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Particle acceleration in magnetic islands by the resonance pumping occurring in the ripple of the heliospheric current sheet

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Crossings of the heliospheric current sheet (HCS) at the Earth's orbit are often associated with observations of anisotropic beams of energetic protons accelerated to energies from hundreds of keV to several MeV and above. A connection between this phenomenon and the presence of small-scale magnetic islands (SMIs) with sizes of $\sim$0.01-0.001 AU or less near reconnecting current sheets has recently been found (Khabarova et. al, ApJ, 2015, 2016) and mechanisms for particle acceleration by dynamical magnetic islands have been proposed (Zank et al. ApJ, 2014, 2015; le Roux et al. ApJ 2015, 2016, 2018). We suggest another mechanism that shows how particles can be energized by oscillations of multiple SMIs inside a ripple of the reconnecting HCS. A model of the electromagnetic field of an oscillating 3D SMI with a characteristic size of $\sim$0.001 AU is developed. A SMI is bombarded by protons pre-accelerated by magnetic reconnection to energies of the order of keV to tens of keV. Numerical calculations have demonstrated that the resulting longitudinal inductive electric fields can additionally accelerate protons. There is a local "acceleration" area within a SMI in which by particles gain the energy most effectively. As a result, their average escape energies range from hundreds of keV to 2 MeV and above. Low-energy particles are accelerated more effectively than high-energy and all escaping particles reach the total energy limit. The velocity of escaping particles has a strong spatial anisotropy. The results are consistent with observations in the solar wind.
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