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

Theoretical and experimental studies on THz radiation via two-color laser scheme

Wei-Min Wang[1], Zheng-Ming Sheng[2], Yutong Li[1], Jie Zhang[2]
[1] Institute of Physics, CAS, Beijing 100190 [2]Key Laboratory for Laser Plasmas (MoE)
Shanghai Jiao Tong University,Shanghai 200240
e-mail (speaker): hbwwm1@iphy.ac.cn

Strong broadband terahertz (THz) radiation sources are in high demand in THz spectroscopy and THz-field matter interactions. The widely studied two-color laser scheme [1] can provide such THz sources with field strengths up to multi MV/cm [2]. In this scheme, the frequency ratio of the two laser pulses is fixed at ω_2/ω_1 =1:2. Recently, whether this scheme can be extended to other frequency ratios has become a hot issue [3-5]. Among them, our two theoretic reports [3,5] have predicted that THz radiation can still be generated with some new frequency ratios ω_2/ω_1 =1:4, 2:3, etc.

We present the first experimental demonstration [6] of efficient THz generation with these new frequency ratios. We scan the ω_1-laser wavelength with the ω_2-laser wavelength fixed and observe that the THz energies have three resonant-like peaks located near ω_2/ω_1 = 1:4, 1:2, and 2:3, where the energies at these peaks are at the same order. We observe the THz polarization can be adjusted by rotating the longer-wavelength laser polarization and the polarization adjustment becomes inefficient by rotating the polarization of the other laser with shorter wavelength. This phenomenon agrees with a fourth-power law of the laser wavelength, which is derived by us.

Our investigation [6] also provides a new dimension to explore the THz-generation mechanism. Our experimental results contradict with multi-wave mixing theory, which is one of two main models to explain the THz-generation mechanism under two-color laser excitation. This theory predicts that THz yield obeys different scaling laws with different frequency ratios, but we observe similar scaling. On the other hand, this observation agrees with the other model: plasma-current or gas-ionization model [7-9].

References

[1]J. Cook and R. M. Hochstrasser, Opt. Lett. 25, 1210 (2000).
[2]M. Clerici, M. Peccianti, B. E. Schmidt et al., Phys. Rev. Lett. 110, 253901 (2013).
[3]W.-M. Wang, Y.-T. Li, Z.-M. Sheng, X. Lu, and J. Zhang, Phys. Rev. E 87, 033108 (2013).
[4]V. Kostin, I. Laryushin, A. Silaev, and N. Vvedenskii, Phys. Rev. Lett. 117, 035003 (2016).
[5]W.-M. Wang, Z.-M. Sheng, Y.-T. Li, Y. Zhang, and J. Zhang, Phys. Rev. A 96, 023844 (2017).
[6]L.-L. Zhang, W.-M. Wang, T. Wu et al., Phys. Rev. Lett. 119, 235001 (2017).
[7]K. Y. Kim, J. H. Glownia, A. J. Taylor, and G. Rodriguez, Opt. Express 15, 4577 (2007).
[8]W.-M. Wang, Z.-M. Sheng, H.-C. Wu et al., Opt. Express 16, 16999 (2008).
[9]W.-M. Wang, P. Gibbon, Z.-M. Sheng, and Y.-T. Li, Phys.Rev. Lett. 114, 253901 (2015).