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Relativistic electron injection acceleration in laser-driven magnetic reconnection plasmas

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Magnetic reconnection (MR) is a fundamental plasma process in which regions of oppositely directed magnetic field merge, leading to the conversion of magnetic energy into high speed flows, thermal energy and accelerating particles. Acceleration of particles during MR has become a hot topic in recent years. However what, where and how those accelerated particles are generated are still not well understood. Here we report, using a millimeter plasma device, that, successfully forming a low $\beta \sim 0.03$ (the ratio between the thermal pressure and the magnetic pressure) MR, significant non-thermal electrons are generated, which shows a typical power law and the spectral indices is ~ 1.17 much flatter than those of laser driven high β MR. We also firstly obtained a Gaussian-like MeV electron bump at high energy tail. Combining the experimental results on optical shadows, X-ray self-emissions, and proton radiographs, together with simulations, the process of electron acceleration during MR is clearly described and shows potential applications in development of electron accelerator with optional energy and understanding of the strong particle energization in solar flares and accretion disk coronae et al.

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