Anomalous Nonlinear Compton Scattering in the X-Ray Regime

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The nonlinear Compton scattering has been one of the most thoroughly analysed strong-field phenomenon, whose study started already immediately after the invention of the laser [1-2]. On the other hand, by now, there have been only few direct measurements of high-harmonic generation by free electrons. Recently the second harmonic of X-ray radiation (of incoming photon energy around 10 keV) has been observed in Compton scattering of a high-power free-electron laser beam (of about 10E21 W/cm2 intensity) impinging on beryllium targets [3-4]. An unexpectedly large red-shift (of almost 2 keV) of this spectral component has been observed, in addition to the expected Compton shift (700 eV). This anomaly cannot be explained by assuming the known possible causes like the well-known intensity-dependent frequency shift (because the intensity parameter is 6x10E-3 in the experiment), the quasi-free property of the electron, or thermal effects. In the present contribution, first we shall review the main features of this anomaly and some attempts for its interpretation. Then, we outline our possible interpretation, relying on the concept of dressed radiation associated to the electron, which may be termed as a sort of escort field of massive photons [5]. In the case of electrons the general formula for the dressing by an arbitrary charged particle [5] yields the invariant mass 9.2632 keV/c2 for such an escort field, which is about 55 times smaller than the electron mass. According to our earlier work on the Dirac electron in a plasma environment [6], the intensity parameter of the electron embedded in a massive photon field should be increased by this same factor, in comparison with the vacuum value. On the basis of this consideration we show that the excess contribution to the red-shift in X-ray Compton scattering can be substantially larger than the one coming out from the usual Volkov description, and this gives a possible explaination of the measured anomaly.

References

[1] L S Brown and T W B Kibble, Phys. Rev. **133**, A705 (1964)

[2] V I Ritus and A I Nikishov, Works of the Lebedev Physical Institute **111**, 5 (1979), in Russian

[3] M Fuchs, M Trigo, J Chen, *et al.*, Nat. Phys. **11**, 964 (2015)

[4] B Kettle, A Aquila, S Boutet, *et al.*, New J. Phys. **23**, 115008 (2021)

[5] S Varró, Universe **10**, 86 (2024); DOI:10.3390/universe10020086

[6] S Varró, Laser Phys. Lett. **10**, 095301 (2013); arXiv:1305.4370 (2013)