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HIGH-BRILLIANCE COMPTON LIGHT SOURCES BASED ON CO2 LASERS

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Inverse Compton scattering (ICS) from relativistic electron beams colliding with laser pulses can be used for relatively compact and affordable x-ray and gamma sources complementing conventional synchrotron light sources (SLSs). Several proposals have been put forward on converting electron accelerators to Inverse Compton Scattering (ICS) gamma sources. Different types of particle accelerators have been considered including superconducting energy recovery linacs (S-ERL) and a synchrotron storage rings. A common approach implies combining e-beams with near-IR solid state lasers operating at multi-megahertz repetition rate inside Fabri-Perot optical cavity.

We evaluate here a complementary method of using a long-wave-IR (LWIR) CO2 gas laser of a novel pulse-burst architecture by examples of perspective ICS sources based on a synchrotron accelerator DA⊠NE and an S-ERL CBETA, each paired either with a near-IR solid state laser or with CO2 gas laser. For each of these schemes, we show that a LWIR laser with its 15 kHz cumulative pulse repetition rate can produce average spectral fluxes and brightness competitive with the approach based on state-of-the-art multi-MHz solid state laser. Simultaneously, the LWIR laser driver will provide about four orders of magnitude higher x-ray peak characteristics. This can be achieved due to considerable increase in acting laser pulse energy, combined with an order of magnitude higher number of laser photons per Joule. Operated at 50-500 keV photon energy with peak brilliances 1020-1021 ph/s-mm2-mrad2-0.1%BW the proposed ICS sources will become indispensable for pump-probe and other ultra-fast material studies that require building up meaningful data sets from a single x-ray pulse at the energy scale of atomic interactions.

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