Using Relativistic Mirrors for Photon-Photon Scattering

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An upper bound limit for the photon-photon scattering cross section at relatively low photon energies of 6.5 keV has been obtained which is 20 orders of magnitude higher than the predicted QED cross section [1]. This large discrepancy can be mainly attributed to the smallness of the cross section and the resulting need for high photon fluxes. Laser (source) pulses can be upshifted and sharply focused via the double Doppler effect using relativistic mirrors generated by a counter-propagating high intensity laser (driver) pulse propagating in plasma [2]. We have previously theoretically estimated the possibility of measuring photon-photon scattering in the range of 100-ev to keV using various types of relativistic mirrors in the limit of low source pulse intensity [3]. Here, we use particle-in-cell simulations to show that even high intensity source pulses can be upshifted and sharply focused by relativistic mirrors generated by a counter-propagating driver pulse. At high source pulse intensities boosted harmonics are also observed. We will estimate the necessary laser parameters to observe photon-photon scattering and show whether such a source generated by relativistic mirrors could be used in the study of the basic properties of vacuum such as photon-photon scattering and pair creation.

[1] T. Yamaji, T. Inada, T. Yamazaki, et al., “An experiment of X-ray photon–photon elastic scattering with a Laue-case beam collider,” *Phys. Lett. B* **763**, 454 (2016).

[2] S.V.Bulanov,T.Zh.Esirkepov,M.Kando, et al., “Relativistic mirrors in plasmas. Novel results and perspectives,” *Phys.Usp.* **56**, 429 (2013).

[3] J. K. Koga, S. V. Bulanov, T. Zh. Esirkepov, et al., “Possibility of measuring photon-photon scattering via relativistic mirrors,” *Phys. Rev. A* **86**, 053823 (2012).