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P1.2010 Effects of Coulomb collisions in solid-density laser plasma shocks

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Kinetic shocks in laser-plasmas provide a promising acceleration scheme to produce highly mono-energetic ion beams [1, 2, 3]. The modeling of such setups often neglects Coulomb collisions due to the short time scales of the kinetic processes involved. However, previous results suggest at that collisions might qualitatively affect the behavior of shocks in solid density targets [4], even though the dynamics remains largely governed by collisionless physics.
We investigate the effect of Coulomb collisions on laser-plasma shocks in solid density targets. In particular, we study how collisions affect the laser energy absorption and the ion acceleration. We use the PIC code Smilei [5], which has a relativistic binary collision module [6]. We mainly consider targets containing protons and a heavier ion species in comparable concentration.
In the cases considered, we find that collisions can increase the laser energy absorption by up to 40 % compared to the same setup without collisions. We analyze how a significant collisional scattering of electrons modify previously studied collisionless absorption processes, such as standing wave acceleration [7], leading to higher absorption. The additional absorbed energy leads to a significant increase in the electron temperature, providing a boost to the shock wave amplitude and the propagation speed. The energy of the shock accelerated protons increases by 50-70 % while the accelerated proton yield is not reduced. As expected from the strong charge dependence of collisions with high-charge ions, the ion composition has a major impact on the collisional processes. Besides the increased collisionality, the presence of heavy ions also increase the fraction of reflected ions in accordance with previous results [8].

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