Electron Dynamics in 3D Coronal Magnetic Reconnection Regions

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The presented work focuses on the acceleration mechanism of non- thermal electrons in 3D magnetic reconnection regions of an active solar region in a pre-flare phase and on a coronal hole region producing a solar jet. Magnetohydrodynamics is a suitable theory for describing the solar plasma motion macroscopically. However, in order to investigate particle kinetics, a microscopic particle tracing method is needed to specify the motion of single particles in a self-consistent electromagnetic field. One numerical kinetic approach is a Particle-In-Cell simulation (PIC). The numerical plasma description of MHD and PIC methods are joined in the presented research, introducing one of the first models successfully interconnecting microscopic and macroscopic scales. Although this technique is still in the early stages of development and heavy numerical constraints limit the parameter choice, it provides a new numerical tool for investigations of systems covering a vast range of scales.
Making use of this new method combined with large numerical simulations of the solar atmosphere with a realistic magnetic field topology, particle acceleration up to non-thermal velocities is found to be caused by a systematic, slowly evolving electric field that builds up at the current sheet that separates two different magnetic connectivity domains.