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An Analytical Model Connecting Spectral Multi-Species Modulations with Microscopic Electron-Properties in PW-Class Laser-Ion Acceleration AXEL HUEBL, LBNL (Berkeley, USA), previously HZDR (Dresden, Germany), MARTIN REHWALD, HZDR, TU Dresden (Dresden, Germany), LIESELOTTE OBST-HUEBL, LBNL, previously HZDR, TIM ZIEGLER, MARCO GARTEN, HZDR, TU Dresden, RENE WIDERA, KARL ZEIL, HZDR, THOMAS E. COWAN, HZDR, TU Dresden, MICHAEL BUSSMANN, HZDR, ULRICH SCHRAMM, HZDR, TU Dresden, THOMAS KLUGE, HZDR — Spectral signatures of laser-accelerated ion beams are frequently used to characterize underlying acceleration mechanisms. Yet regularly, more than just one ion species are accelerated in experiments, e.g. from hydro-carbon contamination layers, multiple charge states or mixed materials. Such presence of multiple ion species (q/m) in the accelerating field leads to characteristic modulations in observed proton spectra due to electro-static repulsion during co-propagation. Resulting typical spectral modulations from these effects are presented with an analytical model for PW-class laser-ion acceleration. We improve previous predictions with explicit multi-species interaction for arbitrary mixtures, enabling us to connect important ensemble properties of laser-accelerated electrons with spectral signatures of accelerated ions. We support our new model with extensive particle-in-cell simulations and propose an experimental implementation with a novel cryogenic target, allowing systematic verification of our predictions in an environment without the strong influence of hardly controllable processes such as ionization dynamics.

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