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Ion acceleration through radiation pressure in quanto-electrodynamical regimes

DARIO DEL SORBO, CHRIS RIDGERS, University of York, LASER PLASMAS FUSION TEAM — The strong radiation pressure carried by high-intensity lasers interacting with plasmas can accelerate ions over very short distances. The resulting compact particle accelerator could find applications in medical physics (radiotherapy) as well as in fundamental physics (hadron interactions). With next-generation multi-petawatt lasers, reaching focused intensity $\sim 10^{23}$ Wcm^{-2}, ions could potentially reach GeV energies. However, the physics of laser-matter interactions at these extreme intensities is not well understood. In particular, on acceleration by the electromagnetic fields of the laser, the electrons in the plasma start to radiate hard photons prolifically. These hard photons can decay to electron-positron pairs, a cascade of pair production can ensue leading to the formation of an over-dense pair plasma which can absorb the laser-pulse. We have developed a self-consistent theory for both hole boring and light sail radiation pressure ion-acceleration, accounting for radiation-reaction and pair-creation. We show that the key role is played by a pair plasma that arises between the laser and the accelerated ions, strongly modifying the laser absorption.

Dario Del Sorbo
University of York

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