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Optics in the Relativistic Regime

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Optics has extended the frontier of low energy physics. Here we present the progress in the opposite direction of relativistic intensity regime of optics. With intense and large energy laser, particles may be accelerated to high energies via laser wakefield acceleration (Tajima and Dawson, 1979) over a compact distance orders of magnitude shorter than the RF approach. We should be able to accelerate electrons (over 30m) and ions (over cm) toward TeV with an existing kJ laser. We can check Lorentz invariance in the ultrarelativistic regime. Further, laser allows us to explore the presence of weakly coupling fields such as Dark Matter and Dark Energy with an unprecedented sensitivity. We call this emerging capability as the Laser Particle Physics Paradigm (LP^3).