Strong energy enhancement in a laser-driven magnetic channel through radiation reaction

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A high intensity laser pulse can propagate through a classically overdense plasma while generating a channel structure with a strong quasi-static azimuthal magnetic field in the relativistic transparency regime. This azimuthal magnetic field can significantly enhance the energy gain by laser-accelerated electrons, but this requires a sufficiently strong longitudinal electric current [arXiv:1811.00425]. For the plasmas irradiated by the multi PW laser pulse, one might expect that the inclusion of the radiation reaction effect at higher intensities could make the restriction on the current even more severe. However, counterintuitively, the radiation reaction allows the electrons to enter an otherwise inaccessible regime of acceleration. As a result of the radiation reaction, the energy of the laser-accelerated electrons is enhanced by orders of magnitude, as the laser generates a well-collimated beam of energetic electrons and gamma-rays [Sci Rep 9, 17181 (2019)]. Our results suggest that this effect could be accessible at next-generation laser facilities.

Keywords: Quasi-static magnetic field; Radiation reaction; Electron acceleration