms of particle acceleration. One is the betatron acceleration taking place at the apex of closed loops, which enhances particles perpendicular to magnetic field lines. The other is the inertia drift acceleration taking place in open field lines, which produces upward particles from the Sun. The former may be a candidate for producing loop-top hard X-ray and microwave emissions, and the latter be an origin of escaping particles observed in the interplanetary space.