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Cascaded acceleration of highly energetic carbon ions by single femtosecond laser pulses and nanotargets

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It is demonstrated in experiments and simulations that radiation pressure acceleration (RPA) and sheath acceleration of ions can be automatically cascaded in sequence when a single n ultraintense femtosecond laser pulse is focused on a double-layer target composed of well controlled, slightly underdense plasma and ultrathin foil. We reveal that such cascaded acceleration is especially suited for heavy ion acceleration with femtosecond lasers by combining the merits of RPA and sheath acceleration. At optimal condition, carbon ions with energy per nucleon up to 48 MeV/u were generated with pulse energy of 9.2 J on targets. With the spreading of petawatt laser systems all over the world, laser-based heavy ion sources employing this scheme may trigger significant advances in nuclear physics, high energy density physics, and medical physics.

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