Narrow-band, GeV gold ion beams from ultra-thin foils irradiated by intense sub-picosecond pulses

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Narrow energy band bunches of ions were produced from the interaction of intense (>10^{20} W/cm^2), sub-picosecond-duration laser pulses with ultra-thin (15 nm) gold foils. These included the bulk target species, in particular the Au ions which are accelerated with spectral peaks centred at 1.5 GeV and with fluxes on the order of 10^{12} particles per steradian, far surpassing Au ion fluxes reported by previous works by orders of magnitude [1,2]. 2D particle-in-cell simulations show a complex interplay between different acceleration mechanisms at different stages of interaction, suggesting the Au bunches stem from strong radiation pressure acceleration on a heavy-ion dominant plasma in the moments just before transparency, followed by an efficient acceleration due to transparency-enhanced mechanisms. We show that this effect is scalable to future multi-PW systems, where Au ion bunches at energies of several GeV are feasible.

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