Giant Collimated Gamma-Ray Flashes

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Powerful gamma-ray emissions are ubiquitous in astrophysics, from solar flares [1] to pulsars [2], energetic blazars [3] and neutron star mergers [4]. Here we show that astrophysical-like mechanisms yielding strong gamma-ray emission can be recreated in the laboratory. In fact, when a laser-generated dense ultra-relativistic electron beam interacts with a millimetre-thickness solid conductor, electromagnetic instabilities develop [5] and the ultra-relativistic electrons travel through strong self-generated electromagnetic fields as large as 10^7-10^8 gauss [6]. This results into the production of a collimated gamma-ray pulse with peak brilliance above 10^{25} photons s^{-1} mrad^{-2} mm^{-2} per 0.1% bandwidth, photon energies ranging from 200 keV to GeV, and unprecedented conversion efficiency with up to 60% of the electron beam energy converted into gamma-rays [6]. In addition to their intrinsic interest, these findings pave the way to generating dense electron–positron plasmas for reproducing astrophysical phenomena in the laboratory [7], and to novel investigations in strong-field QED and nuclear physics such as the interaction between real photons in vacuum [8].

References

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