New insights in laser-driven ultra-intense gamma and particle sources for nuclear applications

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Ultra-high intense gamma and secondary particle beams are indispensable tools in many research fields like nuclear, atomic and material science as well as in high-energy density physics research. Especially for nuclear astrophysical applications, ultra-intense and high-flux gamma, neutron and proton beams are necessary to reach astrophysical scenarios in the laboratory. Such ultra-high fluxes of neutrons (in excess of 10^{21} n/(cm^2 s)) are unattainable with existing conventional reactor or accelerator-based facilities. Nowadays, concepts are discussed to generate neutron beams which are based on ultra-high power multi-petawatt lasers operating at $>10^{23}$ W/cm^2 intensities [1]. Laser-driven relativistic electron beams are excellent tools for the generation of MeV gammas and particles. Here, it is presented a novel concept for the efficient generation of gamma and neutron beams based on relativistic laser interactions with a long-scale near critical density plasma at moderate relativistic laser intensities [2]. New experimental insights in laser-driven generation of ultra-intense well-directed multi-MeV beams of photons with fluences of $>10^{12}$ ph/sr and an ultra-high intense neutron source with $>10^{10}$ neutrons per shot are presented [2]. Optimization processes promises an ultra-high neutron fluence of $>10^{11}$ n/cm^2 and corresponding neutron peak-fluxes of $\sim10^{22}$ n/(cm^2 s) already at moderate relativistic laser intensities.

[1] Chen S N and et al 2019 *Matter and Radiation at Extremes* **4** 054402

[2] Günther M M and et al 2020 New insights in laser-generated ultra-intense γ-ray and neutron sources for nuclear applications and science arXiv:2012.10752