



2nd Asia-Pacific Conference on Plasma Physics, 12-17, 11.2018, Kanazawa, Japan

Experimental investigations on wakefield acceleration and induced Compton scattering in laser produced plasmas with extremely high brightness temperature

Y. Kuramitsu^{1,2}, S. J. Tanaka³, T. Moritaka⁴, Y. L. Liu⁵, T. H. Huang⁵, C. W. Peng⁵, T. Y. Huang⁵, N. Khasanah⁵, S. H. Chen⁵, C. H. Chen⁵, Y. L. Chang⁵, Y. S. Hsieh⁵, S. C. Liu⁵, H. H. Chu⁵, J. P. Wang^{5,6}, C. S. Jao⁷, L. N. Hau⁸, L. Doehl⁹, N. Woolsey⁹, Y. Hara², M. Ota², R. Kumar², Y. Sakawa², Y. Fukuda¹⁰, H. Takabe¹¹, M. Koenig^{12,13}, Y. Nariyuki¹⁴, R. Yamazaki³, P. Chen^{15,16}, and M. Hoshino¹⁷

¹ Graduate School of Engineering, Osaka University, Suita

² Institute of Laser Engineering, Osaka University, Suita

³ Department of Physics and Mathematics, Aoyama Gakuin University, Sagami-hara

⁴ Department of Helical Plasma Research, National Institute for Fusion Science, Toki

⁵ Department of Physics, National Central University, Taoyuan

⁶ Institute of Atomic and Molecular Science, Academia Sinica, Taipei

⁷ DESY, Zeuthen

⁸ Graduate Institute of Space Science, National Central University, Taoyuan

⁹ York Plasma Institute, Department of Physics, University of York, York

¹⁰ Kansai Photon Science Institute, National Institutes for Quantum and Radiological Science and Technology, Kizugawa, Kyoto

¹¹ Helmholtz-Zentrum Dresden-Rossendorf, Dresden

¹² Laboratoire pour l'Utilisation des Lasers Intenses, UMR 7605, CNRS - CEA - Université Paris VI - Ecole Polytechnique, Palaiseau Cedex

¹³ Institute for Academic Initiatives, Osaka University, Suita

¹⁴ Faculty of Human Development, University of Toyama, Toyama

¹⁵ Leung Center for Cosmology and Particle Astrophysics & Department of Physics, and Graduate Institute of Astrophysics, National Taiwan University

¹⁶ Kavli Institute for Particle Astrophysics and Cosmology, SLAC National Accelerator Laboratory, Stanford University, California

¹⁷ Department of Earth and Planetary Science, the University of Tokyo, Tokyo
e-mail: kuramitsu@eei.eng.osaka-u.ac.jp

Nonthermal energetic particles in the universe or cosmic rays have been extensively investigated in space physics, astrophysics, and plasma physics, yet the origins of ultra-high energy cosmic rays have been an open problem so far. They are believed to be extra-galactic origins, and one of the possible candidates is wakefield acceleration due to the precursor electromagnetic (light) waves in the relativistic astrophysical shocks [1]. In the purely stochastic process or turbulent wakefield, it is predicted that an energy distribution function of accelerated particles is power-law with an index of -2 [2]. This has been numerically verified, and it universally produces power law spectra with an index of -2 independent of the light and plasma parameters [3]. Using Gekko PW laser system we have experimentally shown that the large amplitude light pulse with large spatial scale compared with the plasma wavelength can produce power law tails in the energy distribution functions independent of plasma density, yet there were only three shots [4, 5]. Numerical simulations of relatively coherent cases show the injection of electrons into the wakefield due to the radiation pressure of local

magnetic field excited by the Weibel instability [6], the relativistic harmonics can be used to identify the local plasma structures [7]. We have performed the turbulent wakefield experiment using 100 TW laser facility at National Central University in Taiwan [8].

Another possible candidate for the high energy electron acceleration is the induced Compton scattering with extremely high brightness temperature, such as pulsar radiations [9]. We model the extreme condition with an intense laser. We will show the first experimental evidence of the induced Compton scattering in the extreme conditions.

References

- [1] Hoshino, ApJ, 672, 940, 2008
- [2] Chen et al., PRL, 89, 161101, 2002
- [3] Kuramitsu et al., ApJL, 682, L113, 2008
- [4] Kuramitsu et al., PoP, 18, 010701, 2011
- [5] Kuramitsu et al., PRE, 83, 026401, 2011
- [6] Liu, Kuramitsu et al., PoP, 25, 013110, 2018
- [7] Kuramitsu et al., HEDP, 23, 6, 2017
- [8] Kuramitsu et al., HEDP, 17, 198, 2015
- [9] Tanaka et al., PTEP, 073E01, 2015