

# Collisionless Shock Acceleration of High-Flux Quasimonoenergetic Proton Beams Driven by Circularly Polarized Laser Pulses

Baifei Shen<sup>1,2</sup>, Hui Zhang<sup>2</sup>, Wenpeng Wang<sup>2</sup>, Jiancai Xu<sup>2</sup>, Shuhua Zhai<sup>2</sup>, Ruxin Li<sup>2</sup>, and Zhizhan Xu<sup>2</sup>

<sup>1</sup> Department of Physics, Shanghai Normal University, Shanghai 200234, China.

<sup>2</sup> State Key Laboratory of High Field Laser Physics, Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences, P. O. Box 800-211, Shanghai 201800, China.

Experiments for laser driven proton acceleration were carried out by using the femtosecond petawatt laser system at Shanghai Institute of Optics and Fine Mechanics (SIOM), Chinese Academy of Sciences (CAS). With an overdense plasma produced by the laser prepulse ionizing an initially ultrathin plastic foil, proton beams with narrow spectral peaks at energies up to 9 MeV, and with fluxes of as high as  $\sim 3 \times 10^{12}$  protons/MeV/sr which is increased by two orders of magnitude compared with previous experimental results, were observed. Two-dimensional particle-in-cell simulations reveal that collisionless shocks are efficiently launched by circularly polarized lasers in exploded plasmas, resulting in a narrow energy spectrum. [1] A highly-collimated argon ion beam with narrow energy spread is produced by irradiating a 45-fs fully-relativistic laser pulse onto an argon cluster target. The argon ions get pre-accelerated from Coulomb explosion and then the laser-driven intense plasma wakefield has a strong modulation on the ion beam in a way that the low energy part is cut off. The optimum and controllable two-stage proton acceleration was realized for the first time by a novel double beam image (DBI) technique in experiment. Two laser pulses are successfully tuned on two separated foils with both spatial collineation and time synchronizing, resulting in spectrum tailoring and an energy increase at the same time. Laser acceleration with 100 PW laser [2] and Laser-driven ultrafast antiproton beam [3] are also discussed.

## References

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2. Baifei Shen et al., Exploring vacuum birefringence based on a 100 PW laser and an x-ray free electron laser beam, Plasma Phys. Control. Fusion 60, 044002(2018).
3. Shun Li, Zhikun Pei, Baifei Shen et al., Physics of Plasmas 25, 023111 (2018).