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Nonthermal particle accelerator of magnetic reconnection

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The nonthermal particle acceleration during magnetic reconnection has remained a fundamental topic in many astrophysical phenomena such as solar flares, pulsar wind, and magnetars and so on for more than half a century, and one of the unresolved questions is the efficiency of the nonthermal particle acceleration. Recently, nonthermal particle acceleration mechanisms during reconnection have been extensively studied by particle-in-cell simulations and hybrid simulations, yet it is an intriguing enigma as to how the magnetic field energy is divided into the thermally heated plasmas and the nonthermal particles. Here we study both non-relativistic and relativistic magnetic reconnections using a large-scale particle-in-cell simulation for a pair plasma, and show that the production of the nonthermal particle becomes efficient with increasing the plasma temperature. In the relativistic hot plasma case, we find that the heated plasmas by reconnection can be approximated by a kappa distribution function with the power-law index of about 2, and the nonthermal energy density of reconnection reaches about more than 95% of the total heated plasma.

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