# Advances in Laser Driven Ion Acceleration

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Laser-driven ion acceleration is conceived to be one of the main applications of many powerful laser facilities that are being projected, built, or already in operation around the world. It opens a way for a future new generation of compact accelerators providing high-quality ion beams for many applications in medicine, industry, science and others. Several acceleration methods, including target normal sheath acceleration (TNSA), shock wave acceleration (SWA), and radiation pressure acceleration (RPA), have been proposed and identified in experiments. However, so far, the obtained ion beams have not achieved the required high qualities yet, such as high energy, narrow energy spread, large particle number, etc. RPA is in principle regarded as the most promising scheme, nevertheless, it currently meets the great challenge: the dramatic growth of the multi-dimensional instabilities that lead to premature break of the effective acceleration and destruction of the beam quality [1]. In this talk, I shall give an overview of recent advances in study of laser-driven ion acceleration at Peking University (PKU) [2, 3, 4, 5]. In particular, I shall report our recent progresses in theoretical and numerical studies on stabilization of laser-driven ion RPA [2, 3]. A novel dynamic stabilization scheme to achieve stable RPA of ions from laser-irradiated ultrathin foils is proposed, where a high-Z material coating in front is used. The coated high-Z material, acting as a moving electron repository, continuously replenishes the accelerating foil with comoving electrons in the light-sail stage due to its successive ionization under laser fields with Gaussian temporal profile. As a result, the detrimental effects such as foil deformation and electron loss induced by the Rayleigh-Taylor-like and other instabilities are significantly offset and suppressed so that stable RPA of ions are maintained. Three-dimensional PIC simulations show that a monoenergetic $\mathrm{Al}^{13+}$ beam with peak energy 3.8GeV and particle number $10^{10}$ (charge $> 20$nC) can be obtained at intensity $10^{22}\mathrm{W/cm^2}$. Experimental verification of this novel scheme is planned on Petawatt laser facilities in China.

## References

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