Super-Heavy Ions Acceleration Driven by Ultrashort Laser Pulses at Ultrahigh Intensity

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The acceleration of super-heavy ions (SHIs, mass number ~ 200) from plasmas driven by ultrashort (tens of femtoseconds) laser pulses is a challenging topic awaiting a breakthrough. Here, we report the experimental results on the generation of deeply ionized super-heavy ions (Au) with unprecedented energy of 1.2 GeV [1] utilizing ultrathin targets and ultrashort laser pulses at an intensity of 10^{22} W/cm^2. A novel self-calibrated diagnostic method was developed to acquire the absolute energy spectra and charge-state distributions of Au ions abundant at the charge state of 51+ and extending to 61+. The measured charge-state distributions supported by 2D particle-in-cell simulations serve as an additional tool to inspect the ionization dynamics associated with SHI acceleration, revealing that the laser intensity is the crucial parameter over the pulse duration for Au acceleration. Achieving a long acceleration time without sacrificing the strength of the acceleration field by utilizing composite targets [2] can substantially increase the maximum energy of Au ions.

References

[1] P. J. Wang, Z. Gong, S. G. Lee et al. *Phys. Rev. X.* Accepted (2021)

[2] P. J. Wang, G. J. Qi, Z. Pan et al. *High Power Laser Sci. Eng.* Accepted (2021)